Abstracts of Presentations

from the

Annual Conference

of the

American Society for Horticultural Science

July 31–August 3, 2012

Miami, Florida

Supplement to *HortScience*
Volume 47(9) September 2012

Contains abstracts of symposia, colloquia, workshops, plus oral and poster presentations from the 2012 ASHS Annual Conference.

A listing of Colloquia, Workshops, Oral, and Poster Sessions by name appears on p. S66

For citation purposes, abstracts should be cited as follows:

(Example)

Kubota, C. and M.A. Kroggel. 2012. Nighttime greenhouse VPD Control for soilless strawberry production in Arizona. HortScience 47(9):S251. (Abstr.)

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Colloquia, Workshop, Oral, and Poster Sessions Listed By Name

Tuesday, July 31 2:00–6:00 PM Chopin

Advances in Breeding Vegetables and Fruits for Enhanced Nutritional Content

Sponsor: Vegetable Breeding (VGBR) Working Group

Moderator: Dilip Panthee

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There is a historical record of crop breeding to alter nutritional components in important world crops. In particular, a body of work describes efforts to systematically change levels of macronutrient pools, such as protein, oil or carbohydrate, especially in agronomic crops, but also in some horticultural crops. More current research efforts have focused on micro-phytonutrients in vegetables and fruits that impart some health promoting effect when consumed. As the world population continues to increase and food demand increases in parallel, there will be a continuous need to monitor nutritional content of our important horticultural crops. In many cases there will be a need to systematically work to increase nutritional content. This colloquium will first seek to present an historical perspective on this subject, demonstrating numerous successful examples wherein important crops have been altered or enhanced for nutritional content over more than a century of modern plant breeding. Several case studies will also be presented, demonstrating how some current efforts approach selecting for and breeding different levels of specific micro-phytonutrients (e.g., anthocyanin) in particular crops (e.g., tomato). Presentations will also describe specific examples in which relatively new approaches (e.g., marker assisted selection or plant transformation) are being used in horticultural crop improvement efforts. Challenges and opportunities for future enhancement efforts in vegetables and fruits will also be examined in order to present a comprehensive discussion and the "big picture" for this topic.

2:00–2:45 PM

Enhancing Intake of Dietary Nutrients from Vegetables and Fruits: How Are We Doing?

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Vegetables and fruits are major sources of micronutrients and phytonutrients, as well as several minerals. Crop domestication and modern breeding have, for some crops, resulted in dramatic changes in nutrient content. Modern examples include projects to improve the protein, fat, carbohydrate, vitamin and mineral nutritional quality of staple crops, and genetic improvement of micronutrient and phytonutrient levels in several vegetable crops. Genetic analysis of numerous micronutrients and phytonutrients in many vegetable and fruit crops sets the stage for future nutritional improvement. The need to improve horticultural crop nutritional value and intake is urgent. Diet is implicated globally in the cause and severity of many diseases, including cancer, heart disease, and diabetes, and consumption of healthier foods has the potential to alleviate both the incidence and severity of these diseases, as well as obesity, which is a causal factor for many chronic diseases. The Dietary Guidelines Advisory Committee identified inadequate intake for three minerals (Ca, Mg, and K), two vitamins (A and C), and fiber for at least half of the U.S. population, and horticultural crops are major sources of several of these nutrients. Increased consumption of healthier foods not only improves human health, but also has positive economic benefits to U.S. agriculture. A USDA–ERS report indicated that consumer adoption of the recommendations of the 2005 Dietary Guidelines for Americans would significantly alter food demand and production with positive economic impact. In spite of these needs, efforts to improve crop nutritional value have not been widely embraced by plant breeders. A primary reason for this lack of effort in improving crop nutritional value is the lack of added economic value to be realized from such an effort. Other factors contributing to the minimal effort in improving crop nutritional values are expensive methodologies to quantify nutrients, difficulties in maintaining product identity and labeling for growers and marketers, and lack of obvious immediate value to consumers. While horticultural crops are key dietary sources of several shortfall nutrients, one study indicates that the nutrient content of most U.S. vegetables has, in fact, declined since 1950. The good news is that broad genetic variation for increasing crop nutrient content exists for most nutrients in most vegetable and fruit crops. An evaluation of past recent history of vegetable and fruit crop improvement will be discussed, and prospects for future efforts to enhance horticultural crop nutrient content and intake will be presented.

2:45–3:15 PM

Breeding Tomatoes with Higher Flavonoids and Phenolics Content

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Flavonoids and phenolics include compounds found in fruits and vegetables with multiple functions, including potential benefits to human health. Among their properties, they may potentially be anti-allergic, anti-inflammatory, antimicrobial, anticarcinogenic, and antioxidant. Flavonoids and phenolics may act as pathogen deterrents, mitigate environmental stresses, and serve as pigments that attract pollinators and seed dispersers to flowers and ripe fruit. Tomatoes are an excellent source of carotenoids but are relatively low in flavonoids and phenolics in the fruit. Wild relatives of tomato do express fruit anthocyanins as well as other flavonoids and associated phenolics. Genes controlling fruit anthocyanin expression have been introgressed into tomato from at least four wild species. Three of these [*Aubergine* (*Abg*), *Anthocyanin Fruit* (*Aft*) and *atroviolaceum* (*atv*)] have been named and characterized. Phenotypic expression in a cultivated background is rather weak, but when either *Abg* or *Aft* was combined with *atv*, anthocyanin expression was significantly enhanced. Anthocyanin expression was light induced and pigment accumulated only in the skin. Amounts ranged up to 10 mg/100 g FW on a whole fruit basis (normal tomato fruits have no anthocyanin). Other flavonoid and phenolic compounds were elevated in these types as well, possessing up to 70 mg/100 g FW compared to 40 mg/100 g FW for normal tomatoes. High anthocyanin tomatoes showed high antioxidant potential, with the water soluble fraction showing approximately 10-fold higher antioxidant activity than the lipid soluble fraction that contains carotenoids. A structural gene, *anthocyanin without* (*aw*) blocks anthocyanin expression but allows accumulation of flavonols upstream in the biosynthetic pathway. When *aw* was combined with *Aft* and *atv*, anthocyanin expression was reduced or eliminated, but total flavonoids and phenolics remained unchanged. Thus, it is possible to obtain tomatoes with near normal fruit color but elevated flavonoids and phenolics. In 2011, 'Indigo Rose' was released as the first high anthocyanin fruit tomato. Further increases in these types of compounds may be possible through evaluation and introgression from *Solanum lycopersicum* var. *cerasiforme* accessions.

3:15–3:45 PM

Genomics and Genetic Improvement of Health Promoting Constituents of Blueberry

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Unique phenolic profiles in blueberries (anthocyanins, proanthocyanidins, and stilbenes) are increasingly implicated in numerous health benefits, and multiple clinical studies are currently underway to further demonstrate their impact on diabetes, macular degeneration, age-related dementia, and other chronic diseases. The free radical scavenging and antioxidant capacity of phenolics was traditionally thought to be the exclusive mechanism by which these compounds affected human health. Recent studies, however, suggest that apoptosis, anti-inflamation, modulation of the MAPK signaling pathway, enhanced induction of xenobiotic detoxification enzymes, and other mechanisims are mediated by the unique phenolic profiles in these fruits. A seven-fold variation of total anthocynanins as well as differences in individual anthocyanin profiles have been observed among cultivated blueberries grown over multiple years in North Carolina, which suggests that the potential exists to breed blueberry for enhanced or modified anthocyanin profiles. In addition, recent genomic resources generated from our lab have produced over 43,000 new SSR markers, estimates of population structure in blueberry, and several potential polyphenolic structural and regulatory MYB candidate genes; all of which should greatly facilitate our progress in this effort.

3:45–4:15 PM

The Intersection of Plant Breeding, Human Health, and Nutritional Security: Lessons Learned and Future Perspectives

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In recent years, propelled by rapid increases in global population and food insecurity, concerns about global, sustainable, and nutritional security have gained substantial momentum. Historically, plant breeding has played a key role in improving yield to keep pace with the rising global population; however, current crop breeding efforts focused on increasing yield may need to shift toward nutritional security. Although the traits affecting yield and disease resistance remain essential, emerging scientific results have highlighted the importance of nutrition, flavor quality, and enhanced health-promoting properties in food security. Plant breeding challenges in addressing nutritional security and the importance of consumer perception of flavor, nutrition, and quality will be discussed. The VFIC plant breeding work in pepper, cantaloupe, citrus, carrot, peach, and plum will provide specific examples of improvements in vegetable and fruit quality and health-promoting properties. Case studies of whole foods compared to bioactive compounds, and lessons learned from such studies will be described. Historical perspectives, case studies, current programs and a future outlook on the role of plant breeding in nutritional security will be discussed. The critical importance of the intersection of plant breeding, human health and nutritional security for the future will be demonstrated. This project is based upon work supported by the USDA–CSREES # 2009-34402-19831 "Designing Foods for Health" through the VFIC.

An asterisk (*) following a name indicates the presenting author.

4:15–4:45 PM

The Use of Genetic Markers and Marker-assisted Selection to Improve the Nutritional Content of a Tropical Fruit Crop

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4:45–5:15 PM

Nutritional Changes in a Vegetable over Time Related to the Improvement of Important Horticultural Traits Using Broccoli As an Example

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For many decades, plant breeders have worked to improve fruit and vegetable crops for numerous economically important traits, such as host plant resistance to disease, yield, and fruit or vegetable quality. Most improvements have been made with little knowledge as to how, or if, nutritional or phytonutrient concentrations might also be indirectly altered in the process. There has been some speculation that concentrations of nutrients in fruits and vegetables may have actually been reduced as crops have undergone improvements. However, for most horticultural crops, any current evidence indicating changes in mineral concentration is circumstantial at best. To effectively determine whether or not changes may have occurred over time with the development and release of new cultivars replacing older ones, appropriate field studies must be conducted wherein concentrations in harvested fruits and vegetables from "old" versus "new" crop cultivars are compared directly. Few such studies have been conducted with fruit or vegetable crops. Using broccoli as a test crop, we have conducted field studies to compare mineral concentrations in broccoli heads harvested from cultivars released over several decades. The oldest broccoli cultivars tested in these studies had relatively high concentrations of most minerals assayed, but they produced inferior quality heads that are not saleable in the current marketplace. More importantly, with cultivars released and grown from the 1970s to the present, we found no evidence that mineral concentrations of harvested heads that meet modern quality standards have declined or increased. This is an interesting outcome because there is no indication that breeders have been monitoring mineral concentrations of broccoli during this period in which hybrids became the predominant cultivar type and numerous horticultural quality attributes were enhanced. In some specific cases, breeding efforts have sought to enhance particular phytonutrients with known health promoting effects. Specific examples of this are found in efforts to increase levels of aliphatic glucosinolates in broccoli or work to increase carotenoid levels in carrots. In general, horticultural crop breeders in both the public and private sectors now consider nutritional content of fruits and vegetables as additional quality attributes with similar importance as other traits. Maintaining high nutritional content of new horticultural cultivars will be important in future crop improvement efforts; however, these efforts must balance the ever present demand for increased resistance to existing and emerging diseases, tolerance to different abiotic stresses, improved quality attributes, and also adequate crop yield.

5:15–5:45 PM

The Future of Breeding Fruit and Vegetables with Human Health Functionality: Realities, Challenges, and Opportunities

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While recognition and awareness of potentially health functional compounds in fruits and vegetables has increased the past 15 years, much remains to be learned concerning the long-term value of phytochemicals in the context of a complex modern human diet. Some consumers express concern that evidence of efficacy for particular foods or ingredients appears, only to be contradicted soon thereafter by further studies. Others seek highly reductive approaches to health functionality based on information from complex mixtures of plant-based extracts. Still others focus attention on whole, raw, or minimally-processed foods. Great expectations have been built for fruits and vegetables, but few clear outcomes have been realized. Despite our lack of understanding, and often without substantial preliminary data, many plant breeders and biotechnologists have made efforts to enhance the concentration or quality of suspected health-promoting substances in crops, and some surprising and potentially valuable modifications have been effected. Traditional breeding, marker-facilitated selection, transformation, chromosome manipulations, and the creation of new mutant alleles have been employed in these strategies and provided variable outcomes. But these efforts have also underscored a number of important concerns underlying the challenges to improving vegetable health functionality. These include: unknown bioavailability of the target compounds; biosynthesis of target compounds in species or plant organs where these compounds are non-native; challenges with over-expression of transgenes; modification of antinutritional factors or defensive compounds that serve other purposes in the plant; consumer preferences for processed foods; declining consumer interest in cooking whole foods; reductions in fruit and vegetable consumption among U.S. consumers; and the extent of genetic variability for metabolism of plant-based compounds in humans. While selection in plant breeding programs is certainly effective in modifying crop plants for phytochemical content, it is no guarantee of improved human health outcomes. Future progress will be partly tied to our ability to work in an interdisciplinary fashion with nutritional and food scientists, and those in biomedical fields, to ascertain if true and clinically-relevant health functionalities can be obtained from plant-based compounds. It is hoped that such efforts will clarify issues of bioavailability, dosage, frequency, the effects of cooking and processing, and genetic differences among eaters. Perhaps more importantly however, future progress with respect to human health will be associated with the consumer's interest

in fruit and vegetable consumption for its own sake, as a lifestyle and a practice, rather than as a solution to medical problems.

Tuesday, July 31 2:00–6:00 PM Concourse 1

Biodegradable Plastic Mulches for Specialty Crop Production: Current Status and Future Directions

Sponsor: Plasticulture (PLAST) Working Group

Moderator: Carol Miles

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This colloquium will focus on the new multi-disciplinary topic of using biodegradable mulches in specialty crop production systems. It will feature speakers who are international leaders in horticulture, soil, polymer, textile, and socio-economic sciences. Important aspects of product development, field application, grower acceptance, and environmental impact/benefit will be explored and shared.

2:00–2:15 PM

Biodegradable Plastic Mulches for Specialty Crop Production

Carol Miles*
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Plastic mulch has long been used for specialty crop production and provides many benefits including reduced weed growth, improved moisture control, increased soil temperature, and enhanced plant growth. However, plastic mulch is costly to retrieve and dispose, and has inherently low biodegradability which limits its use in sustainable agriculture. Biodegradable mulches have the potential to provide the same benefits as plastic mulch with the added advantage of fully degrading at the end of the cropping season. This colloquium will provide an overview of biodegradable plastics in general and biodegradable plastic mulches specifically used in agriculture.

2:15–3:00 PM

Understanding the Science of Biodegradability and Exploring Misleading Claims

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Biodegradability is a measure of the ability of microorganisms present in the disposal environment to utilize carbon substrates for energy. Plastics (carbon substrates) can be engineered to be biodegradable, thereby providing for their removal in an environmentally responsible, safe, timely and efficacious manner. This is a particularly important and valuable attribute for single use, disposable, and short-life products such as plastic mulches used for specialty crop production as well as packaging and other consumer articles. Unfortunately, there are a growing number of misleading, deceptive, and scientifically unsubstantiated biodegradability claims proliferating in the marketplace. Evidence of degradation, fragmentation or partial biodegradation is used to claim that the plastic substrates will not accumulate or persist in the environment. Degradation/fragmentation or partial biodegradation is not a sustainable option, and will lead to potentially serious environmental and human health consequences. Documenting complete biodegradation (microbial assimilation) of the plastic substrate in the targeted disposal environment (soil) within a specified and measurable period is necessary to ensure safe and complete removal of the plastic material. We will review fundamental principles and the science underlying biodegradability and degradability of polymer materials in the environment, and describe the harmonized International Standards that are in place to demonstrate microbial utilization of the plastic substrate. Ways to differentiate the new biobased plastics being introduced in the market place and their value and attributes will be discussed. Participants will learn how to recognize misleading claims regarding plastic biodegradation and bioplastics, and the right questions to ask about these products. Participants will also become knowledgeable on the International Standards for biodegradability and will gain a fundamental understanding of the issues regarding plastic biodegradation and bioplastics.

3:00–3:30 PM

Fabricating Biodegradable Mulches

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Considerable effort has been made in the last 25 years by industry, academia, and government laboratories to develop biodegradable mulches which can be plowed into the soil at the end of the growing season, to subsequently become fully mineralized into carbon dioxide and water during succeeding months. This presentation will provide a review of biodegradable mulch research and development from a historical and materials-related perspective, and present the current state-of-the-art, including feedstock performance and biodegradability. Recent research by the authors on the development of poly(lactic acid) (PLA)-based biodegradable mulches fabricated by using nonwovens textile technology will also be presented. Preliminary findings on performance of these PLA mulches as assessed through soil burial in greenhouse experiments in Tennessee, and in field trials with high tunnels and open fields in Tennessee, Texas, and Washington will also be included.

An asterisk (*) following a name indicates the presenting author.

3:30–4:00 PM

Biodegradable Mulches and Specialty Crop Production

Michael D. Orzolek*
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The use of plastic mulch for the production of vegetable crops in the U.S. has doubled in the last 10 years. While energy costs have risen dramatically in the last 5 years, plastic film manufacturers have saved money on the production of mulch film by reducing the thickness of the film; film thickness has gradually gone from 1.5 mil. to 0.5–0.7 mil. during this time period. One disadvantage of the thin plastic film is the retrieval potential for growers after the crop has been harvested in the field. Thin films 0.7 mil. or less do not retrieve from the field very easily and thus are more difficult to remove for recycling or disposal. Plastic mulch films that are biodegradable have been developed, and are being sold commercially in Europe and North America. These new, innovative plastic films biodegrade during composting, and are being evaluated for biodegradability in the field. They can also be rototilled into the soil at the end of the growing season, saving at least $100/A for pick up and disposal. Field research has demonstrated that the biodegradable mulches will produce equivalent marketable yields of most specialty horticultural crops compared to standard plastic mulch. Warm season vegetable crops have performed very well when grown on biodegradable plastic mulch. Two issues that growers may be apprehensive about are the initial cost of the biodegradable mulch compared to standard plastic mulch, and the sometimes unpredictable degradation rate and timing of biodegradable mulch. This presentation will discuss the history of biodegradable mulches in the market place in the U.S., including early products and issues regarding their biodegradability in the field and in composting. Also discussed will be an overview of some current biodegradable mulches and their impact on yield of vegetable crops.

4:00–4:30 PM

Evaluating Biodegradable Mulches in Diverse Climates in the U.S.

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In a recent study, deterioration, weed control, and tomato yield were evaluated for three commercially available mulches marketed as biodegradable (BioBag, BioTelo, WeedGuardPlus), an experimental spunbond poly (lactic acid) mulch (SB-PLA), and black plastic mulch. This study occurred in three climatically diverse regions of the United States: the subtropical southeast, with a hot and humid summer climate (Knoxville, TN); the High Plains south, with a hot and dry summer climate (Lubbock, TX); and the Pacific Northwest, with a cool, humid summer climate (Mount Vernon, WA). The test crop was tomato grown in both open field and high tunnel production systems. In all three locations, mulch deterioration (measured visually) was greater in the open field when compared to the high tunnels—likely due to increased moisture, solar radiation, and wind (with associated blowing abrasive soil particles) in open field environments. Mulch deterioration was greatest for the commercially-advertised biodegradable mulches. Weed pressure was greatest under the experimental SB-PLA-10 mulch—likely due to the opaque nature of the fabric, which favored weed seed germination. The SB-PLA-10 was reformulated and recolored to alleviate this problem. Tomato yields were improved with mulch treatments when compared to bare ground in Knoxville and Mount Vernon, whereas in Lubbock, bare ground and spunbond fabric tended to have the highest tomato yield—likely due to the reduced soil temperatures in those plots.

4:30–5:00 PM

Biodegradable Mulches and Soil Quality

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Biodegradable mulch films could be desirable alternatives to black plastic in agriculture, however, little is known about their degradability in soil across contrasting environments. The objectives of our study were to: 1) measure % area reduction of four potentially biodegradable mulches for up to 2-year burial in soil following use in tomato crop production; and 2) assess soil biological properties (enzyme assays, microbial biomass, and nitrogen mineralization potential) as soil quality indicators. Four replications of both high-tunnel and open-field sites were established in three distinct eco-regions of the United States (southeastern Tennessee; northwestern Washington; southern high plains Texas). Mulch plots at each site included: experimental spunbond poly-lactic acid (SB-PLA-10), BioBag and BioTelo (two commercially-available starch-based films), and WeedGuardPlus (cellulose-based commercial mulch). No mulch was the control. Following 2010 tomato harvest, used mulches were removed and cut into pieces, soil was tilled, and 161 cm^2 nylon mesh bags each containing 103 cm^2 of a mulch and ~400 g of resident soil were reburied into each mulch's corresponding plot. To date, mesh bags have been extracted at two 6-month intervals. At 12-month field incubation, 0% reduc-

tion was observed for spunbond at all plot locations. Reduction of BioBag and BioTelo was greatest in Texas (84% and 75%, respectively) with no differences between high-tunnel and open-field. In Washington, no obvious reduction was observed among BioBag and BioTelo, with one exception (88% in open-fields); in Tennessee there was also minimal reduction with one exception (87% in high-tunnels). BioBag and BioTelo showed an average of 15% and 57% reduced area, respectively, in open fields in Tennessee. WeedGuard showed 100% area reduction at all sites across all three regions with one exception (81% in TN). WeedGuard also showed enhanced enzymatic potential relative to no-mulch control (11% higher averaged across all plots). Soil biological responses were variable among plot locations, treatments and sampling dates. No specific trends were observed for nitrogen mineralization potential among mulch treatments, but WeedGuard samples generally had higher enzymatic potential than no-mulch with variable responses from the other BDM treatments. The lack of consistent responses among mulches, sites, regions, and post soil incorporation, indicates that other factors (temperature, moisture, soil pH) may play a more important role in soil quality than actual degradation of these materials over time.

5:00–5:30 PM

Biodegradable Plastic Mulches: Barriers and Bridges to Adoption

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Since 2009, the experiences and perspectives of specialty crop growers, Extension personnel, agricultural input suppliers, and others have been assessed in order to better understand the barriers and bridges to the adoption of biodegradable plastic mulches for specialty crop production systems in the United States. This presentation reports the results from a survey of progressive growers (Beus, 2008), six focus groups with individuals involved in biodegradable plastic mulch agro-production systems (Beus, Jones and Kirschner, 2010–11), and a survey of Extension personnel, agricultural input suppliers, and other individuals (intermediaries) who work with specialty crop growers (2012). Surveys and focus group meetings have taken place in Tennessee, Texas, and Washington, three diverse agricultural regions of the United States. Results showed that approximately 30% of progressive growers were using biodegradable plastic mulches, but they were not satisfied because of unpredictable or incomplete biodegradation. Most growers (79%) lacked adequate access to information about biodegradable plastic mulches, and 50% were interested in working with scientists and Extension educators on research related to them. From the focus group meetings, perceived barriers to the adoption of biodegradable plastic mulches included high cost, lack of knowledge, uncertain performance, and uncertain long-term impact on the soil. Perceived bridges to adoption included environmental benefits, reduced waste, and effective weed control. The intermediary survey results are forthcoming. The survey and focus group findings can be used to guide the activities of all those involved in the development and promotion of biodegradable plastic mulches for U.S. specialty crop production systems.

5:30—6:00 PM

Discussion and Closing Remarks

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Biodegradable plastic mulches represent an exciting new venture in agriculture. There are the anticipated benefits of reducing crop production costs while minimizing undesired plastic waste in the environment. The work of scientists in multiple disciplines is leading to accelerated findings regarding fabrication, microbial utilization in soil, reactions under diverse climatic conditions, impacts on crop yield and quality, and consumer acceptance. As we increase our understanding regarding the claims associated with biodegradability, agricultural scientists are able to contribute to the development of biodegradable plastic products outside of mulches, or even outside of agriculture. Future research may also focus on issues related to the risks and benefits of carbon emissions during microbial break-down, utilization of targeted microbial degraders, and accommodating organic production requirements.

Wednesday, August 1
8:00 AM–12:00 PM **Concourse 1**

Regulating Water Quality: Current Legislation, Future Impacts

Sponsor: Nursery Crops (NUR) Working Group

Moderator: Sarah A. White
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In recent years, scientists have gained a better understanding of the impact of nutrient enrichment on ecological systems. With enhanced knowledge of the potentially detrimental impacts of eutrophication on our ecological resources, environmental groups and the public began to demand greater protection and restoration of these resources. Regulations have been enacted in various regions throughout the United States to limit nutrient loading, with the ultimate goal of improving surface water quality and restoring ecological function (fisheries, native plant communities, etc.). This colloquium will focus on: 1) three current water quality regulations and the rationale for limiting nutrient release into surface waters; 2) horticultural production management and the economic impacts current regulations have on growers in Florida; and 3) proven technologies that growers can apply to help meet these stringent water quality criteria. Presenters

for the first topic will discuss the TMDLs (Total Maximum Daily Loads) enacted in the Chesapeake Bay Watershed in 2010, with specific focus on collaborative efforts of growers, researchers, and regulators in Maryland to derive meaningful loading rate estimates to facilitate better predictions of potential nutrient load reductions via changed horticultural production practices; the Numeric Nutrient Criterion enacted in Florida in 2009 focusing on the costs of unchecked nutrient enrichment of surface waters from an environmentalist perspective; and a water quality mandate in California, with specific emphasis on current sampling protocols for determination of compliance with water quality limits and the potential for improving accuracy in current nutrient loading estimation techniques. Two case studies, presented by a Florida nursery grower and citrus producer, will discuss the impacts of the numeric nutrient criterion on changes in production, irrigation, and runoff handling practices and economic viability. We will close by presenting technologies that a variety of horticultural producers can apply to better manage and treat runoff so that impacts on environmental health and surface waters are abated.

8:00–8:45 AM

Researchers Working with Regulators & Growers to Calculate Accurate Loading Rates

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Restoration efforts in the Chesapeake Bay recently intensified with the 2010 introduction of federal Total Maximum Daily Load (TMDL) limits for all 94 bay watershed segments. These regulations have specific, binding consequences if any of the six states or the District of Columbia fail to meet interim goals, including loss of federal dollars for various programs and increasing regulation of point sources, if non-point (agricultural and urban) nutrient reduction goals are not met in the watershed. An expert agricultural review panel was recently formed to advise how the precision of the Chesapeake Bay model can be increased, through a better understanding of agricultural practices, including precision nutrient and water management and many other best management practices employed by growers. This information will guide both current and future model development, to increase the accuracy of the model. The nursery and greenhouse industry poses several unique characteristics compared to general agriculture, which must be accounted for in order to produce a more precise estimate of loading rates. A more accurate accounting of land area by operation type is a primary issue, since the current model relies on USDA agricultural census data, which does not match well with operational production on the ground. This is very important since the type of operation (field, container-nursery, or greenhouse operation) has a significant impact on plant density, types of fertilizer used and application rate, which combine with irrigation and water management practices to affect nutrient runoff potential. It is also important to represent a variety of implemented best management practices, such as slow-release fertilizers, in-row buffer strips, and containment in the model, and accurately assess how these mitigate both nutrient and sediment runoff from individual operations. It is possible that the TMDL process currently being implemented throughout the Chesapeake Bay will be used as a remediation process for other impaired waterways in the future. Information learned from the Chesapeake Bay TMDL process could be applicable to other estuarine water bodies, which have similar water-use regulations and issues. The lessons learned about the Chesapeake Bay model in general, and for the nursery and greenhouse industry in particular, will likely provide guidance for how industry can be proactive in reducing environmental impacts and protect the economic viability of growers in the future.

8:45–9:05 AM

Bioreactors for Nutrient Remediation

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Nitrate-N losses in surface drainage and runoff water from ornamental plant production areas can be significant. In nitrogen-limited watersheds discharge of nitrogen from production areas can have significant, negative impacts on non-target aquatic systems. These studies monitored nitrate-N concentrations in production area drainage water originating from a foliage plant production area. Concentrations were monitored during a transition from 100% reliance on fertigation using urea and nitrate-based soluble formulations (SF) to a nitrate-based controlled release formulation (CRF). In addition, this project also evaluated the potential use of microbial-based (denitrification), flow-through bioreactors for their nitrate-remediation ability. Duplicate bioreactor systems were constructed at a local foliage plant nursery. Each bioreactor system consisted of four 242-L tanks with connections alternating between bottom and top. The tanks were filled with Kaldnes® media to provide surface area for attachment of native microflora. Molasses was supplied as a carbon source for denitrification and water flow rates through the systems ranged from 5 to 18 L/min. during tests. During the SF use period, NO_3-N concentrations ranged from 0.5–322.0 $mg \cdot L^{-1}$, with a median concentration of 31.2 $mg \cdot L^{-1}$. Conversely, NO_3-N concentrations during the slow-release fertilization program ranged from 0–147.9 $mg \cdot L^{-1}$ with a median concentration of 0.9 $mg \cdot L^{-1}$. Nitrate-N concentrations in drainage water during the CRF program were reduced by 94% to 97% at the 10th through 95th centiles relative to the SF fertilization program. Results indicate consistent removal of 80% to 100% of the nitrate flowing into the systems using the bioreactors. Accumulation of ammoniacal and nitrite nitrogen did not occur, indicating that the nitrate-nitrogen was removed from the water, and not simply transformed into another water-soluble species. Occasions where removal rates were less than 80% were usually traced to faulty delivery of the

carbon source. Results indicate that CRF fertilizer formulations and the modular microbial-based bioremediation systems may be a useful tool for helping water managers meet stringent nitrogen water quality regulations, especially at nurseries with limited space for expansion of water retention facilities.

9:05–9:25 AM

Wetland Technologies for Nutrient Remediation

Sarah A. White*
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Milton D. Taylor
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The need to protect our water resources and increasing public awareness of the importance of cleaner water for ecological and health purposes have driving creation of regulations limiting nutrient release from traditionally exempt, nonpoint source agricultural contributors. Growers all over the United States will likely need to modify irrigation and fertilization practices to reduce impacts on our current resources. Modification of production practices alone may not be adequate to meet regulated nutrient criterion limits for runoff, whether from irrigation or stormwater source, entering surface waters. Two wetland technologies, one in common use for over forty years and the other an emerging application, are ideally suited to help agricultural producers meet these regulations. Constructed wetlands (either free water surface or subsurface flow) have been used to treat a variety of wastewaters and over the past ten years have been implemented by nursery growers to remediate irrigation runoff. We have monitored two free water surface constructed wetlands since 2003 and results demonstrate that nitrogen is consistently removed, though removal efficacy varies with season. Spring and summer nitrogen removal efficacy averaged 94.1% while winter nitrogen removal efficacy averaged 70.7%. Free water surface constructed wetlands do not consistently remediate phosphorus. Floating treatment wetlands effectively remediate both nitrogen and phosphorus, this unique technology utilizes buoyancy and floating mats to maintain plant crowns above the water surface while permitting plant root systems to serve as filters and to provide surface area for microbial colonization in the water column. Our research has shown that floating treatment wetlands effectively remediate nitrogen with effluent concentrations leaving medium and small-scale systems averaged 0.12 ± 0.02 and 0.03 ± 0.01 $mg \cdot L^{-1}$ nitrogen, respectively. Total phosphorus concentrations in effluent leaving the medium and small scale systems averaged 0.03 ± 0.01 and 0.02 ± 0.01 $mg \cdot L^{-1}$, respectively. Both wetland technologies have benefits and limitations. The choice of treatment technology applied by growers should be based upon site-specific considerations and the endpoint under consideration.

9:25–10:10 AM

Why We Need Numeric Nutrient Limits and How to Implement Them

David Guest*
Earth Justice, Tallahassee, FL; dguest@earthjustice.org

Over the past few decades, pollution of lakes, streams, and estuaries by inadequately treated sewage, manure pollution, and fertilizer run-off has triggered a growing number of algae blooms, many of which are toxic. Public health has been threatened and large numbers of pets have died after swimming in toxic algae waters. Traditionally, the state used a narrative standard in an attempt to limit the effects of these pollutants. That narrative prohibits the addition of phosphorus and nitrogen in concentrations that cause an imbalance in natural aquatic flora or fauna. In practice, this standard has failed to prevent algae blooms because it is reactive in nature: violations are almost always identified after the fact. The purpose and effect of numeric limits on phosphorus and nitrogen is to prevent algae blooms because numeric limits are like speed limit signs that prevent accidents. Numeric limits can and will serve that purpose. Industries that discharge nutrient polluted water have mounted a major legal and political campaign to avoid regulation. That campaign failed and the task now is to implement nutrient pollution limits in practical and cost effective ways.

10:10–10:55 AM

Watershed Management and Educational Programs in California—A Case Study

Donald J. Merhaut*
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Impairment of watersheds by nutrients and pesticides from urban and agricultural entities is a major problem worldwide. In California, all surface and groundwater sources are monitored, regulated, and distributed by one agency, the California State Water Resources Control Board (SWRCB). The SWRCB has divided the state into nine regions; each Regional Water Quality Control Board (RWQCB) is responsible for the watersheds within their assigned area. During the past three years, monitoring and mitigating nutrient and pesticide runoff into the Calleguas Creek

and Santa Clara Watersheds located in Ventura and Los Angeles Counties, overseen by Region 4 – Los Angeles Regional Water Quality Control Board, has been under a program to educate all of agriculture on the Best Management Practices (BMPs) that are needed to mitigate nutrient and pesticide runoff from production sites. There are four agencies involved with this grant: 1) University of California; 2) University of California Agriculture and Natural Resources; 3) Ventura Country Resource Conservation District (VCRCD); and 4) the Ventura County Agricultural Irrigated Lands Group (VCAILG). The specific nutrients and pesticides targeted in the educational programs are based on monitoring done by VCAILG. Based on runoff data, educational programs are developed by the Specialists and Farm Advisors from the University of California to teach growers what BMPs to implement that target the water quality issues in their part of the watershed. In addition, surveys are conducted with farmers within the watershed to see what BMPs they are or will be implementing within the three-year period. These surveys are being conducted by the VCRCD and VCAILG. Each year, water quality monitoring is conducted to see if BMP programs that are implemented are effective at reducing the nutrients and pesticides that are impairing water quality. The success of this program and the issues associated with it will be discussed.

10:55–11:15 AM

Managing Nutrient Runoff in a Container Nursery

Steve Beeman*
Beeman's Nursery, New Smyrna Beach, FL; beemansnursery@att.net

11:15–11:35 AM

Advanced Citrus Production Systems

Pete Spyke*
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Wednesday, August 1, 2012 **Concourse 1**

Breeding in a Genomics Era: State of the Art and New Opportunities

Sponsor: Genetics and Germplasm (GG) Working Group

Moderators:

David Douches
Michigan State University, East Lansing, MI; douchesd@msu.edu

Brian Irish
USDA–ARS, TARS, Mayaguez, PR; brian.irish@ars.usda.gov

The sequencing of plant genomes and the development of genome wide SNP arrays for a number of agronomic and specialty-crops is leading to new opportunities to better understand the organization of variation in germplasm and to develop new breeding strategies. USDA funded large collaborative grant programs, such as The USDA–AFRI funded SolCAP and USDA–SCRI funded RosBREED projects as well as private/public partnerships exist and have aided in expediting the breeding process by funding research. The objectives of the colloquium will be to help bridge the gap between breeding, MAS and genotyping with agronomic crops and vegetable/horticultural crops, with a target audience of professionals and students involved in improvement and conservation of horticultural crops.

2:00–2:45 PM

What the Infinium 8303 Potato SNP Array Tells Us about 100 Years of Potato Breeding

David Douches*
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In order to characterize the phenotypic and genotypic diversity, and changes that have occurred within cultivated potato, a germplasm panel was created, which is composed of important and historical cultivars, advanced breeding lines, and wild species previously used in breeding to characterize changes that have occurred within cultivated potato species. A retrospective look into the genomic changes that occurred through a century of breeding was conducted. In addition, populations were generated to map traits important to the North American breeding community. This material was genotyped using the SolCAP Infinium potato SNP array which provides a set of genome-wide markers. We have used two diploid potato populations to assess concordance between map location of SNPs and the potato genome sequence location; generated a SNP-based tetraploid genetic map; conducted QTL analysis of a tetraploid population; and examined the genome wide level of SNP heterozygosity. Population structure analysis demonstrated four subpopulations within the diversity panel with chip processing clones, wild species, and genetic stocks grouping separately from the other cultivated potato market classes. Additionally, pair-wise kinship estimates revealed clear separation of the market classes as well as two distinct subgroups within the chip processing germplasm. Diversification between market classes was observed for traits under selective pressure within market classes (i.e., tuber sucrose in chip processing clones). In contrast, market class diversification was not observed for traits of universal importance such as yield. Across the panel little change was observed for most traits over the century of breeding, however, within market classes improvement over time was evident (i.e., SFA chip color in chip processing clones). While diversification and improvement has been made

within the cultivated accessions through phenotypic selection, understanding the genetic basis of traits will allow for more rapid improvement to occur over the next century of breeding.

2:45–3:30 PM

The Effects of Human Selection on Elite Tomato Germplasm and Implications for Genome-based Selection

David Francis*
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David Douches
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Human selection to produce tomatoes for distinct market niches, end uses, and environments has had profound effect on the tomato plant, the shape and size of fruit, and diversity of resistance. To assess the distribution of genetic variation and inform future plant breeding, "next generation" sequence data were generated for six tomato varieties and analyzed in a single nucleotide polymorphism (SNP) discovery pipeline. A public SNP array was developed from these analyses using allele frequency data as a principle criterion. To address hypotheses about the effect of human selection and the distribution of variation, a panel of 384 cultivated varieties ranging from land-race and vintage classes to elite parents was assembled. Contemporary varieties possess greater genetic diversity relative to the gene pool of older cultivated varieties. Analysis of allelic variation, haplotype blocks, and linkage disequilibrium (LD) decay along each chromosome suggest that human selection has not been uniform across the genome. Breeding for specific market niches has led to selection for groups of unlinked genes. Regions of the genome containing a high frequency of alleles under selection also contain genes affecting fruit size and shape, disease resistance, plant habit, and sugar metabolism, all likely targets for modification through human selection. Knowledge of allele frequency, recombination, and physical position were used to develop optimized sets of SNPs for genome wide selection in different market classes. Gain under selection in contemporary breeding programs now appears to be limited by recombination, ability to collect accurate phenotypic data for large populations, and the lack of multiple trait indices that reflect market value.

3:30–4:15 PM

Successful DNA-informed Breeding for Tree Fruit: The RosBREED Experience

Cameron P. Peace*
Washington State Univ., Pullman, WA; cpeace@wsu.edu

4:15–5:00 PM

Leveraging the Cacao Genome for the Identification of Genes Regulating Important Agronomic Traits

J.C. Motamayor*
Mars, Inc., Miami, FL; juan.motamayor@effem.com

5:00–5:45 PM

Lessons from Genomewide Selection in Agronomic Crops

Rex Bernardo*
Univ. of Minnesota, St. Paul, MN; bernardo@umn.edu

Genomewide selection (or genomic selection) allows marker-based selection without QTL mapping. In genomewide selection, equations that predict genotypic value are first developed from phenotypic and marker data in a training population. The prediction equations are then used to assess genotypic values in a test population that has been genotyped, but not phenotyped. Genomewide selection is therefore predicated on genotyping being cheaper and quicker thanphenotyping. Key lessons from applying genomewide selection in agronomic crops will be reviewed. First, genomewide selection is most advantageous when heritability is high in the training population, but is low or zero in the test population. Several examples of how such situation can be achieved will be presented. Second, predictions are usually most accurate with a simple model that assumes that each marker accounts for an equal proportion of the total genetic variance. Third, predictions are usually most accurate if epistasis is assumed absent. Fourth, traits differ in their prediction accuracies even when the marker density, population size, and heritability are kept constant. Empirical data are therefore needed to determine which traits are the most predictable and which traits are not. Fifth, for finding marker-trait associations, models that incorporate genomewide background effects are superior to composite interval mapping and to the QK model used for association mapping. The presentation will conclude by discussing future needs in applying genomewide selection in plants.

* * *

Friday, August 3, 2012, 9:30 AM–5:00 PM **Sevilla**

Symposium: A Decade of Progress in Organic Agriculture Science, Teaching, and Extension

Sponsor: Organic Horticulture Working Group

Moderator: Erin Silva, University of Wisconsin, Madison, WI; emsilva@wisc.edu

This symposium, organized by the Organic Working Group at the 10 year anniversary of the inception of National Organic Program, will provide a past, present, and future overview of organic research, extension, and education. Invited speakers with strong programs in organic research, extension, and teaching will present in several key areas related to organic vegetable and fruit production, providing both a historical overview as well as specific examples from their own programs. Industry representatives will provide perspective from outside of the university system. The ultimate goal of this symposium is several-fold: 1) to reflect upon the last 10 years set a foundation to strengthen research, teaching, and outreach activities moving into the future; 2) to engage horticultural researchers and educators traditionally not working in organic agriculture; and 3) to create a networking opportunity for researchers to discuss future research and education ideas.

9:00–9:30 AM

Welcome, Introduction

Erin Silva
University of Wisconsin, Madison

9:35–10:15 AM

Ten Years of the National Program: Past, Present, and Future

Mark Lipson*
USDA–OSEC, MRP, Washington, DC; mark.lipson@osec.usda.gov

Since the National Organic Standards came into effect in 2002, significant progress has been made at the federal government level with respect to support for organic agriculture and organic farmers. The national standards and their enforcement, along with efforts such as the USDA–Organic Research and Extension Initiative grant program, USDA's conservation program funding for organic practices, and the Organic Certification Cost–Share program have made a significant impact on the growth of the organic industry. USDA's annual investments specifically for organic production and markets have grown from a negligible amount in 2002 to over $75 million in 2012. Meanwhile, U.S. sales of certified organic products have grown from about $9 billion to about $30 billion. In this session, Mark Lipson, Organic and Sustainable Agriculture Policy Advisor in the Office of the Undersecretary for Marketing and Regulatory Programs at the U.S. Dept. of Agriculture, will present an overview of USDA organic policy and programs over the past decade. He will also discuss the opportunities and challenges faced by USDA in meeting its strategic objective for the U.S. organic sector (increasing to over 20,000 operations by 2015) and provide an update on organic policy issues in the current Farm Bill process.

10:15–10:45 AM

The Current Status of Organic Agriculture at Land-Grants: Development of Education and Outreach

Erin Silva*
University of Wisconsin, Madison, WI; emsilva@wisc.edu

In response to growing student interest over the last decade, an increasing number of public and private colleges and universities have established courses, certificates, and degree programs in sustainable and organic agriculture. These programs employ a multitude of strategies to link the practical training needs of organic practitioners with the academic component, including the incorporation of working organic student farms, internship programs, community service elements, and coursework. Over the past decade, organic-related courses often have seen high enrollment from students across broad majors and colleges; this trend continues to be observed as food and sustainability issues remain in the forefront of the public consciousness. Student Organic Farms have played an important role in bringing students together around the topic of practical training in organic production. The management and funding of student farms varies widely among institutions, as does the degree to which the farm is integrated within the organic curriculum. Balancing the multiple goals of the farm with respect to student learning and participation remains a challenge in these endeavors.

10:45–11:15 AM

Developing Extension Programming in Organic Agriculture

Annette L. Wszelaki*
University of Tennessee, Knoxville, TN; annettew@utk.edu

11:15 AM–12:00 PM

Perspectives from the Field: Farmer and Industry Experiences with the Land-Grant World

Danielle D. Treadwell*
University of Florida, Gainesville, FL; ddtreadw@ufl.edu

The farmer and industry voices are vital in the success of research, extension, and teaching efforts addressing organic agriculture. In this session, Danielle Treadwell will lead farmer/industry representatives in a discussion of successes, needs, and opportunities with respect to organic agriculture at research and teaching institutions.

An asterisk (*) following a name indicates the presenting author.

12:00–1:15 PM—**Lunch**

1:15–1:45 PM

The Evolution of Organic Research: Trends of the Past Decade

Mary M. Peet*
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Organic research has been going on for much more than a decade, of course. In "Farmers of Forty Centuries: Organic Farming in China, Korea, and Japan," F.H. King made the argument almost a century ago that many traditional agricultural practices can still inform those interested in sustainability. However, federal programs arguably legitimized research in this area. The Organic Foods Production Act (OFPA) established the National Organic Program (NOP) in 1990. Final rules for implementing this legislation came out in 2000 and nationwide organic standards for certification under a national organic label were first established in 2002. From this point onward, it was possible to define legally what practices were 'allowable' and which were not. With this legal definition of organic, it was possible to distinguish scientific research in organic agriculture from related areas by drawing some boundaries. The organic label also allowed the organic industry to grow. In 2011 alone, the value rose 9.5% to $31.5 billion in sales, according to the Organic Trade Association's (OTA's) 2012 Organic Industry Survey. While growth has slowed from the double-digit rise in the 1990s, growth continued even during the 2008 recession. Federal support for organic research dates from about the same time. The 1998 farm bill created the Organic Transitions Program (ORG). The 2002 farm bill created the Organic Agriculture Research and Extension Initiative (OREI) and OREI was also included in the 2008 Farm Bill. In 2009, mandatory funding for the OREI increased to $18 million with additional increases in subsequent years through 2012 to $20 million. Included in the 2008 Farm Bill legislation, along with the funding increases, was a legislatively defined goal of determining the environmental impacts of organic agriculture, including impacts on water, air and soil quality. While federal support is important to organic research, states also provide significant funding. Funding trends will be discussed, including the relative contribution of federal entities and state partners.

1:45–2:15 PM

Organic Vegetable Research: Twenty Years of Progress

Kathleen Delate*
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By 2008, land under organic agricultural production in the U.S. had increased to 1.9 million ha, with 66,380 ha in organic vegetable crops. Great advancements in organic vegetable research and production have occurred since the inception of the National Organic Program (NOP) rules in 2002. This presentation will focus on three areas of the country: the Midwest (Iowa and Wisconsin); the South (Florida); and the West coast (California and Washington) where researchers have focused on improved vegetable performance, weed management, and soil quality enhancement. Results associated with different varietal selections, grafting technologies, compost applications, and reduced tillage systems will be presented. Various technologies have been explored to reduce tillage in organic systems, including the use of a no-till roller/crimper to terminate fall-planted cover crops prior to commercial crop planting in the spring. Weed management has ranged from fair to excellent in the organic no-till system, with rye/hairy vetch generally providing the most weed suppression. Crops with a high nitrogen demand, such as sweet corn, may suffer from N immobilization during cover crop decomposition. Irrigated no-till tomato yields have equaled those in tilled plots, but cover crop seed and management costs have led to higher costs of production in tilled systems. Carbon and nitrogen pools are enhanced under organic no-till and lysimeter data have shown decreased nitrate leaching under plots with cover crops. Overall, the irrigated organic no-till vegetable systems have demonstrated the most promise for reducing tillage in organic systems, and with soil carbon enhancement in no-till systems, potential green payments could offset any economic losses in no-till systems.

2:15–2:45 PM

Breeding for Organic Crop Production

James R. Myers*
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There is a profound need for crop varieties bred for and adapted to production in organic systems. The rationale for this is that organic production systems create a different environment from conventional systems, and that variety by production system interaction exists. Such interaction implies that for optimal performance, a variety needs to be adapted to the environment for which it is intended. The Northern Organic Vegetable Improvement Collaborative (NOVIC) is a farmer participatory project to evaluate existing commercially available varieties, and to breed new varieties in and for organic production. The project spans four regions (NY, WI, WA, and OR) with research on broccoli, carrot, winter squash, snap pea, and sweet corn. Varieties and breeding lines are evaluated in a mother-daughter trial design with the replicated mother trials on institutional research farms and single replicate daughter trials distributed

on regional commercial organic farms. Data from these trials are shared with regional grower groups and are published on the NOVIC website. Outcomes from the project will be discussed. We will also summarize the present state of the art of organic crop breeding.

2:45–3:00 PM—**Break**

3:00–3:30 PM

Long-term Organic Systems Research in Horticultural Food Crops in the "Salad Bowl of America"

Eric Brennan*
USDA–ARS, Salinas, CA; Eric.Brennan@ars.usda.gov

Long-term agricultural systems research is crucially important to understand the sustainability of various management practices and provide robust information needed to develop more efficient food production systems. Such research is particularly important and yet extremely uncommon for high-input horticultural crops where there is high risk of nutrient leaching, and in organic systems where certification standards limit pest control strategies and soil fertility management is based on organic matter inputs. While long-term systems studies with agronomic crops have provided important insights, it is questionable if these are relevant for horticultural systems that are significantly more input-, tillage-, and management-intensive, highly dependent on hand labor, and focused on product quality over quantity. The Salinas Organic Cropping Systems (SOCS) trial is one example of long-term horticultural research, and is the longest running organic systems study focused on high-value, high-input, cool-season horticultural food crops in the U.S. This ongoing nine-year trial is located in the heart of Salinas Valley on the central coast of California. This region is known as the "Salad Bowl of America" because it produces and exports more cool-season vegetables than any region of the U.S. The SOCS trial focuses on cover crop and compost effects in eight certified organic systems that produce lettuce, broccoli and strawberries. The trial uses a unique research approach whereby commercial-scale production occurs on USDA–ARS land with collaborative assistance from local organic farms to help offset research costs. This collaboration enhances the credibility and support for the research through involvement of industry, and ensures that production quality standards are met because the produce from the research is marketed by the collaborating farms. Like most long-term agricultural research, the SOCS trial began as a short-term (i.e. 2.5 year) study and evolved into a long-term study. The objectives of this presentation are to: 1) describe the evolution of the trial; 2) provide examples of unique challenges to develop and manage long-term systems research for high-input, high-value, tillage-intensive horticultural crops; 3) share some lessons learned while developing and managing the SOCS trial; and 4) highlight some of the unexpected results from the first nine years of the trial.

3:30–4:00 PM

Organic Fruit Production

Curt Rom*
University of Arkansas, Fayetteville, AR; crom@uark.edu

4:00–4:30 PM

Organic Agriculture's Issues Related to Food Safety: Research, Perception, and Regulation

Francisco Diez-Gonzalez*
University of Minnesota, Dept. of Food Science and Nutrition, St Paul, MN; fdiez@umn.edu

The demand of organically produced foods has continued to increase in the last decade as organic products are considered to offer a variety of advantages over conventionally produced foods. At the same time as consumers assume that organic foods are safer alternatives, many experts have been warning the public about the potential risks associated with organic agriculture practices. The lack of pesticides, antibiotics and other artificial inputs is one of the aspects that consumers associate with enhanced safety of organic foods. In contrast, the use of animal manure for crop fertilization, the lack of effective sanitizers for processing plants and the ban of antibiotics for livestock have been associated to potential for foodborne diseases caused by pathogenic microorganisms. To this date there is relatively little epidemiological and scientific evidence linked to increased risk of foodborne diseases of organic foods, but the recent occurrence of relatively high profile outbreaks and the fact that several of the major pathogenic bacteria are zoonotic organisms has justified the need for a thorough risk assessment. Because there are relatively few antimicrobial substances that could be considered organic, regulators have allowed the use of synthetic materials with reservations, but the development of alternative natural antimicrobials is critical for the sustainability of organic food production. Current organic regulations require that manure should be composted before application onto crop fields, but they also allow the application of raw manure at least 90 or 120 days before harvest depending on crop type. Those regulations were issued more than a decade ago and during this many studies have reported that some bacterial species may remain viable in soil for more than 120 days. Given the continued demand for organic foods and the recognition that current regulations may not offer proper protection, it would be advisable that after more than a decade since the Organic Rule was enacted, those regulations were revised.

4:30–5:00 PM

Panel Discussion: Future Directions of Organic Research

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Friday, August 3, 2012, 9:30 AM–5:00 PM **Trade Room**

Symposium:

The Use, Application and Analysis of Experimental and Field Sensor Data for Horticultural Applications

Advance registration required —limited to 30 Participants

Sponsor: Water Utilization and Management (WUM) Working Group

Moderators:

Marc van Iersel, University of Georgia, Athens, GA; mvanier@uga.edu

Jongyun Kim, University of Maryland, College Park, MD; jongyun@umd.edu

This symposium, sponsored by the Water Utilization Management and Nursery working groups, Decagon Devices and the SCRI – MINDS project will be focused on the use and application of soil and environmental sensors for horticultural crop research and production. This day-long workshop will demonstrate equipment both from Decagon Devices and Campbell Scientific, but will emphasize best practices in using sensors in various situations. Objectives: The workshop is designed for Faculty, research scientists, and graduate students interested in using sensors for soil, plant and environmental research measurements both in the lab and the field. The workshop will include four sections, with each topic consisting of a 30-minute presentation on fundamental theory and application issues, followed by a 1 hour hands-on practicum session. Four 1 ½ hour sessions will focus on:

1. Water content sensors, accuracy and calibration in soil and soilless substrates.
2. Environmental sensors (weather and plant canopy) data and their uses.
3. Datalogger use and programming.
4. Software for data analysis and decision-making.

9:30–11:00 AM

Environmental Sensors for Measuring Weather and Intra-canopy Conditions

John D. Lea-Cox*
University of Maryland, College Park, MD; jlc@umd.edu

Sensor networks give us the ability to collect microclimatic data at various scales of precision, including temperature, relative humidity, total radiation and photosynthetic photon flux, rainfall, leaf wetness, wind speed and direction. This suite of sensors can provide powerful insight into the variability of environmental conditions within a production area for research purposes, and characterizing this variability is important for sensor placement, to minimize the quantity of sensors required. The primary data can also be used to calculate integrated variables such as degree-day, vapor pressure deficit and daily light integral, which give keen insight into plant productivity, relative growth rate and water use. The associated practicum will demonstrate and discuss the placement, calibration and maintenance of these environmental sensors. A demonstration of Decagon (DataTrac) software will illustrate how the various data and integrated variables are easily calculated and displayed.

11:00 AM–12:30 PM

Accuracy and Calibration of Water Content Sensors

Doug Cobos*
Decagon Devices, Inc., Pullman, WA; doug@decagon.com

When measuring the volumetric water content (VWC) of natural and artificial plant growth substrates with dielectric moisture sensors, three distinct factors can lead to loss of accuracy in the VWC measurement: 1) inaccuracy in the sensor's measurement of dielectric constant (sensor error); 2) error in the conversion of dielectric constant to VWC (calibration error); and 3) air voids or overly compacted substrate due to poor sensor installation. We will discuss the magnitude of possible error induced by each factor and present strategies to minimize errors and generate best possible accuracy in VWC measurements in the greenhouse and nursery settings. The associated practicum session will demonstrate methods for generating substrate specific calibrations, which are critical for accurate measurements in widely varied artificial and natural growth substrates.

12:30–1:30 PM—**Lunch Break**

1:30–3:00 PM

Using Dataloggers for Measurement and Control of Environmental Conditions

Marc van Iersel*
University of Georgia, Athens, GA; mvanier@uga.edu

Dataloggers allow for automated measurement of a wide range of environmental conditions and are most commonly used for relatively simple tasks. However, most dataloggers can do much more than just conduct simple measurement: they can perform calculations using the measured parameters, run simple models, and perhaps most important they can be used to control and

An asterisk (*) following a name indicates the presenting author.

manipulate experimental conditions. The latter makes dataloggers extremely valuable research tools since they can be used to achieve a level of control that would be hard to accomplish without automation. This session will focus on the basics of datalogger programming and on the use of dataloggers to control external equipment based on measured parameters.

3:00–4:30 PM

Using Software for Data Collection, Analysis and Decision Making

Jongyun Kim*
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The use of automated dataloggers to measure aerial environmental conditions and soil moisture from various sensors can provide useful information for research or in commercial production operations. However, organizing and visualizing large amounts of data is only possible when data is systematically collected and logically analyzed. This session will discuss the use of various software in managing large, real-time datasets, and we will share our experiences in organizing and analyzing these data. This session also will cover some useful tips in programming and using Campbell (Loggernet) and Decagon (DataTrac) software, which will provide insight into utilizing dataloggers for many research applications. We will also highlight new software and a graphic user interface that the SCRI-MINDS project has developed for real-time monitoring and control of irrigation.

* * *

Workshops

2012 Annual Conference of the American Society for Horticultural Science, Miami, Florida

Tuesday, July 31, 2012 **Balmoral**

Recent Advances in Palm Horticulture

Sponsor: Ornamentals/Landscape and Turf (O/LT) Working Group

Moderator: Donald R. Hodel
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Palms (family Arecaceae) are perhaps the most distinctive group of ornamental landscape plants, comprising a natural group that even laypeople can readily identify. Palms are increasingly common in outdoor landscapes in tropical and subtropical regions and have long been favorites for interiorscapes everywhere. In the United States, landscape palms are common in Florida, California, and Hawaii, and their use is increasing in Arizona, Nevada, Texas, and many of the Gulf and south Atlantic coastal states. Palms are even being used outdoors in more temperate regions. However, palms differ significantly from other woody landscape plants in their cultural needs and unconventional management practices. Fortunately, the last five years have seen a rapid increase in palm horticulture research. These presentations discuss and summarize the most recent research-based information and developments in palm nutrition and fertilizers, leaf removal and tie up and transplanting, vegetative management, nursery container production, and disease management. This information is applicable to horticulturists, growers, extension agents, educators, and other professionals in the landscape and nursery industries.

1:45–2:00 PM

The Effects of Fertilization and Severe Pruning on Canopy Size and Potassium Deficiency Severity in Sabal Palmetto

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Field plantings of mature *Sabal palmetto* palms established in 2006 received no fertilizer or 4.9 g·m^{-2} of N every 3 months from either 16N–1.7P–6.7K or 8N–0.9P–10K–4Mg fertilizer. Half of the palms in each fertilizer treatment were pruned annually by removing all but 3 of the youngest leaves (severe pruning) while the other half had only completely dead leaves removed. After 3 years, there were no significant differences due to fertilizer treatment in the number of total leaves, the number of potassium-deficiency symptom-free leaves (green leaves), the percentage of leaves that were symptom free (percent green), or the potassium-deficiency symptom severity score (K score). Severely pruned palms had significantly fewer total leaves, but had a higher percentage of green leaves and K scores than those having only dead leaves removed. These data suggest that severe pruning reduces the number of leaves in the canopy below that number that can be supported by existing K reserves in the palm. Exceeding this number of leaves results in visible K deficiency symptoms due to dilution of the palm's limited K reserves. Pruning was discontinued in 2009 and thereafter half of all palms received 9.8 g·m^{-2} of N every 3 months from 8N–0.9P–10K–4Mg for 3 years. The other half received no fertilizer during that period. Fertilized palms had about 50% more total and green leaves than unfertilized palms, but percent green and K scores did not differ between fertilizer treatments. These data support our hypothesis that the severity of visual K deficiency symptoms will improve with fertilization until the palm attains its maximum genetically-determined canopy size.

2:00–2:15 PM

The Effect of Leaf Removal and Tie up on Water Loss and Estimated Crop Coefficients of Juvenile, Trunkless, Containerized Canary Island Date Palms and Queen Palms

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Thirty juvenile, trunkless plants each of Canary Island date palms (*Phoenix canariensis* Chabaud) and queen palms (*Syagrus romanzoffiana* (Cham.) Glassman) growing in 68-liter (15-gallon), standard nursery containers were subjected to five leaf removal and tie up treatments ranging from no leaf removal/no tie up (control) to complete leaf removal. The container opening, from the lip to the palm base, was covered with aluminum foil to reduce evaporative water loss from the potting medium. Containers were initially irrigated to container capacity, allowed to drain overnight, then weighed the following morning and again at one-, two-, or three-day intervals. Other than the initial weighing, the amount of water lost after each weighing was immediately replaced. The differences in weights between the intervals would indicate the approximate the amount of water lost via leaf transpiration during each interval. Any combination of leaf removal and tie up reduced leaf transpirational water loss for both species. Complete leaf removal resulted in the least amount of water loss while no leaf removal and no tie up resulted in the greatest water loss. Crop coefficients ranged from 0.8 to 5.0 for Canary Island date palms and 2.1 to 4.0 for queen palms, which are comparable in magnitude to those developed for several woody shrubs. This information provides guidelines for leaf removal and tie up when transplanting palms and is another tool to help nursery and irrigation managers schedule irrigations more accurately.

An asterisk (*) following a name indicates the presenting author.

2:15–2:30 PM

The Effect of Sand Backfill on Transplanted Palms

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A common, standard industry practice to use straight builder's sand as the sole backfill medium when transplanting palms has no research basis. In a study conducted at Irvine California, queen palms [*Syagrus romanzoffiana* (Cham.) Glassman], Chinese windmill palms [*Trachycarpus fortunei* (Hook.) H. Wendl.] and king palms [*Archontophoenix cunninghamiana* (H. Wendl.) H. Wendl. & Drude], were transplanted using either unamended sand or native site soil as the sole backfill material. After 2 years, backfill medium had no effect on new leaf production in queen and Chinese windmill palms but king palms produced an average of 800% more leaves with sand backfill. Backfill medium had no effect on the percent of the leaf canopy that was green for any species. Of the portion of the canopy that was green, backfill medium had no effect on the intensity of green color in queen and Chinese windmill palms but sand backfill improved green color in king palms by one full rating mark (5-point scale). All queen palms survived regardless of backfill medium. All Chinese windmill palms with sand backfill survived compared to 80% survival with soil backfill. For king palms, 60% survived with sand backfill while 40% survived with soil backfill. While growth and color of queen and Chinese windmill palms were similar regardless of backfill material, growth, color, and survival of king palms was improved with sand.

2:30–2:45 PM

The Effect of Glyphosate on Suppressing Basal Suckers on Mediterranean Fan Palm

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Clumping landscape palms such as Mediterranean fan palm (*Chamaerops humilis* L.) produce basal offshoots (suckers) that are typically pruned to manipulate clump density and future palm height, which is a time-consuming and costly procedure. To investigate an alternative method, we pruned five suckers on each of 10 landscape clumps; the just-pruned surfaces on 5 clumps were treated with a 3% solution of glyphosate while the other 5 clumps were left untreated. Every 6 months, we re-cut the same suckers to the original pruning point and dried and weighed the clippings. We also counted new leaf growth from unpruned suckers and assessed overall palm quality. Glyphosate reduced cumulative sucker biomass by nearly 70% compared to untreated suckers during the 2 years of the study. Clumps with glyphosate-treated suckers tended to produce fewer leaves overall (7 treated vs. 9 untreated) but quality of the clump was unaffected. Thus, glyphosate or similar materials may hold promise for retarding or eliminating small, short, unwanted basal suckers of clumping palms. Further work is needed, though, to determine more accurate frequency and rates of application as well as long-term effect (5 years or more) on clumps.

2:45–3:00 PM

The Effect of Container Type on the Nursery Growth of Kentia Palms and King Palms

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Several non-traditional, "air-root-pruning" container types are available to growers that purportedly enhance growth of shrubs and trees by manipulating soil aeration and root growth to produce a better root system for outplanting in the landscape but also for potting up into larger containers. In a two-year study at a California nursery, three non-traditional, root-pruning container types produced mixed results but none produced significantly greater root mass, leaf or stem growth, or overall quality than a standard container for production of kentia palms [*Howea forsteriana* (F. Muell.) Becc.] and king palms [*Archontophoenix cunninghamiana* (H. Wendl.) H. Wendl. & Drude]. With one of the air root pruning containers, we observed a more uniform root system with denser but shorter secondary roots that may confer a survival advantage when outplanting, but was not investigated in this study. Generally, palms in larger containers tended to produce more growth and were of higher quality than those in smaller containers. When examining treatment effects over time, there were no advantages of using root-pruning containers for enhanced early leaf or stem caliper growth.

3:00–3:15 PM

How Many Hosts Can *Fusarium oxysporum* ff. spp. *canariensis* and *palmarum* Affect?

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Formae speciales of the fungus *Fusarium oxysporum* are defined based on pathogenicity to one or more plant hosts. Both *Fusarium oxysporum* ff. spp. *canariensis* (*Foc*) and *palmarum* (*Fop*) cause Fusarium wilt of palms in Florida, with *Foc*'s primary host being *Phoenix canariensis* and *Fop*'s primary hosts being *Syagrus romanzoffiana* and *Washingtonia robusta*. Over

the past 5 years, both pathogens have been isolated from other palm hosts. Pathogenicity studies have been initiated using palm seedlings to examine the host range for each pathogen. The primary problem initially encountered in these experiments was obtaining consistent results with the *Phoenix* species. It was determined that for both *Foc* and *Fop*, the most consistent results are obtained when the bottom 5 cm of the root system is cut off prior to inoculation. Preliminary data indicates that *Foc* can also affect *P. sylvestris* and *P. reclinata* but not *S. romanzoffiana* and *W. robusta*, while *Fop* can also affect *W. filifera, P. canariensis, P. dactylifera, P. reclinata, P. sylvestris* and the hybrid *S. romanzoffiana* x *Butia capitata*. It was observed that both *W. robusta* and *W. filifera* are highly susceptible to *Fop*, with both palm species usually dying within 4 weeks of inoculation, even when the root system is left intact.

3:15—3:30 PM

Susceptibility of Landscape Palms to *Fusarium oxysporum* f.sp. *canariensis* under Nitrate and Ammoniacal Fertilization

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Five common landscape palms, *Phoenix canariensis* Chabaud, *P. dacytlifera* L., *P. reclinata* Jacq., *P. roebelinii* O'Brien, and *Washingtonia filifera* (Linden ex Andre) H. Wendl. ex de Bary were planted in random blocks in a field that had been previously (25 y prior) infested with the pathogen that causes wilt in *P. canariensis, Fusarium oxysporum* f.sp. *canariensis*. Random blocks containing each palm were fertilized with nitrate, ammonium, a blend of nitrate and ammonium, a "palm-special" fertilizer, or unfertilized. Mortality counts and growth rates were recorded over the next two years. *Fusarium oxysporum* f.sp. *canariensis* attacked *P. canariensis*, *P. reclinata*, and *W. filifera* while *P. dactylifera* and *P. roebelinii* were not attacked. Fertilizer treatments had no effect on disease development.

3:30–3:45 PM

Palm Phytoplasmas in Florida and the Caribbean Basin

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Until 2006, the only phytoplasma disease documented on palms in Florida was lethal yellowing (LY), caused by subgroup 16SrIV-A. LY is widespread in the Caribbean Basin, including the Yucatan peninsula of Mexico. While *Cocos nucifera* L. is the primary palm affected by LY, there are over 30 documented palm hosts, including *Phoenix* spp. A disease with similar symptoms on *Phoenix* spp. was documented in Corpus Christi, Texas in 2000. The pathogen was identified as subgroup 16SrIV-D. It is presumed that this phytoplasma was the cause of a lethal decline on *Phoenix* spp. in the Rio Grande Valley of Texas in the 1970s. In 2006, this phytoplasma (16SrIV-D) was detected in declining *Phoenix* spp. in west central Florida. During subsequent surveys of declining palms in this area, a third phytoplasma, subgroup 16SR-IVF, was documented in a limited number of declining palms, but has not been detected since that time. In 2008, numerous *Sabal palmetto* (Walter) Lodd. ex Schult. & Schult. f. with symptoms typical of lethal yellowing-type disease was observed in west central Florida. It was determined that subgroup 16SrIV-D was the cause of the observed symptoms. This discovery was the first time a phytoplasma disease had been documented on a palm native to Florida, even in the areas historically affected by lethal yellowing (16SrIV-A). Subsequently, subgroups 16SrIV-A and 16Sr-IVD have been documented in native palms in the Yucatan peninsula, coastal Texas and Puerto Rico.

Tuesday, July 31 3:00–5:00 PM Windsor

ASHS Primer

Sponsor: Collegiate Activities Committee

Coordinator: Tracy A.O. Dougher
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Attending an ASHS professional conference as an undergraduate student or graduate student for the first time can be an overwhelming experience. To help sort out the mystery of where to go, what to do, how to find where the talks are, what can I attend or even what is ASHS, this workshop is designed to provide basic information on what opportunities are available to students attending a national conference. This workshop will answer student questions about the conference and help guide students to gain the most from their conference experience.

Tuesday, July 31 4:00–6:00 PM Balmoral

Master Gardener Volunteer Program Management and Project Ideas That Work

Sponsor: Consumer Horticulture and Master Gardeners (CHMG) Working Group

Moderator: Pamela J. Bennett
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Many Extension organizations around the country are facing budget cuts and staff reduction. In order to continue to be a leader and remain in the forefront as a consumer horticulture resource, Counties are relying on volunteers to increase outreach efforts. The focus of this workshop is share successful projects

An asterisk (*) following a name indicates the presenting author.

that expand Master Gardener volunteer outreach which leads to increasing Extension's effectiveness as well as develop a portfolio of these efforts. Three speakers will jump-start the discussion with specific projects; facilitated discussion will follow in order to gather input for the portfolio.

Dianne Dilger Jacobson will present the "Volunteer Mobile Irrigation Lab." Volunteers are trained to utilize the mobile lab and to teach homeowners irrigation recommendations regarding design, installation, operation and maintenance of their irrigation systems.

Alison Stoven O'Conner will present "Larimer County Farmers' Market." Larimer County Extension originally supported the market by funding the construction of a CMG information booth, establishing market policies and managing finances, while CMGs managed all other market aspects, including marketing and vendor recruitment. Today, CMGs can volunteer at the 24-week market as one of many volunteer opportunities.

Heidi Krastch will present "Nevada Master Gardeners Facilitate On-campus Student Learning." Through a cooperative agreement between the College of Agriculture, Biotechnology and Natural Resources and the College of Extension and donations of seed and seedlings from a number of community organizations, UNCE Master Gardeners are growing plants that represent the major plant families native to the Great Basin ecoregion and have excellent ornamental potential for urban landscapes. Such collaborations facilitate communication across disciplines and provide diversity in the range of experiences available to both students and master gardeners.

4:00–4:15 PM

Master Gardener Volunteer Project Ideas That Work

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Extension organizations around the country are facing budget cuts and staff reduction. In order to continue to be a leader and remain in the forefront as a consumer horticulture resource, Counties are relying on volunteers to increase outreach efforts. The focus of this workshop is to share successful projects that expand Master Gardener volunteer outreach, which leads to increasing Extension's effectiveness as well as develop a portfolio of these efforts. Three speakers will jump-start the discussion with specific projects; facilitated discussion will follow in order to gather input for the portfolio. Dianne Dilger Jacobson will present the "Volunteer Mobile Irrigation Lab." Volunteers are trained to utilize the mobile lab and to teach homeowners irrigation recommendations regarding design, installation, operation and maintenance of their irrigation systems. Alison Stoven O'Conner will present "Larimer County Farmers' Market." Larimer County Extension originally supported the market by funding the construction of a CMG information booth, establishing market policies, and managing finances, while CMGs managed all other market aspects, including marketing and vendor recruitment. Today, CMGs can volunteer at the 24-week market as one of many volunteer opportunities. Heidi Krastch will present "Nevada Master Gardeners Facilitate On-campus Student Learning." Through a cooperative agreement between the College of Agriculture, Biotechnology and Natural Resources and the College of Extension and donations of seed and seedlings from a number of community organizations, UNCE Master Gardeners are growing plants that represent the major plant families native to the Great Basin ecoregion and have excellent ornamental potential for urban landscapes. Such collaborations facilitate communication across disciplines and provide diversity in the range of experiences available to both students and master gardeners.

Tuesday, July 31 4:00–6:00 PM Sandringham

Public Funding of Horticultural Science Depends on Us

Sponsor: National Issues Task Force

Moderator: Thomas Björkman

This workshop will tell the story of how ASHS and its members are making the 2012 Farm Bill friendly to horticultural research and extension. Insight on changes at NIFA that affect horticultural scientists' planning for grant support.

Wednesday, August 1 8:00–10:00 AM Trade Room

RosBREED: Discoveries and Breeding Databases for the Fruit Research Community

Sponsor: Fruit Breeding (FRBR) Working Group

Moderator: Ksenija Gasic
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"RosBREED", a multi-disciplinary multi-institutional project funded by the Specialty Crops Research Program of the United States Department of Agriculture's National Institute of Food and Agriculture, is dedicated to the genetic improvement of rosaceous crops by targeted application of genomics and socio-economics knowledge and tools to increase the efficiency of breeding programs, engage stakeholders, and train the next generation of plant breeders. Through the involvement of the U.S. Rosaceae genomics, genetics and breeding community, RosBREED is integrating modern genomics tools with traditional breeding approaches to increase the efficiency of rosaceous cultivar development. Using newly developed SNP genotyping

arrays, existing marker-locus-trait (M-L-T) associations are being validated and new M-L-T associations are being discovered for critical traits that control fruit development and physiology. We will showcase these M-L-T associations, termed "Jewels in the Genome", including the application of this knowledge to scientists seeking to understand these biological processes. Pedigree based and decision based breeding software developed by RosBREED, in collaboration with its international partners, that has application beyond rosaceous crops, will also be showcased. Finally, being the first translational genomics CAP project funded for a fruit crop family, RosBREED will provide non-rosaceous crop breeders insight into how one diverse plant community can come together to embrace our crop diversity (including polyploid complexity), and move forward with a common goal.

8:00–8:15 AM

RosBREED Mission—Jewels in the Genome

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The mission of RosBREED, a multi-state, multi-institutional, multi-national project dedicated to the genetic improvement of Rosaceae crops in the U.S., is to integrate modern genomics tools with traditional breeding approaches to transform crop improvement and significantly improve the profitability of U.S. Rosaceae crop industries. Within the vast repertoire of genetic information in crop genomes, individual marker–locus–trait associations are being discovered that control critical production and fruit quality traits. With the involvement of the U.S. Rosaceae research community, RosBREED has enabled the application of this genetic information to inform breeding decisions. These trait locus discoveries are being described as "jewels in the genome", where the traits have high value to industry sectors and consumers and the influencing loci can be directly monitored by breeders. The analogy embodies the process of finding promising gems and polishing them into "jewels". This workshop focuses on describing the functional alleles for these jewels (i.e., their facets) and showcases new software tools that are enabling effective use of this knowledge.

8:15–8:35 AM

Rosbreed's Breeding Germplasm Used for Validation of Promising Trait Loci

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The use of a comprehensive germplasm set representing materials that breeders use is critical for efficiently enabling systematic and statistically robust validation and utility assessment of jewels in the genome (high value marker–locus–trait (M-L-T) associations). Therefore, at the onset of the RosBREED project, 12 demonstration breeding programs compiled relevant germplasm to constitute a "Crop Reference Sets" (CR Sets) for validation and utility assessment of M-L-T associations in each crop (apple, peach, strawberry, sweet cherry, and tart cherry). All data for the CR Sets will be archived on the Genome Database for Rosaceae and publicly available. In establishing each CR Set, breeding programs identified important breeding parents and traced their pedigrees. To efficiently represent the genomes of these key individuals, available progeny, intermediate ancestors, and founders were included. In addition to the CR Sets, additional Breeding Pedigree Sets (BP Sets) specific to each breeding program were established so that, together with the CR Sets, there was full representation of further important breeding parents. The CR and BP Sets have been phenotyped since 2010 for fruit quality traits and other critical traits using standardized phenotyping protocols developed by the breeding teams. SNP genome scans provided high-resolution genetic data that is being used to validate known M-L-T associations and identify new ones. Genetic tests for several reported M-L-T associations in each crop were fast-tracked through the validation and utility assessment process to demonstrate the use of reference germplasm sets. The visualization of pedigree, phenotypic, and genotypic data for these germplasm sets is enabled for any fruit and nut crop with the publicly available software, Pedimap.

8:35–8:55 AM

Loci Important for Apple Fruit Quality: What Is Known about Their Functional Alleles?

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Delicious taste, excellent texture, and attractive appearance are attributes of apple fruit quality highly desired by consumers and targeted by U.S. breeders. RosBREED's powerful collaborative approach, with multi-institution standardized phenotyping, high-resolution genome-scanning with cutting-edge technologies, careful choice of breeding-representative germplasm, software capability to analyze QTLs across mixed pedigrees, and systematic conversion-to-application has not only detected but validated interesting QTLs with valuable alleles for apple fruit quality. If a trait is under genetic control and it has been phenotyped, chances are very good that we will find its controlling loci and translate them into the language of crop improvement. With our focus on determining functional alleles/haplotypes and their distribution in breeding germplasm, we are ensuring that, at long last, DNA information from QTL studies is applicable for breeding. In this presentation, functional alleles at trait loci such as *Md-ACS1*, *Md-ACO1*, *Ma*, and *Rf* for taste, texture, appearance, and other components of apple fruit quality will be described in a practical breeding context.

8:55–9:15 AM

Loci Important for Peach and Cherry Fruit Size and Quality: What Is Known about Their Functional Alleles?

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Peach and cherry are the two *Prunus* stone fruit crops that are currently targeted in RosBREED for the adoption of marker-assisted breeding. Peach serves as a well resourced model fruit crop while cherry stands to directly benefit from research advances in its relative. Three "jewels in the genome" for peach and cherry are the current targets for application in breeding. Peach breeders select cultivar candidates that meet their criteria for fruit texture (melting vs. non-melting flesh) and pit adherence to the flesh (clingstone vs. freestone). These phenotypes are explained by genes at the *Freestone-Melting flesh* locus on peach chromosome 4 that contains the *endoPG* gene (a gene encoding a cell wall pectin-cleaving enzyme called endopolygalactouronase that plays a major role in fruit softening). Genetic tests are available for the functional alleles that can be used to predict whether peach fruit will be freestone melting flesh (FMF), clingstone melting flesh (CMF), clingstone non-melting flesh (CNMF), or clingstone non-softening flesh (CNSF). In sweet cherry, fruit size is a critical trait for breeding as larger fruit receives a premium price in the market place. A QTL for fruit size on cherry chromosome 2 exhibits multiple functional alleles associated with large, medium, or small fruit. Knowledge of the functional alleles for these marker-locus-trait associations will be presented along with how this knowledge is being used to increase the efficiency of breeding peaches and cherries with superior fruit quality.

9:15–9:35 AM

Data Overload: Breeding Decision–Support Software to the Rescue!

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Crop improvement programs have become increasingly sophisticated with the advent of DNA-informed breeding. Now breeders not only have to keep track of the pedigree records and phenotypic data for their selections, but also genotypic data and its meaning. Utilizing this vast amount of data to make the best crossing and seedling selection decisions can quickly become overwhelming. In RosBREED we are addressing this challenge with development of an online Breeding Information Management System (BIMS) to organize and handle breeding data in a systematic manner to support breeding decisions. BIMS provides interfaces where breeders can search their data by dataset, location, variety, trait with threshold limits, marker allele, and pedigree. From the results page, breeders can download phenotypic and genotypic data as well as view detailed data of individual varieties. BIMS resides within the Genome Database for Rosaceae (GDR), and the breeding data are linked to the related genetics and genomics data for further investigation. BIMS also provides a tool to choose a variety, its progenitors and descendants in the pedigree, and phenotypic and genotypic data of this pedigree to produce an input file for the publicly available software, Pedimap, which enables the visualization of these data. Also available in BIMS are two tools that support breeding decisions. The "Cross Assist" module, already available, with new functionalities being added as suggested by users, helps identify efficient parental combinations that provide a high proportion of seedlings with desired performance levels. The "Seedling Select" module, still in prototype form, helps breeders identify efficient seedling selection schemes by integrating DNA tests into routine breeding operations with early-stage culling of seedlings that do not contain desired performance levels and retention of those that do. Both these tools help breeders generate better progenies with available resources—saving thousands of dollars otherwise spent evaluating inferior progeny.

9:35–10:00 AM

Discussion

Amy Iezzoni*
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Wednesday, August 1 10:00 AM–12:00 PM
Balmoral

A Survey on the Contribution of Indigenous Peoples of North America to Horticulture

Sponsor: History of Horticultural Science (HIST) Working Group

Coordinator: Jules Janick
Purdue University, janick@purdue.edu

A survey on the contribution of indigenous peoples of North America to horticulture. Topics covered include crop domestication and crop culture.

10:00–10:40 AM

Development of New World Crops by Indigenous Americans

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Advanced agricultural and horticultural systems are a feature of Pre-Columbian civilizations of the New World. In fact, practically all of the crops that originated in the New World were domesticated before European incursions. Thus, the New World crops currently grown in Europe, Asia, and Africa must be considered as a contribution of indigenous cultures to humanity. The history of these indigenous crops can be found in the written post-Columbian record of explorers, correspondents, travelers, and botanists. It can also be traced in the iconographic record derived from illustrated manuscripts, herbals, paintings, and sculpture. This information is particularly useful for such fields as taxonomy, genetics, crop domestication, crop evolution, and genetic diversity. Major New World crops to be reviewed include grains and pseudograins (maize, amaranth, and quinoa), legumes (common bean, Lima beans, peanut), cucurbits (pumpkins, squash, and chayote), solanaceous fruits (tomato, pepino, capsicum peppers); starchy roots and tubers (sweet potato, potato, and cassava), fruit and nuts (pineapple, papaya, strawberry, and blueberry, cactus pear, cashew), beverage crops (cacao and mate), ornamentals (dahlia, fuchsia, and sunflower), and industrial crops (Hevea rubber and cotton).

10:40–11:20 AM

Manna in Winter: Indigenous Americans and Blueberries

Kim E. Hummer*
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More than 35 species of blueberries (*Vaccinium* L.) and huckleberries (*Vaccinium* and *Gaylussacia* Kunth.) are indigenous to North America. The indigenous North American peoples, wise in the ways of survival, recognized the quality of these edible fruits and revered these plants. Beyond food needs, these plants played significant roles in their culture, sociology, economics, and spirituality. Because these traditions (developed and gathered over millennia) were transmitted orally, documentation of this use has been determined through archeological data, written records from western civilization after first contact, and recent surveys of present day native peoples. The wealth of indigenous knowledge on blueberries, huckleberries, and other foods was shared with European immigrants. These fruits were used by many tribes throughout North America. Samuel de Champlain documented that fresh and dried blueberries provided "manna in winter" when other food was scarce. Pemmican, a preserved concoction of lean meat, fat, and blueberries or other fruit, enabled survival. Blueberry products, such as *ohentaqué, hahique, satar, sakisatar, sautauthig, k'enkash, navagi* and *nunasdlut*'i, were important to Native Americans. Roger Williams, Meriwether Lewis, and David Thoreau, each were impressed with the uses of blueberries by indigenous Americans. The social, technological, and horticultural changes that gave rise to a commercial wild huckleberry and blueberry gathering and production history will be summarized.

11:20 AM–12:00 PM

The Chilean Strawberry (*Fragaria chiloensis*): Over 1000 Years of Domestication

Chad E. Finn*
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The cultivated strawberry of South America, the octoploid *Fragaria chiloensis* L. has a long and interesting history. While the origin of the species in Chile cannot be completely determined, it is suspected to be an introduction from North America by birds. After making landfall in Chile, the species spread from the coast into the mountains developing a number of four ecotypes over a long period. At least two native people, the Mapuche, between Rio Bio-Bio and south-central Chile, and the Picunche, between Rio Itata and Rio Bio-Bio, began the domestication process. While white and red fruited forms were developed, the white form (because of fruit size) seemed to have been preferred as the red fruited types are not mentioned frequently in the literature. At the time of the Spanish invasion of Chile, *F. chiloensis* was widely grown in small garden plots. Over time under the Spanish rule, larger plantings first of 1–2 ha and later of many hectares were grown. As the Spanish continued their exploration and conquest of South America, they carried *F. chiloensis* with them up the western coast to Peru, Ecuador and Colombia. For many years these scattered plantings were the source of fresh fruit for the burgeoning populations. The cultivated *F.* x*ananassa* Duch. ex Rozier was introduced in Chile around 1830, but the *F. chiloensis* was still preferentially grown. In the early 1900s, a large canning industry that served hundreds of acres of *F. chiloensis* planting

thrived. By the 1950s, *F.* x*ananassa* began to predominate and the rise of the importance of the University of California and European developed strawberries that was impacting the world also displaced much of the traditional production. An increased awareness of this vast genetic resource arose in the 1980s and 1990s. Faculty, particularly at the Universidad de Talca, have collected and characterized germplasm that represents not only tremendous diversity but captures many of the land races that have been developed. This germplasm has been utilized in small commercial plantings (0.1–0.3 ha) and in breeding programs to further develop *F. chiloensis* commercial cultivars. There is still a small but vibrant community of small growers in Chile (along the North-Central coast of the Pacific Ocean) and Ecuador (mainly around Ambato) producing the land races for commercial sale in local markets. It is estimated that around 30 ha of open field plantings are cultivated in Chile with yields averaging around 3–4 tons/ha.

Wednesday, August 1 10:00 AM–12:00 PM Flagler

Updates and Revisions in Intellectual Property: Patents and Other IPR Policy Changes in the United States

Sponsor: Intellectual Property Rights (IPR) Working Group

Moderator: John R. Clark
University of Arkansas, Fayetteville, AR; jrclark@uark.edu

This workshop will update attendees on recent changes and interpretations of intellectual property rights in the United States. Topics will be of interest to both academic and industry inventors and users of proprietary technology.

10:00–10:40 AM

America Invents Act: A First Look At First-to-File for Inventors

Tambryn VanHeyningen*
Andrus, Sceales, Starke & Sawall, Milwaukee, WI

On September 16, 2011, President Obama signed the America Invents Act into law and the most significant reform of the patent laws in the past 50 years began to take effect. The America Invents Act makes major changes to all aspects of patent law, but in this session the focus will be on the aspects most important to inventors. Specifically, this presentation will focus on understanding the changes made to move the United States from a first-to-invent to a first-to-file system and the changes to the definitions of prior art and the effects of these changes on patentability of inventions. For inventors used to filing foreign applications, the changes are meant to harmonize the laws in the United States with those in most other countries of the world. For those inventors used to relying on the one year grace period provided in current United States law, the changes will be significant. These changes are scheduled to take effect on March 16, 2013, so the time to prepare for these changes is now and strategies will be discussed for adapting to these changes.

10:40–11:20 AM

Owning Patents: Why Do We Need Magic Words and What Does Stanford Have to Do with It?

Lisa C. Childs*
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John R. Clark
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This seminar will cover various topics related to ownership of patents. Topics to be touched on include: the recent Supreme Court decision *Stanford vs. Roche*; differences between equitable and legal title; how to transfer ownership; why bother notarizing assignments; shop rights and "hired to invent"; inventions by students; impact of the present and future tense on ownership; and transferring federally funded inventions owned by universities to others. These issues include recent changes or interpretations of intellectual property policies or procedures or are routine but important components of IPR protection or processes encountered at university or other public institutions.

Wednesday, August 1 1:45–3:45 PM Tuttle

Learning Outcomes What Every Student Should Know

Sponsor: Teaching Methods (TCHG) Working Group

Moderator: Kimberly K. Moore
Fort Lauderdale, FL; klock@ufl.edu

The objectives of this workshop are to: 1) review the process for determining the learning outcomes associated with the ASHS certified horticulturist exam; 2) demonstrate the value of being a certified professional; and 3) compare learning outcomes at different universities to the outcomes identified by the ASHS certified horticulturist exam

1:45–2:05 PM

Learning Outcomes: What Every Student Should Know

Kimberly K. Moore*
Fort Lauderdale, FL; klock@ufl.edu

Whether training undergraduate or graduate students in horticulture, all educators hope that their students have mastered specific skills and knowledge. Curricula around the country are based on key learning objectives that assess skills and knowledge over a range of horticultural topics. In a time of dwindling resources, it is critical to ensure that we are preparing our students to be successful when they leave our institutions. The American Society

for Horticultural Science (ASHS) had developed the Certified Horticulturist examination with 35 learning objectives that correspond to tasks or sets of tracks in which a horticulturist should be proficient. These tasks were independently determined by a job task force that worked with the industry to develop a list of proficiencies each graduate should possess.

2:05–2:55 PM

The ASHS Certified Horticulturist: Standards and More

Raymond Talke*
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In 2009, The American Society for Horticultural Science introduced the preeminent credential for people working in the horticultural field, the ASHS Certified Horticulturist. However, there was almost three years of hard work involved in designing this credential before the first certification examination was offered. This presentation will review the process used to create the ASHS Certified Horticulturist job description, establish the standards of practice and develop the certification examination. Particular emphasis will be placed on the creation of standards of practice in the field so that participants can use these standards to educate and evaluate professionals in the field of horticulture.

2:55–3:45 PM

The Value of the Certified Horticulturist Credential to the Innovative Practitioner

George Fitzpatrick*
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Certification examinations whose questions are based on terminal objectives that were identified by job task analyses (JTA) and objectives ranking surveys (ORS) have higher levels of validity than certification programs whose exam questions are not based on such objective criteria. Practitioners who possess these valid certification credentials are qualified for more lucrative and innovative professional assignments, since their credential is based on demonstrated mastery of skills and knowledge identified and raked by the JTA an ORS. This presentation will describe examples of the expanded opportunities that have been obtained by professionals who have qualified for credentials based on both practical experience and examination based on valid terminal objectives.

3:45–5:00 PM

Beyond the ASHS Certified Horticulturist Exam

Curt Rom
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Ann Marie VanDerZanden*
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Undergraduate horticulture curriculums across the country have unique learning outcomes to meet the needs of various stakeholders. This directed discussion will highlight how learning objectives from the curriculum of three universities compare top the objectives identified by the ASHS Certified Horticulturist development team. How much alignment is there? What do the differences mean and what are the next steps university faculty should take to ensure graduates are well prepared?

Wednesday, August 1 1:45–3:45 PM Flagler

Tropical Fruits and Vegetables: Impact on the U.S. Economy, Quality, Health, and Food Safety

Sponsor: Tropical Horticultural Crops (TROP) Working Group

Moderator: Bhimanagouda S. Patil
Texas A&M University, Vegetable and Fruit Improvement Center, College Station, TX; b-patil@tamu.edu

Research on tropical fruits and vegetables has seen tremendous advancements in the past few decades. However in the recent years, the "healthy living" concept instilled among the consumers, has lead to exploration of fruits and vegetables beyond the continental barriers. Increase in consumer awareness on health benefits of tropical fruits and vegetables can be attributed to the recent advances on the role of dietary components in reducing risks certain diseases. Interestingly, US consumers started appreciating taste, flavor and health benefits of tropical fruits and vegetables. Once considered exotic and only pictorially described, now there is demand by certain sectors of consumers for such fruits and vegetables. The enhanced market significantly started impacting the U.S. economy. Furthermore, exploring these understudied fruits and vegetables pose food safety concerns. While challenges are daunting, it is critical that one should make use of opportunities by integrating policies, food safety, human health and flavor attributes due to pre and postharvest practices. The workshop will provide a platform for scientists, policy makers and industry leaders to evaluate the challenges and opportunities for sustainable and nutritional security of tropical fruits and vegetables.

1:45–2:15 PM

Overview of Bioactive Compounds Derived from Tropical Fruits and Vegetables and Their Implications on Human Health

Bhimanagouda S. Patil*
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In recent years, imports of certain selected tropical fruits and vegetables to the United States have increased due to demand by the diverse ethnic population, delicious taste and consumers awareness on healthy foods. Additionally, wide geographical ranges of the tropics result in distinct environmental conditions which significantly influence the diversity and quality of the fruits and vegetables. While studies related to fruits and vegetables grown in the United States and their role in human health has been expanding, similar studies on tropical fruits and vegetables are limited. Current studies related to tropical fruits and vegetables and their implications on reducing risk of certain cancers and cardiovascular diseases will be discussed. The role of tropical fruits and vegetables in healthy lifestyle at the global level and current limitations and future opportunities will be presented. This project is based upon work supported by the USDA–CSREES # 2009-34402-19831 "Designing Foods for Health" through the VFIC.

2:15–2:40 PM

Food Safety Concerns of Tropical Fruits and Vegetables

David Gombas*
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Food safety of fresh fruits and vegetables has come under scrutiny in the past decade, with several widely publicized outbreaks resulting in reduced consumer confidence in these highly nutritious foods. A 2011 Salmonella outbreak linked to papayas demonstrates that tropical fruits and vegetables are not immune to these issues. For the first time, the U.S. Food and Drug Administration has indicated an intent to propose regulations for the safe production and handling of fresh fruits and vegetables. Concurrently, an FDA intent to propose regulations for Foreign Supplier Verification means that fresh produce growers and handlers that export to the U.S. will be held to the same regulatory food safety standards as U.S. operations. Without a process step that can be validated to eliminate any contaminating pathogens, fresh produce relies on prevention of contamination as the primary means of achieving safety. This is made more difficult by the produce generally being grown outdoors, where several risk factors for contamination cannot be completely controlled. Nevertheless, the fresh produce industry has developed guidelines and audit standards to help growers and handlers minimize these potential risks. How these standards, guidelines, and potential regulations will affect and can aid tropical produce growers and handlers will be discussed.

2:40–3:05 PM

Economic Outlook of Tropical Fruits in the United States: Consumers' View

Marco Palma*
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Per capita consumption of fruits and vegetables in the U.S. increased 21% from 1970 to 2000. Since then, per capita levels for the major fruits and vegetables has remained relatively flat with an overall reduction in total fruit consumption. New consumer trends and shifts in demand show consumers are paying more attention to specialized products with increased benefits. This presentation will highlight the major consumer macro-trends for tropical fruit consumption in the U.S. First, consumer changes in terms of the level of consumption and type of products will be reviewed. Special emphasis will be given to international trade trends and matching supply sources with demand. Secondly, local foods and specialized market trends will be discussed and their potential to play a role in the traditional supply change will be evaluated. Third, Functional foods, or foods with additional health benefits will also be reviewed. Finally, the potential impacts of the Dietary Guidelines for Americans 2010 will be discussed.

3:05–3:30 PM

Potential Benefits of Supplemental Calcium Additions for Sustaining Citrus Production and Quality

Shad D. Nelson*
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Citrus growers in South Texas make money primarily through the fresh market citrus varieties. This citrus producing region is a subtropical environment with a high heat and humidity index nearly year round due to its close proximity to the Gulf of Mexico. The control of citrus related pests that impact external fruit quality is of primary concern to South Texas citrus growers to prevent the down-grading of fruit to the juice market. Of recent concern, Huanglongbing (HLB) or 'greening disease' as transmitted by the Asian Citrus Pysllid (ACP), was discovered in January 2012, in South Texas. HLB disease has the potential to drastically and rapidly reduce citrus production for both conventional and organic citrus producers. Populations of ACP are throughout the citrus producing region of South Texas, thus immediate measures that reduce ACP infestations to citrus trees is one method to limit the spread of HLB. The objective of a serious of studies focused on supplement calcium additions to soil and foliage of citrus trees in high calcareous soil systems. Field and laboratory studies were performed over the past three years to evaluate what impact supplemental calcium applications

would have on ACP infestation levels to young citrus shoot flush. Results have demonstrated a positive correlation between lower ACP infestations in trees receiving additional calcium application, regardless of whether the macro-nutrient is applied to the soil or to foliage. These findings are encouraging for the long term sustainability of citrus production for both organic and conventional growers.

3:30–3:45 PM

Panel Discussion

Ram M. Uckoo*
Texas A&M University, Vegetable and Fruit Improvement Center, College Station, TX; rammohanuckoo@yahoo.com

Wednesday, August 1 4:00–6:00 PM Sevilla

Grant Writing and Beyond: How to Write a Grant and What to Do Once You Get It

Sponsor: Graduate Student (GRAD) Working Group

Moderator: Kristin Abney
The University of Georgia, Athens, GA; kabney22@gmail.com

Grant writing is an important skill that is in demand in today's job market, but how should you go about writing a grant and what do you do once you receive it? More goes into writing a grant than one might think. Besides having a great idea, you must also have a justification, a budget, and a timeline just to name a few things. After the grant has been written, it goes to a committee which will then determine if the grant is worthy of funding. If you're one of the lucky ones whose grant gets funded, then you have to figure out how to budget the money and write the reports. The goal of this workshop is to show graduate students how to write a grant, what to expect when it goes to committee, and how to administer it once you have been funded. There will also be extra time for discussions about each part of grant writing.

4:00–4:15 PM

Grant Preparation Pointers and Budgeting Basics

Dean A. Kopsell*
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4:15–4:30 PM

Proposal Reviews: What Happens After Submission?

Marc van Iersel*
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After you submit your grant proposal to a funding agency, there is little you can do but sit and wait. But what happens during the review process? How do various funding agencies process grant proposals, how do reviewers evaluate proposals, and how are funding decisions made? Which strengths and weaknesses in a proposal are most likely to make a difference? Understanding the review process can help you get a leg up on the competition. But even if your proposal is selected for funding, the funding agency may not provide all the funding you requested in your budget. How do you respond and how much help can you expect from your university in the process? If your proposal is not funded, should you resubmit your proposal at the next opportunity, find a different funding agency, or just let it go? An appropriate response to a previous review can greatly strengthen a subsequent proposal. Strategies to maximize your chances will be discussed.

4:30–4:45 PM

Administering Grants—The Good, the Bad, and the Beauty of Having Funding

John D. Lea-Cox*
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Today, grants are an inevitable requirement of being an academic, whether you teach, do research, or are involved in extension education. Successful grant writing of course is the front end of the process, but perhaps more importantly, successful management of a grant will help ensure the intended results and impacts of the project. This requires different skills than we are typically taught in graduate school. Very often, you are thrust into the arcane world of administering money, people, and perhaps most importantly, your time. Navigating through this process can be daunting at first, but there are a few basic techniques that will help you do this. We will explore and discuss these during this presentation.

Wednesday, August 1 4:00–6:00 PM Flagler

Issues in Local Food Systems

Sponsor: Local Foods (LOCSY) Working Group

Moderator: Christine Coker
Coastal Res. & Ext. Center, Biloxi, MS; ccoker@ra.msstate.edu

The emphasis on food security and food systems continues to play an important role in the discussion of local foods. Through this interactive workshop, participants will: 1) be exposed to a balanced discussion of the term "local;" 2) become familiar with challenges and successes of other regions; 3) strengthen and establish collaborations; and 4) identify opportunities for ASHS and its stakeholders to close resource gaps through research, extension, and teaching infrastructure. Invited presentations and facilitated panel discussions will allow for open dialogue focused on local food systems and their supporting infrastructure. The workshop will explore the roles of various partners in local food systems including: community planners and planning agencies, non-profit organizations, and horticulturists and other University, Extension, and Experiment Station personnel. Specific issues to be covered include, but are not limited to, academia's role in local food systems, food safety,

views from urban farmers, and trends in local foods.

4:00–4:15 PM

What Role Do We Play in Local Food Systems?

Christine Coker*
Coastal Res. & Ext. Center, Biloxi, MS; ccoker@ra.msstate.edu

University personnel, particularly Extension and Experiment Station faculty and staff, are on the front lines in terms of current trends in agriculture. So it holds true for the local food movement. Horticulturists are no longer only interested in the production of fruits and vegetables, but also in the local value chain and consumer preferences. Scientists and specialists are now finding consumers to be as much a part of their audience and clientele as the farmers they have traditionally served. The local food movement has created new opportunities for training producers for selling to their local markets. We are also presented with the challenge of educating consumers about agriculture in general, and local products, specifically. Additionally, more home gardeners are becoming interested in backyard food production and urban farming practices. Schools and churches, civic organizations, and neighborhoods are showing increased interest in community gardens. While Extension and Experiment Station personnel have traditionally been a resource for gardening advice and expertise, this new interest in urban agriculture takes basic gardening to the next level. New issues are being raised including food safety, postharvest handling and storage, marketing, and more. Horticulturists must become part of a team of experts to serve the varied interests involved in local food systems.

4:15–4:30 PM

Urban Nano Farming

Gary R. Bachman*
Coastal Research and Extension Center, Mississippi State University, Biloxi, MS; gbachman@ext.msstate.edu

There is a growing interest among consumers of where their produce is grown. Locally grown produce is becoming more popular when compared to that which is grown organically and shipped long distance. Many home owners are taking the locally grown philosophy literally by wanting to grow at least some of their own fresh vegetables. Having enough room to garden is a perceived obstacle for many home owners when considering a vegetable garden for the first time. The Urban Nano Farm was created as a demonstration of growing vegetables in an urban setting from a research/teaching perspective. Crop growing strategy in a small space is a primary focus, from raised beds to various types of containers. Crop selection appropriate for small space growing, crop rotation, and seasonal crop succession are actively examined. Fertilizer and pest control are important considerations for many home gardeners. Plant growth and health is evaluated following the use of traditional synthetic formulations as well as materials certified for use in organic growing strategies. Consumer produce and varietal preferences are compiled from the local farmers market and used for crop planning and demonstrations.

4:30 –4:45 PM

Preaching Local Food Production to Homeowners

Kathryn Fontenot*
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Burden Center, located in Baton Rouge, Louisiana, is home to 440 acres dedicated to ornamental, fruit, and vegetable research. Since 2009, Burden Center has held annual spring fruit and vegetable field days targeting home gardeners. Avid and beginner gardeners visit the research center to learn how to grow fruit and vegetable crops in their backyards. Gardeners tour fields while LSU AgCenter faculty present favorite vegetable varieties, information regarding identifying disease and insect,s and general cultural practices. In addition to visiting fields, gardeners participate in taste test studies with various vegetable crops. The production information from the field studies along with gardeners' taste test recommendations are then distributed throughout Louisiana at various garden events. The LSU AgCenter hosts these field days with the intention of spreading research-based production information to local food growers.

Thursday, August 2 8:00–10:00 AM
Trade Room

From Gene to Phenotype: Molecular Control of Flavors

Sponsors: Plant Biotechnology (BTCH) and Postharvest (PH) Working Groups

Moderator: Nahla Bassil
USDA–ARS, Corvallis, OR; bassiln@hort.oregonstate.edu

Over the last decade there has been dramatic increase in genomics-level information for horticultural crops. It is now possible to begin application of molecular tools to practical issues in crop improvement. Flavor is an integrated interpretation of gustatory, olfactory and somatosensory properties of food. Unfortunately, breeding for improved flavor has been de-prioritized for breeders in favor of properties such as yield, disease resistance and post-harvest quality. Today consumers find the flavors of most horticultural crops disappointing. Herein lies an opportunity to generate improved fruits and vegetables with better flavor and consumer preference. Such developments would have positive benefits for growers and human health. This workshop will present recent examples of how our knowledge of gene sequences has led to breakthroughs in the development of crops with improved flavor. Interdisciplinary approaches melding genomics, molecular biology, biochemistry, postharvest physiology, and consumer science have been used to design and deliver the next generation of flavorful plant products. Some of the recent examples will be presented.

8:00–8:15 AM

Aroma Development in Melon: From Pathway Elucidation to Sensory Perception

Florence Negre-Zakharov*
Davis, CA; fnegre@ucdavis.edu

8:15–8:30 AM

Regulation of Plant Volatile Biosynthesis in the Petunia Model

Thomas Colquhoun*
University of Florida, Gainesville, FL; ucntcme1@ufl.edu

8:30–8:45 AM

Fixing the Broken Tomato: The Chemistry of a Great Tasting Tomato

Denise M. Tieman*
University of Florida, Gainesville, FL; dtieman@ufl.edu

8:45–9:00 AM

Reclaiming Lost Flavors in Cultivated Strawberry

Kevin M. Folta*
University of Florida, Gainesville, FL; kfolta@ufl.edu

9:00–9:15 AM

Evidence for De Novo Synthesis of Fatty Acids in the Formation of Straight-chain Esters in Physalis (Goldenberry)

Randolph Beaudry*
Michigan State University, East Lansing, MI; beaudry@msu.edu

Thursday, August 2 8:00–10:00 AM Balmoral

Mechanized Harvest of Blueberries for the Fresh Market

Sponsor: Viticulture and Small Fruits (VSF) Working Group

Moderator: Jeffrey G. Williamson
University of Florida, Gainesville, FL; jgrw@ufl.edu

Harvest labor represents the single greatest production cost for hand-harvested blueberries. Efforts to reduce production costs through mechanized harvesting are underway but present challenges with regards to berry quality, postharvest shelf life, and harvest efficiency. This workshop will address the following topics with regards to mechanical harvesting of blueberry for fresh markets: 1) cultivar characteristics that are compatible with current mechanical harvesting technologies; 2) cultural practices that facilitate efficient mechanical harvesting; 3) major points of impact to berries during mechanical harvesting; and 4) berry quality during storage.

8:00–8:10 AM

Introduction and Overview of the Workshop

Jeffrey G. Williamson*
University of Florida, Gainesville, FL; jgrw@ufl.edu

8:10–8:30 AM

Using *Vaccinium arboreum* As a Source of Machine Harvest Traits for Blueberry

James W. Olmstead*
University of Florida, Gainesville, FL; jwolmstead@ufl.edu

8:30–8:50 AM

Using a Miniature Instrumented Sphere to Delineate Blueberry Mechanical Harvesting Process for Potential Fruit Impact Points

Changying Li*
University of Georgia, Tifton, GA; cyli@uga.edu

8:50–9:10 AM

Strategies to Increase Efficiency of Mechanical Harvest of Blueberry

Fumiomi Takeda*
Appalachian Fruit Research Station, Kearneysville, WV; Fumi.Takeda@ars.usda.gov

9:10–9:30 AM

Potential of Canopy Shakers to Harvest Southern Highbush Blueberry: Fruit Quality At Harvest and during Storage

Steven A. Sargent*
University of Florida, Gainesville, FL; sasa@ufl.edu

9:30–10:00 AM

Past, Present, and Future of Mechanical Harvest of Blueberries for the Fresh Market: An Industry Perspective

Brian Kreiger*
BEI International, LLC, South Haven, MI; bkreiger@beiintl.com

Thursday, August 2 8:30 AM–12:30 PM Dupont

International Engagement: Linking to Horticulture CRSP and USAID

Sponsors: International Horticulture and Issues (IHI) and International Horticultural Consultants (ICON) Working Groups

Moderator: John L. Griffis Jr.
Florida Gulf Coast University, Ft. Myers, FL; jgriffis@fgcu.edu

Horticulture CRSP and other USAID programs are working to improve food security, nutrition, and incomes of horticultural

producers worldwide. There are several ways to engage in international research and development supported by Horticulture CRSP and USAID, including involvement in Horticulture CRSP's projects, Regional Centers of Innovation, Knowledge Bank, and Trellis Fund. Horticulture CRSP currently supports 15 projects through 18 U.S. university partners in 21 developing countries on topics spanning the entire horticultural value chain. The Horticulture CRSP Regional Centers of Innovation in Kenya, Honduras, and Thailand provide horticultural researchers access to in-country partners, training facilities, office space, in-country facilitation and liaison, and access to in-country communication to arrange training, activities and meetings. The Horticulture CRSP Trellis Fund provides small scale in-country development organizations access to U.S. graduate student expertise providing benefit to both the student and the in-country institutions by matching the organizations with students and providing modest funds to support the organization's farmer outreach program and student travel to the developing country. The Knowledge Bank (http://hortkb.weebly.com) provides credible practical crop information on fruits, nuts, flowers and vegetables to help extension and development workers improve the lives of people in lesser developed countries. The Horticulture CRSP encourages feedback from ASHS conference participants on program enhancements such as technologies and training innovations that might be incorporated into our Regional Centers of Innovation.

8:30–9:00 AM

Overview of the Horticulture CRSP—What It Is and How It Operates

L. George Wilson*
USAID/EGAT/AG, Washington, DC; lwilson@usaid.gov

Amanda Crump
Horticulture CRSP, Davis, CA; acrump@ucdavis.edu

Horticulture CRSP and USAID are working to improve food security, nutrition, and incomes of horticultural producers worldwide. There are several ways to engage in international research and development supported by Horticulture CRSP and USAID, including involvement in Horticulture CRSP's projects, Regional Centers of Innovation, Knowledge Bank, and Trellis Fund. Horticulture CRSP currently supports 15 projects through 18 U.S. university partners in 21 developing countries on topics spanning the entire horticultural value chain. The Horticulture CRSP Regional Centers of Innovation in Kenya, Honduras, and Thailand provide horticultural researchers access to in-country partners, training facilities, office space, in-country facilitation and liaison, and access to in-country communication to arrange training, activities, and meetings. The Horticulture CRSP Trellis Fund provides small scale in-country development organizations access to U.S. graduate student expertise providing benefit to both the student and the in-country institutions by matching the organizations with students and providing modest funds to support the organization's farmer outreach program and student travel to the developing country. The Knowledge Bank (http://hortkb.weebly.com) provides credible practical crop information on fruits, nuts, flowers, and vegetables to help extension and development workers improve the lives of people in lesser developed countries. The Horticulture CRSP encourages feedback from ASHS conference participants on program enhancements such as technologies and training innovations that might be incorporated into Regional Centers of Innovation.

9:00–9:20 AM

Improved Small-scale Vegetable Production and Productivity in Africa with the Use of Agricultural Nets

Mathieu Ngouajio*
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Pierre Guillet
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Almost 33% of the sub-Saharan Africa population, close to 200 million people, is undernourished. One of the contributing factors is the low fruit and vegetable consumption, which

is estimated at 22% to 82% below the intake value threshold of 400 g/day recommended by the World Health Organization and Food and Agricultural Organization. This severe malnutrition leads to many chronic diseases among populations. Most vegetable growers in the region are smallholders with limited access to improved germplasm, pest and disease control tools, and improved crop production technologies. Vegetable farms are routinely devastated by pests, diseases, unreliable rains, and extended drought conditions. The goal of this partnership is to develop low-cost strategies for pest and micro-climate management in vegetable production systems. Studies were conducted in Benin and Kenya to test the impact of agro-nets on pest exclusion and vegetable productivity using cabbage and tomato as model crops. Tomato and cabbage seedlings or transplants were grown either in the open air or under netting. Mesh size was 0.4 mm for transplant production and 0.9 mm for field production. The impact of netting on air temperature and relative humidity varied with location and growing season. Under hot and humid growing conditions (Benin), the air temperature under the nets was too high suggesting the need for nets with large mesh size. In cooler areas (Egerton, Kenya); the temperature increase under the net was beneficial for crop development. The use of nets improved seed germination, seedling establishment, and seedling growth in all growing conditions. The nets were beneficial for cabbage production with a reduction in pesticide input and showed good potential for tomato production. This technology needs more study to develop procedures for climate control inside the nets as well as for irrigation and management of pests that develop inside the net. This project was funded by the United States Agency for International Development (USAID) under Award No. EPP-A-00-09-00004 through Horticulture CRSP at UC Davis. For more information on the project visit http://www.bionetagro.org/

9:20–9:40 AM

African Indigenous Vegetables

Stephen C. Weller*
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The goal of the African Indigenous Vegetables (AIVs) horticulture CRSP is to provide science-based research on African nightshades, Amaranthus, and spider plant to show these crops will improve nutrition while providing food security and income generation for small holder farmers in Kenya, Tanzania, and Zambia. This Horticulture CRSP project is evaluating improved AIV germplasm along with improved production practices, better postharvest handling, and increased market access to achieve these goals.

9:40–10:00 AM

Vegetable Grafting/Protected Agriculture for African Growers

Matthew D. Kleinhenz*
The Ohio State University, Ohio Agricultural Research and Development Center, Wooster, OH; kleinhenz.1@osu.edu

Tomato and pepper production and consumption are key sources of income and nutrition in East Africa; however, production there is limited by various types of stress. Grafting and microenvironment management can reduce these stresses but are underutilized by area farmers. This Exploratory Project is built on the partnership of the Kenya Agricultural Research Institute, 700+ member Kangai Tisa Horticultural Farmers Association and the Ohio State University. We help Kenyan vegetable farmers to use grafted plants and microenvironment management tools (e.g., low/high tunnels) more frequently and effectively. Knowledge and resources developed in this project will also be employed in Uganda and Tanzania.

10:00–10:30 AM

Opportunities in International Agriculture: Perspectives from a USAID Officer

John E. Bowman*
U.S. Agency for International Development, Washington, DC; jobowman@usaid.gov

10:30–10:45 AM

Intermediate Question and Answer Session

John L. Griffis Jr.*
Florida Gulf Coast University, Ft. Myers, FL; jgriffis@fgcu.edu

J. Pablo Morales-Payan
University of Puerto Rico, Mayaguez Campus, Mayaguez, PR; morales.payan@upr.edu

10:45–11:10 AM

South Sudan Coffee Development Program—*Coffea arabica* Germplasm Assessment and Conservation Research Plan

Sarada Krishnan*
Denver Botanic Gardens, Denver, CO; krishnas@botanicgardens.org

Coffee is an extremely important agricultural commodity (Vega et al. 2003) produced in about 80 tropical countries, with an annual production of nearly seven million tons of green beans (Musoli et al. 2009). It is the second most valuable commodity exported by developing countries after oil, with over 75 million people depending on it for their livelihood (Vega et al. 2003; Pendergrast 2009). It is thought that coffee was introduced to Yemen from its origins in Ethiopia around the sixth century (Pendergrast 1999). From Yemen, two genetic bases spread giving rise to most of the present commercial cultivars of Arabica coffee grown worldwide (Anthony et al. 2002). The two subpopulations of wild coffee introduced from Ethiopia to Yemen underwent successive reductions in genetic diversity with the first reduction occurring with the introduction of coffee to Yemen 1,500 to 300 years ago (Anthony et al. 2002). Introduction of coffee to Java, Amsterdam, and La Réunion at the beginning of the 18th century led to further reductions in genetic diversity (Anthony et al. 2002). In addition to Ethiopia, the Boma Plateau of South Sudan (Thomas 1942; Meyer 1965) and Mount Marsabit

in northern Kenya are also considered to be centers of genetic diversity of *C. arabica* (Meyer 1965). A consortium led by Texas A&M University's Norman Borlaug Institute for International Agriculture has been commissioned to support the John Garang University of Science and Technology (JG-MUST). The goal is to improve applied agriculture and technical education, create research capacity and institutional linkages to increase productivity, conservation, and resource management of coffee. The specific research objectives of the Germplasm Assessment and Conservation project are: 1) assessment of genetic diversity of wild populations of *Coffea arabica* in the Boma Plateau; and 2) based on genetic diversity studies, establish a *Coffea* field genebank in South Sudan using specimens representing the greatest genetic diversity.

11:10–11:30 AM

Consulting in Armenia

Richard C. Funt*
Columbus, OH; richardfunt@sbcglobal.net

Dr. Funt has provided various advising and consulting services to Armenia since 2003. Teams have consisted of individuals from Utah, Arkansas, and Texas with the USDA Marketing Assistance Program, the ACDI/VOCA Water to Market Program and UMCOR (United Methodist Committee on Relief) in community development. He has worked with growers and various NGO's in Armenia to improve fruit and vegetable productivity by introducing new rootstocks and cultivars that are disease and drought resistant and possess long term storage capacity and quality. Improving libraries, providing fact sheets in English and Armenian, establishing soil and water testing laboratories, and developing demonstration sites on irrigation are among the many ways that assistance can provide for the future of Armenian agriculture.

11:30–11:50 AM

Developing a Interior Foliage Industry in Bangladesh—A Winrock International/USAID Farmer-to-Farmer Project

John L. Griffis Jr.*
Florida Gulf Coast University, Ft. Myers, FL; jgriffis@fgcu.edu

In recent years, commercial production of cut flowers and ornamental plants in Bangladesh has been increasing gradually and so has the demand for foliage plants and seeds of seasonal flowers. The floriculture industry has increased as a commercial enterprise among farmers and entrepreneurs. A large number of plant shops have opened in Dhaka and in other big cities as well. Bangladesh also has a huge potential to develop an export market in cut flowers, potted plants, cut foliage, peat moss, coco-compost, etc., if quality is maintained per international standards. The floriculture industry faces problems due to the lack of access to modern technical and management practices required for upgrading production, postharvest handling, quality control, packaging and marketing. The specific client for this Winrock International farmer-to-farmer project, BRAC Horticulture Enterprise (BRAC), produces and sells different cut flowers and ornamental plants in the local urban market. However, they lack improved and advanced technology in the following aspects: 1) Production and management techniques (both in field and greenhouse conditions), postharvest handling, packaging, quality control, storage and marketing of cut flowers and ornamental plants; 2) knowledge in seed selection, soil preparation, irrigation, pest management, fertilization, nutrition, plant propagation, proper lighting (photoperiodism), and other relevant issues for ornamental plants; and 3) selection of improved varieties of cut flowers and ornamental plants that are commercially viable for domestic and international markets. BRAC is a development organization dedicated to the alleviation of poverty by empowering the poor to realize their potential and bring about positive change in their own lives. It started out in Bangladesh in 1972, and over the course of evolution, they have established themselves as a pioneer in recognizing and tackling the many different realities of poverty. Presently they have 18 enterprises under different programs. BRAC horticulture nursery started its activities in 1998. For sustainable and consistent development of the enterprise, BRAC has now focused on the urban market. The objective is to take green to every household in Dhaka. So far, BRAC horticulture enterprise has concentrated on ornamental and decorative plant production and sales along with the associated activities especially for urban market. In this regard, BRAC has established a sale store for ornamental and decorative plants in Gulshan, Dhaka City and it has also started selling through 11 superstores. BRAC is a social enterprise. The net surplus generated from the enterprise will be ploughed back to other rural development activities of BRAC.

11:50 AM–12:15 PM

Bridging the GAP: Increasing the Competitiveness of Ugandan Women in the Marketplace

Mary Holz-Clause*
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Increasing the competitiveness of Ugandan women farmers is the focus of the farmer-to-farmer project with Iowa farm women and women farmers in the Kamuli district of Uganda. Ugandan women farmers have previously made strides toward food self-sufficiency, but many still lack the production, postharvest management, and marketing skills needed to generate enough money for their families' needs. Maize is a major food and cash crop for women, and they expressed interest in soybeans as another dual

purpose crop. Both crops are in demand in Ugandan markets. Crop quality has been poor in the district, with estimated losses of 40% of the maize crop. Low grain quality due to high moisture, drying crops on bare ground, and beating maize to thresh it, reduces both the volume of grain available for sale and the price received. Lack of business skills limits farmers' ability to access better markets and improve profitability. Women farmers are anxious to sell more commercially, but lack understanding of business formation that would help them working together to access better markets. The project, funded by USAID, focuses on building both crop management and marketing skills with 80 Ugandan women farmers and improving grain management and business development. Using a proven approach to teaching and techniques, each volunteer group builds upon the work and efforts of previous groups.

12:15–12:30 PM

IHI and ICON Future Program Discussion

John L. Griffis Jr.*
Florida Gulf Coast University, Ft. Myers, FL; jgriffis@fgcu.edu
J. Pablo Morales-Payan
University of Puerto Rico, Mayaguez Campus, Mayaguez, PR; morales.payan@upr.edu

Session to discuss future program direction for IHI and ICON Working Groups.

Thursday, August 2 9:45–11:45 AM
Concourse 1

Invasive Plants: Breeding, Production, Ecology, and Management

Sponsors: Ornamental Plant Breeding (OPB) and Invasive Plant Research (INPR) Working Groups

Moderator: James Altland
USDA–ARS, MWA ATRU, Wooster, OH; james.altland@ars.usda.gov

Globalization of the world economy continues to cause concern over introduction of invasive species, including plants, which are likely to cause harm or economic harm to natural areas or human health. This is especially relevant to horticultural industries, in particular ornamental plant production, that rely heavily on production of non-native plants and importing new taxa to generate continued interest and plant sales. In this complex web of consumer demand, plant breeding and introduction, and globalization of human societies along with their pests and plants, it is unclear where the responsibility lies for introducing, monitoring, and controlling the spread of invasive species. The issue is complex and involves a variety of sectors including plant breeders that make new introductions, landscape ecologists that monitor native habitats, non-government organizations that often act as proponents of "native only" plantings, the nursery industry, and government departments that develop legislation and regulation concerning invasive plants. The objective of this workshop is to unite experts with backgrounds in plant breeding, plant production, landscape ecology, native habitat protection and restoration to provide attendees with the unique, and sometimes overlapping, perspectives on how society and science may respond to the threat of invasive plants.

9:45–10:00 AM

Population Control: Quantifying and Interpreting Measures of Popagule Pressure

Thomas G. Ranney*
NC State University, Mills River, NC; tom_ranney@ncsu.edu

10:00–10:15 AM

Plant Introductions: Resistance, Coexistence or Hostile Takeover?

John Lambrinos*
Oregon State University, Corvallis, OR; lambrinj@hort.oregonstate.edu

10:15–10:30 AM

Florida Nursery Production, Striving to Stay Florida Friendly

Rick Brown*
Riverview Flower Farm, Seffner, FL; rb@floridafriendlyplants.com

10:30–10:45 AM

Protection and Stewardship of Natural Areas Threatened by Invasive Plants

Jim Burch*
Florida Exotic Pest Plant Council, Ochopee, FL; Jim_Burch@nps.gov

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Thursday, August 2 10:15 AM–12:15 PM
Trade Room

Rootstocks: Challenges and Progress

Sponsor: Pomology (POM) Working Group

Moderator: Holly Little
Acadian AgriTech, Sacramento, CA; hlittle@acadian.ca

There has been an ongoing need to develop new and improved rootstocks for horticultural crops. There can be many reasons why rootstocks are preferred or even necessary over own-rooted plants, including dwarfing, pest and disease resistance, and abiotic stress tolerance (salinity, drought). In this workshop we will look at the past and progress of developing rootstocks to meet these needs, as well as evaluation of rootstocks for nutrient uptake and translocation, and root distribution in the soil, as

well as effects on the scion. The many challenges in rootstock development and ways to overcome them will also be presented. The workshop will give examples of the history and progress of breeding rootstocks from several horticultural tree crops, but will be applicable to multiple species.

10:15–10:40 AM

Current State of Pear Rootstock Research: Progress and Priorities

Richard L. Bell*
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Rachel B. Elkins
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Todd Einhorn
Oregon State University, Hood River, OR; todd.einhorn@oregonstate.edu

The industry has been stagnating due to declining consumption of processed pears and competition from imported pears and other fruits, as reflected in the loss of 10,000 acres, or 15%, since 2000. Two major factors in pear acreage decline are lack of precocity and high cost of production. Existing mature trees are large and widely spaced in orchards, and new trees are slow to bear, which discourages replanting. Close spacing accelerates per acre yields, but trees that are planted more closely tend to overgrow their space because growers must still rely on standard rootstocks. Pears are also extremely labor intensive. The U.S. pear orchard situation is in contrast to European, and to a lesser extent, South American orchards, which successfully utilize the truly dwarfing rootstock quince (*Cydonia oblonga* Mill.), which has enabled high density plantings and modern training systems. Quince has been found to lack desirable horticultural characteristics for the U.S., e.g. cold hardiness in the Pacific Northwest, long-term vigor and productivity in California, and fire blight tolerance. Because of the above described scenario, there is broad and deep consensus among all sectors of the U.S. pear industry that achieving efficient (precocious, good yield, fruit size), truly size-controlling rootstocks is imperative for the pear industry to remain competitive nationally and globally. Most U.S. effort has focused on evaluating commercially available rootstocks from the U.S. or other countries and advanced selections from international sources. Worldwide, there are at least 12 active breeding programs developing *Pyrus* rootstocks for European pear, and at least additional nine developing quince rootstocks for pear. A review of the literature identified 24 evaluation programs. This presentation will summarize the current breeding and evaluation research, as well as orchard systems trials in the U.S. We will also outline needed basic and applied research, based on experience and stakeholder input from both the Pacific Northwest and California, which have defined a number of basic and applied research and extension needs. Applied research needs include efficient propagation and orchard systems.

10:40–11:00 AM

Development and Evaluation of Rootstocks for Avocado (*Persea americana* Mill.) Production

Mary Lu Arpaia*
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Greg Douhan
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Zelda van Rooyen
Westfalia Technological Services, Tzaneen; zeldavr@westfalia.co.za

The search for alternate/superior avocado (*Persea americana* Mill.) rootstocks in the United States was initiated in the 1940's as avocado root rot caused by *Phytophthora cinnamomi* was devastating the industry. It was not until 1970, however, that a suitable technique for clonally propagating rootstock material was developed by T. Frolich and R. Platt and another 5 years before this technique was commercialized by H. Brokaw. The first released clonal rootstock, Duke 7, has been widely planted worldwide and has moderate resistance to the disease. Since 1975 several additional rootstocks have been released that have improved resistance to avocado root rot as compared to Duke 7 from both the University of California (UC) program as well as that of Westfalia Fruit Estates in South Africa. While the search for avocado root rot tolerant rootstocks has been the focus of the UC and South Africa programs, salinity tolerant rootstocks has been the focus of the selection program in Israel. Several seedling lines of the West Indian race have been identified that show high tolerance to saline conditions. These programs will be discussed in greater detail as well as the cloning process used to propagate the rootstocks.

11:00–11:20 AM

Evaluating Citrus Rootstock Tolerance to Biotic and Abiotic Stress

Kim D. Bowman*
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Ute Albrecht
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Citrus crops are threatened by a broad assortment of biotic and abiotic stresses. Since many of these have a major effect on the rootstock of the tree, it is critical to use rootstocks that are resistant or tolerant. USDA has an active citrus rootstock development program in Florida, and the evaluation of new candidate rootstocks for tolerance to the important threats is critical for success. Four new rootstocks released by USDA in the past 10 years have attracted large commercial interest, in part, because of resistance or tolerance to several important diseases and abiotic stresses. In addition to long term field trials at multiple locations where tolerance to stress is assessed in a commercial production setting, short term experiments are conducted in the greenhouse or field to assess tolerance to specific diseases or other stresses. Greenhouse studies involving controlled inoculation with citrus tristeza virus

(CTV) or *Candidatus* Liberibacter asiaticus (Las), the suspected causal organism of huanglongbing disease, are used to assess rootstock tolerance to these important diseases. Greenhouse and short term field trials are also used to evaluate rootstock tolerance to *Phytophthora nicotianae* and *P. palmivora*. The recently released rootstocks US-897 and US-942 were observed to have some tolerance to CTV, Las, and *Phytophthora* species. Similar testing is being used to evaluate the tolerance of other rootstocks being considered for future release. Greenhouse studies with high pH soil are also being conducted to identify rootstocks which tolerate conditions of pH 7.5-8.5, which are common in some Florida citrus production areas. Recent results of testing for these biotic and abiotic stresses will be presented.

11:20–11:40 AM

Effects of Groundcover Management Systems on Root Distribution and Demography in an Avocado Orchard

Amaya F. Atucha*
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Ian Merwin
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We conducted minirhizotron observations of root demography and distribution for three years in a newly planted 'Haas' avocado (*Persea americana* Mill) orchard on 'Mexicola' seedling rootstocks, established on a steep hillside in central Chile. Our objective was to investigate whether different groundcover management systems (GMS) affect avocado tree performance and environmental externalities. The general hypothesis was that avocado root phenology, production, morphology, vertical distribution, and lifespan would be affected by GMS treatments. A more specific hypothesis was that avocado tree roots would be negatively affected by belowground interspecific competition from groundcover species that were planted to minimize soil erosion and runoff. The trees were grown in four GMS: 1) Bare Soil (BS), a combination of pre- and post-emergence herbicides; 2) Vegetation Strip (VS), post-emergence herbicide applied in a 1-m wide strip centered on the tree row plus a groundcover mixture seeded between tree rows; 3) A complete groundcover (GC), the same groundcovers as in the VS treatment covering the entire surface of the plots. More roots were observed in the non-bearing year (2009–10) than in the bearing year (2010–11). Trees in BS plots produced the most aboveground shoot and fruit biomass, and they had more shallow and larger diameter roots. Trees in VS and GC plots had more roots in the 31–50 cm depth, and roots of smaller diameter. Lifespans of roots emerging in fall were 54% and 57% greater than those emerging during summer and spring, respectively; and soil depth and root diameter were positively correlated with root survival. Compared with the GC plots, the lifespans of thinner roots (< 0.2 mm) in the BS and VS plots were 61% and 47% greater, respectively. These results demonstrated morphological plasticity of avocado root systems in response to different growing conditions (compared to their native humid subtropical habitat) and to resource and non-resource competition when grown in mixed herbaceous groundcover stands.

11:40 AM–12:00 PM

Elucidating the Genetics of Absorption and Translocation of Macro- and Micronutrients by Apple Rootstocks in the Context of Breeding Populations

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Apple rootstocks are the foundation of a productive apple orchard by providing anchorage, access to water and nutrients, precocity, dwarfing, and disease protection to the scion. During the process of breeding new apple rootstocks, very little attention has been devoted to studying the absorption and translocation of macro- and micronutrients into the scion leaves and fruit. Recent research in our lab has uncovered abundant genetic variation in the apple rootstock germplasm pool for traits relating to plant nutrition. We grafted replicates of an apple rootstock breeding population with the same scion (Gala) and grew these finished trees in a replicated potted trial with uniform soil media and fertilizers. At the end of the growing season we measured leaf mineral concentrations of the leaves (dry weight basis), and used these data to test for genetic influence on the uptake of macro- and micronutrients. Quantitative trait analysis in this breeding population uncovered quantitative trait loci (QTLs) for leaf mineral concentrations of leaves for potassium (K), sodium (Na), phosphorous (P), calcium (Ca), zinc (Zn), magnesium (Mg), and molybdenum (Mo). Correlation analysis of the relationships between different nutrients uncovered significant positive linear correlations between Ca and Cu, Mg, P, and S. A significant correlation was also detected between Cu and K, Cu and P, and also between K and P and between S and P. Segregation of a major QTL for leaf K concentration in certain rootstocks had strong effects on the concentrations of other nutrients in the leaves. We are attempting to understand the physiological influence of these QTLs on other measurable traits in apple rootstocks and scions. It is possible that even subtle changes in plant nutrients caused by variable gene combinations in the rootstocks can affect productivity and disease resistance of apple trees. Of the elite and commercial apple rootstocks released by our program, G.890, G.210, G.935, G.214, CG.5087, and CG.4011; all inherited the high K leaf concentration QTL, while only G.969 inherited the low K allele. The preponderance of the high allele in elite rootstocks might

be a sign of its importance for field performance. The discovery, breeding and selection of efficient absorbers and translocators of mineral nutrients should increase efficiency and predictability for developing better rootstocks and have a positive impact on sustainable apple production worldwide.

Thursday, August 2 10:15 AM–12:15 PM
Sandringham

Significance of Tropical/ Subtropical Tree Fruit Germplasm in Florida and Puerto Rico

Sponsor: Genetics and Germplasm (GG) Working Group

Moderator: Brian Irish
USDA–ARS, TARS, Mayaguez, PR; brian.irish@ars.usda.gov

Tropical and subtropical tree fruit crops are an important component of both the Florida and Puerto Rican agricultural economies providing jobs and millions of dollars in revenue. These aforementioned industries have relied heavily on sourcing new varieties from available plant germplasm with improved horticultural traits. Public, private, state and federal government organizations have dedicated resources for research on tropical/subtropical tree fruit crops. This workshop intends to present the impact of tropical and subtropical tree fruit genetic resources on breeding/selection programs and on the industry in Florida and Puerto Rico as well as show commonalities and marked differences that exist between the two distinct regions.

10:15–10:33 AM

Evaluation of Tropical Fruit Crop Genetic Resources for Commercial Production

Ricardo Goenaga*
USDA–ARS, Mayaguez, PR; ricardo.goenaga@ars.usda.gov

10:33–10:48 AM

University of Puerto Rico, Mayaguez Fruit Crops Research

J. Pablo Morales-Payan*
University of Puerto Rico, Mayaguez, PR; morales.payan@upr.edu

10:48–11:03 AM

The Need for Improved Mango Germplasm for the Puerto Rican Industry

Yair Aron*
Martex Farms SE, Carolina, PR; yair@coqui.net

11:03–11:18 AM

South Florida Tropical Fruit Crops and Germplasm

Jonathan Crane*
University of Florida, Homestead, FL; jhcr@ufl.edu

11:18–11:33 AM

Tropical Fruit Germplasm and Genetic Research At the Shrs: 1987 to 2012

Raymond Schnell*
Mars, Inc., Miami, FL; Ray.Schnell@effem.com

11:33–11:48 AM

Tropical Fruit Germplasm Collecting: The Impact on Agriculture in Tropical America

Richard J. Campbell*
Fairchild Tropical Gardens Research Center, Miami, FL; rcampbell@fairchildgarden.org

Thursday, August 2 12:45–3:45 PM
Sandringham

SCRI Project Director Workshop

Sponsor: Specialty Crops Research Initiative (SCRI)

Coordinator: Thomas A. Bewick
USDA–NIFA, tbewick@csrees.usda.gov

This workshop will provide a forum where SCRI awardees from 2008 can report their findings. Help ARS scientists learn how to develop non-federal matching funds. Consider how to use emergency Hatch funding to develop an SCRI project team. Provide information on writing impact statements.

Thursday, August 2, 2012 1:45–3:45 PM
Balmoral

Changing the Pace Adopting a PechaKucha Approach to Presentations

Sponsor: Teaching Methods (TCHG) Working Group

Moderator: Tim Rhodus
The Ohio State University, Columbus, OH; rhodus.1@osu.edu

This workshop will acquaint the audience with the PechaKucha format for organizing a group of presentations.The term PechaKucha is Japanese for "chit-chat". Under this approach, presenters are restricted to sharing their story through only 20 slides that automatically advance every 20 seconds. The first panel of speakers will present a series of progressive topics targeted to an "Education" audience. The second panel of speakers will deliver talks appropriate for an "Extension" audience and the third panel will address topics of interest to a "Research" audience. Opportunity for questions and answers will be provided between each panel and at the end of the session.

1:45–1:55 PM

Using IPads in the Classroom

Tim Rhodus*
The Ohio State University, Columbus, OH; rhodus.1@osu.edu

Tablet computing and mobile apps have become the cutting edge for new instructional technologies and educators at all grade levels are looking for ways to integrate these technologies into their curriculum. In January 2012, students in the Ohio State course, "Creating a Virtual Perspective" were provided with an iPad 2 tablet for completing various in-class technology-related activities, including: browsing the web to identify new trends in technology, selecting interesting apps from the iTunes App Store for installing on the iPad, performing screen captures and converting the images into online slide shows, making weekly blog postings with embedded audio and video clips, and presenting several presentations to the class. Hardware, software, and wireless requirements for managing the iPad mobile lab will be presented, along with student observations.

1:55–2:05 PM

Using Technology to Teach Floral Design

Terri Woods Starman*
Texas A&M University, College Station, TX; tstarman@tamu.edu

Floral Design/Event Planning is one of five specializations of the horticulture curriculum in the Department of Horticultural Sciences at Texas A&M University. The department is also home to the Benz Endowed Chair of Floral Design. Sixty six percent of the undergraduate students enrolled in the Bachelor of Arts degree and 28% of the total students enrolled in the department declare Floral Design as their major. Horticulture 203, Floral Design, taught in the department, is one of the most-sought after courses on the Texas A&M campus. The enrollment in HORT 203 is limited currently to four lab sections (approximately 72 students) per semester, while demand from students reaches into the hundreds. Clearly, enrollment could be doubled or tripled if additional sections could be offered. A way to increase the enrollment in HORT 203 is by converting the course to a Web-hybrid model, wherein the lectures and lab instruction are delivered in a Web-based mode, with the students coming to the physical lab to construct designs and receive critical feedback. Being a visual field, synchronous computer technology such as learning management systems and web conferencing are conducive to delivering course content. This technology permits students and instructors to have creative exchanges, brainstorm, and interact with the floral industry. Video chat softwares such as ooVoo, Google +, Skype, and others, are multi-user, synchronous software for video collaboration. They can be used for such things as collaboration on themes for special events and allowing visual selection of floral products from wholesalers by students. Another helpful technology for teaching floral design utilizes a web cam mounted on glasses to record short descriptive video segments of floral designs being created. This methodology can be used to demonstrate floral design techniques to the student from the designer's perspective in a spontaneous rather than staged manner. After recording, the video is exported via USB to a computer for storage and reference. Other technologies are being incorporated into teaching floral design to assist students with identification of types of floral products and styles of designs as well as to create e-portfolios for marketing the student's creative and business skills.

2:05–2:15 PM

Involving Undergraduate Students on Hands-on Activities and Research

Bala Rathinasabapathi*
University of Florida, Gainesville, FL; brath@ufl.edu

The objective of this presentation is to outline the presenter's successful strategies and challenges in integrating hands-on activities and research in undergraduate education in Horticulture. Undergraduate research and laboratory education provide the students special opportunities to understand the subject matter in-depth, to relate what they have learned to potential future careers, and to realize the practical usefulness of what they have learned from textbooks, internet, and the class lectures; and to use their creative potential to the fullest. However, for the teacher, undergraduate laboratory education, and project-based learning modules pose special challenges including limited time to bring the project to a milestone, being not able to use research methods that would involve difficult-to master techniques, and the cost in terms of time, human resources, and supplies to generate quality research data or educational product. Taking into account these factors, the presenter has devised a long-term research project in breeding peppers. In the "Building Better Peppers" project, groups of undergraduate students participate in generating (a) educational material for both classroom use and public dissemination, (b) collect literature on a specific topic and generate hypotheses to test, and (c) do supervised research collecting data to test hypotheses focused on a single question. Both the long-term sustainability and the use of low-cost technologies are the special features of this project.

2:15–2:25 PM

Strategies for Using an Active Learning Classroom: The Edible Landscape as a Case Study

Thomas E. Michaels*
University of Minnesota, St Paul, MN; michaels@umn.edu

2:25–2:35 PM

Horticultural Outreach for 5,000+ with Fall Flower & Garden Fest

Richard G. Snyder*
Mississippi State University, Crystal Springs, MS; Rick.Snyder@msstate.edu

How does an Extension Specialist maximize the outreach potential in horticulture and home gardening? This is what this presentation attempts to address in a PechaKucha of exactly 20 slides. Fall Flower & Garden Fest is a culmination of 34 years of evolution and refinement which began as a small experiment station field day (~200 people) for local vegetable growers in

Mississippi. Beginning in the late 1980s, major changes were introduced. These included transitioning from a commercial grower event to one for the general gardening public. To accomplish this, several major changes were implemented: broadening of the diversity of vegetables from a few commercial varieties to about 400 home garden and commercial selections, including specialty crops and ethnic vegetables; adding herbs, roses, annual flower trials, perennials, ornamental grasses, and bananas; displaying winners of the All-America Selections® and Mississippi Medallion programs; installing specialty gardens such as butterfly and hummingbird gardens and a tropical garden; putting special features into the 3-acre garden such as a climbing garden, vegetable tunnel, and a hardscape pergola with both shading and seating. In addition to creating "gardens within the garden", an essential element of growing a gardening event includes education. Currently the Fest has 15 Garden Seminars and 6 guided Walking Tours each day, several demonstrations and workshops, on-site soil testing, and a Plant Doctor Table to address any and all horticultural questions. One of the most successful changes was to bring in nurseries and garden centers to sell plants directly to the public. Sales of plants and garden-related items are extremely popular among participants with thousands of plants being sold each day. As the event grew, it was changed to a 2-day program. Other infrastructure changes that are critical to an event this size are establishing a steering committee with regular planning meetings, creating and updating a website (http://msucares.com/fallfest), arranging for food vendors, solicitation and management of exhibitors and speakers, coordination with other agencies, volunteers, and university personnel, promotion and marketing, and evaluation. The Fest has attracted between 5,000 and 6,000 people from across the region during each of the past few years and we believe it to be one of the largest home gardening events in the southeastern U.S.

2:35–2:45 PM

Installing Rain Gardens at County Extension Offices

Richard E. Durham*
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The University of Kentucky Environmental and Natural Resources Issues Task Force (ENRI) is partnering with local Kentucky County Extension Offices and regional 4-H Camps to install rain gardens. In 2011, ENRI led workshops to install gardens in four counties across the state. These rain gardens resulted from a day-long, hands-on workshop involving local county agents and master gardeners, and were meant as prototypes to develop educational materials and instill interest in local education opportunities regarding water quality. The installation process involves one or more state specialists visiting the site for the potential rain garden, and working with the local organizer to roughly prepare the site on the day before the workshop. Another specialist worked with the local organizer to select and purchase plants prior to the workshop. The workshop consists of participants engaged in presentations about water quality and rain garden design followed by finishing construction of the rain garden initiated the previous day. The rain gardens range in size from approximately 150 sq. ft. to over 400 sq. ft. The most expensive aspect to construction has been plants and mulch and total on-sight costs have generally been less than $500. Additional workshops are planned in 2012 including four involving 4-H staff at each of the regional 4-H Camps in Kentucky. This paper will describe the process of selecting and preparing the rain garden sites and provide a prototype for workshops to teach water quality topics and provide hands-on experience in designing and installing a rain garden.

2:45–2:55 PM

University and Industry Roles in Extension Teaching into the Future

Paul F. Fisher*
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With decreasing extension funding and capacity from traditional university, state, and federal sources, two trends are occurring in floriculture outreach. These include (a) direct outreach delivery by industry, (b) marketing of extension content, primarily by publishing firms, and (c) university-industry consortia with industry sponsorship. Direct outreach by industry has obvious potential bias. However, established allied sectors such as plant breeding/seed or cutting suppliers, media, fertilizer, and chemical companies have PhD-trained technical managers, many of whom have served an "academic internship" as faculty before moving to industry. Publishing firms provide website resources to market and deliver online and printed content from university and industry content providers. The Water Education Alliance for Horticulture (watereducationalliance.org) is an example of a consortium led by the University of Florida, with academic collaborators from multiple institutions, and funding by 17 companies. The Alliance aims to help growers conserve irrigation water and manage water quality issues through a website, workshops, webinars, articles, newsletters, and grower tools. University benefits from a consortium approach include: a secure and ongoing funding stream; funding from multiple competitive sources reduces potential bias compared with a few dominant industry sources ("coopetition"); input by motivated stakeholders on extension and research priorities; marketing of the program by sponsors; and participation by industry experts in workshops and extension materials. Companies benefit from ready access to research priorities and outputs, credibility from association with the university, marketing exposure through sponsor recognition in extension outputs. There are potential pitfalls for extension such as: conflicts of interest between private interest and the public unbiased, and science-based mission; the need for ongoing entrepreneurial effort to maintain funding; and lack of recognition in tenure and promotion of this funding stream.

2:55–3:05 PM

Kansas Healthy Yards and Communities

Cheryl R. Boyer*
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Kansas Healthy Yards and Communities is an environmental initiative of Kansas State University Research and Extension (KSRE). The program's mission is to encourage citizens with yards and who are part of a community to enhance their quality of life through earth-friendly gardening practices. It is centered on 9 healthy yards practices: build and maintain a healthy soil; right plant right place; water wise; mulch; grasscycle and compost; fertilizing; managing yard pests; stormwater runoff and pollution/water quality; and songbirds and butterflies. The program is a product of Cooperative Extension leadership and stakeholder involvement. Extension specialists and county agents collaborated with industry professionals and homeowners to draft an assessment (homeowner quiz) that would give homeowners a place to start improving their yards. Homeowners can take the assessment online at www.KansasGreenYards.org, at a garden show event, or at their local Extension office. Participants "score" their gardening practices to see where they can make improvements. They can then turn to a collection of more than 200 short how-to videos to learn how to put the practices into place. The website has been live since June 2009. Since that time it has attracted 18,333 unique visitors who viewed 94,369 pages on the site (average of 3.69 pages per visit). The Kansas Healthy Yards and Communities program encourages sustainable practices for homeowners as well as landscape professionals in Kansas. The program reduces nonpoint source pollution when homeowners change the way they manage landscape additives and waste (fertilizers, yard debris, etc.). Additionally, sustainable yard practices encourage less water and pesticide use, reduce soil erosion and enhance human quality of life. The development of this program has provided opportunities for industry collaboration and homeowner engagement, facilitated by Cooperative Extension. The healthy yard practices included in the program have been encouraged for many years, but Kansas Healthy Yards and Communities provides a mechanism for homeowners to actively engage in learning to improve their gardening practices, whether they prefer to receive that information in person or online at their own convenience.

3:05–3:15 PM

Ratios of Reproductive to Vegetative Growth in Six Blackberry Cultivars

Eric Stafne*
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Blackberry fruit is gaining popularity in the U.S. and overseas. New cultivars have been developed in recent years that provide more options for growers and homeowners alike. Although proven in major blackberry growing regions around the world, these cultivars have not been tested extensively in potential emerging areas. In Oklahoma, some growers noticed that canes were dying with ripening fruit still attached. The fruit would not reach maturity and thus be unharvestable. One potential cause is an unbalanced leaf-to-fruit ratio. In this study, six blackberry cultivars were used to assess the reproductive and vegetative growth ratios. Three plots with three canes per plot were individually harvested, had leaf counts, and leaf area measurements. Leaves were counted on canes in mid-June, during harvest, and mid-July, immediately after the final harvest. 'Apache' had the greatest number of leaves per berry in June (2.6) and July (2.0). In June, all other cultivars (Chickasaw, Natchez, Ouachita, Triple Crown, and Tupi) were not significantly different from each other, but ranged from 1.4 to 1.1 leaves per berry. In July, 'Chickasaw' was significantly different, having only 0.6 leaves per berry. 'Natchez' produced the most berries and the most leaves. These data may help give insight into the phenomenon of premature cane death.

3:15–3:25 PM

Highlands County Mobile Irrigation Lab

Dianne Jacobson*
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Florida faces water scarcity problems due in part to population increases, tourist, and current drought conditions. Because the nation and world faces many of the same challenges regarding water, scarcity will also have national and global relevance. Irrigation of lawns and landscaping in Florida represents the single largest use of water from our municipal water supplies. This water use has seriously impacted the aquifer, which is a source of our drinking water and water that supports our ecosystems. In addition, fertilizers and pesticides used on lawns are major sources of pollution in our lakes, rivers. According to UF Irrigation Specialist, regular irrigation checks with installation of rain sensors constitute up to a 50% savings of your water use in your landscape. To help the residents within the Peace River Basin area of Highlands County reduce their potable drinking water usage and pollution to our water systems a volunteer mobile irrigation lab in Highlands County was formed and the urban homeowners within the Peace River Basin area were targeted. 428 site visits were performed by checking the condition of the landscape by observing and documenting the existing irrigation system. The goal is to achieve the highest distribution uniformity and efficiency as possible. This is achieved by providing recommendations for improving the design, installation, operation and maintenance of the system. Success requires a commitment on the owner's part to maintain the system to proper specifications and to learn how to operate the irrigation clock and system. The MIL to date has provided a water savings of 102,720 gpd (gallons per day) of potable water. 35 low volume lateral line breaks were found/repaired saving an additional 1,512,000 gpm (gallons per minute) of potable water. When systems were checked and homeowners questioned; 93% of the 428 sites had unmatched precipitation rates/mixed heads, 72% of the 428 sites had their clocks set on the wrong duration, time of day, or not adjusted to seasonal needs and with only 28% of the 428 sites knew how to set their irrigation clock.

3:25–3:35 PM

National Grass Research Trials

Mary Hockenberry Meyer*
University of Minnesota, Chaska, MN; meyer023@umn.edu

Landscape grasses are increasing in popularity and use due to their low maintenance requirements and natural appearance. Many named selections of native grasses are sold today, but few have been tested in any trials to evaluate these grasses for different areas of the United States. In 2012, a group of university and botanic gardens will be trialing approximately 20 native forms of *Panicum virgatum*, switchgrass, and five forms of *Schizachyrium scoparium*, little bluestem, in 11 states at 18 locations. States include Vermont, Ohio, Pennsylvania, North Carolina, Florida, Texas, California, Colorado, Nebraska, Minnesota, and Oregon. Plants will be established in 2012 and evaluated for the following three years. Information from the trials will be compiled and posted on a national website for growers and gardeners to view. Plants will be evaluated for many characteristics including overall growth, pests, flowering impact and duration, foliage color, lodging, cold and heat tolerance, and overall ornamental value.

3:35 PM - 3:45 PM

Bend Me, Shape Me—Light Enhancing Crop Growth

Kent D. Kobayashi*
University of Hawaii at Manoa, Honolulu, HI; kentko@hawaii.edu

Bend me, shape me—you have the power to turn on the light! Light is a key environmental factor influencing crop growth. Specifically, light spectrum can affect growth, morphology, and development. Studies using various techniques to alter light spectrum have shown that they have profound effects. Such techniques include light-emitting diodes (LEDs) and photoselective shadecloths and plastic films. Demonstrating the PechaKucha format, this presentation briefly covers some examples of light spectrum manipulation for growth and flowering of crops.

Thursday, August 2, 2012 1:45–3:45 PM
Dupont

Identifying, Quantifying, and Minimizing Variation in Controlled Environments

Sponsor: Growth Chamber and Controlled Environments (CE) Working Group

Moderator: Gioia D. Massa
Surface Systems Division, Kennedy Space Center, FL; gioia.massa@nasa.gov

The CE working group, along with related organizations, has worked since the late 1970s to reduce variability in environmental and cultural parameters in controlled environments through testing to identify and quantify variability, and through standards development. The original driver for this activity was to improve comparability among experiments conducted in controlled environments by researchers at different locations, and while this goal remains, the increasing use of large controlled environment facilities in commercial agriculture has again brought this concern to the forefront. This workshop will provide an overview of factors contributing to variability in controlled environments, the impact of variability in greenhouses and other controlled environment facilities used for commercial applications such as crop production and high-throughput plant screening, and techniques to identify and minimize problems related to variability. This information will have application to those researchers, ornamental and vegetable crop producers, plant breeders, and plant biotechnologists who work in controlled environments.

Thursday, August 2, 2012 2:00–4:00 PM
Trade Room

Organic Agriculture in the Tropics

Sponsor: Organic Horticulture (ORGH) Working Group

Moderator: James Nienhuis
University of Wisconsin, Madison, Madison, WI; nienhuis@wisc.edu

This workshop will discuss the unique challenges to organic vegetable production in the tropics.

1:45–2:00 PM

Organic Vegetable Production in the Tropics

James Nienhuis*
University of Wisconsin, Madison, Madison, WI; nienhuis@wisc.edu

The risks associated with organic vegetable production in the tropics are greater than those in temperate climates. The objective of this workshop is to discuss the unique challenges to certification, marketing, and pest control associated with organic vegetable production in tropical climates.

Thursday, August 2, 2012 2:00–4:00 PM
Sevilla

Protected Cultivation for Fruit Crops

Sponsor: American Pomological Society

Coordinator: Mercy A. Olmstead
University of Florida, mercy1@ufl.edu

The use of protected cultivation for fruit crops, particularly perennial tree fruits, has not been adopted on the same scale as in annual small fruit and vegetable production systems. However, marketing and environmental constraints have led many

to explore the use of protected cultivation for fruit crops. The challenges in producing fruit crops in protected agricultural systems are currently being addressed by the proposed workshop speakers. The objectives of this workshop are to explore the concepts of protected agriculture as it applies to fruit horticulture, and illustrate the potential for protected agriculture to address biotic and abiotic challenges to fruit production.

2:00–2:30 PM

Micrometeorological Principles of Protected Cultivation

Julie M. Tarara*
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2:30–2:50 PM

Peach Production in China

Desmond R. Layne*
Clemson University, Clemson, SC; dlayne@clemson.edu

2:50–3:10 PM

Strawberries in Protected Cultivated Systems

Russell W. Wallace*
Texas AgriLife Research & Extension Center, Lubbock, TX; rwwallace@ag.tamu.edu

3:10–3:30 PM

Advances on Protected Culture of Strawberry and Blueberry in Florida

Bielinski M. Santos*
University of Florida, Gulf Coast Research and Education Center, IFAS, Wimauma, FL; bmsantos@ufl.edu

3:30–4:00 PM

High Tunnel Production of Sweet Cherries

Gregory A. Lang*
Michigan State University, East Lansing, MI; langg@msu.edu

Thursday, August 2, 2012 4:00–6:00 PM
Sandringham

Advances in Plasticulture Technology and Education Delivery

Sponsor: Plasticulture (PLAST) Working Group

Moderator: E. Barclay Poling
NC State University, Raleigh, NC; strawberrydoc@gmail.com

Innovative uses of plastics will be discussed in the context of high tunnel tomatoes; row covers for vegetable crop production in tropical and temperate climates; and one presentation will focus on utilizing biodegradable mulch (BDM) to increase sustainability of high tunnel tomato production in northwestern Washington. An update on recycling of used agricultural plastics will be provided by an industry member. Because of high soil and organic matter contamination, used agricultural plastics are notoriously hard to recycle. Several successful attempts have been made in the past 2–3 years, and examples of these will be discussed, including a full recycling process in California that includes washing systems, shipment to overseas recyclers, and incineration to provide energy for cement-making operations in Florida and Guatemala. There will be another talk on how high tunnels are being used to extend the growing season of fresh vegetables in an urban environment (Philadelphia). While high tunnels for vegetable production offer well-defined benefits, growers have difficulty practicing crop rotation and this increases risks of soil-borne diseases. Accordingly, the influence on grafting on fruit yield and quality of tomatoes grown in high tunnels will be discussed in relation to a recent trial at the Rutgers Ag Research and Extension Center, Bridgeton, NJ. Finally, a recently retired land grant extension specialist will discuss his new E-advisory service for over 100 strawberry plasticulture growers in 12 eastern states. The *Strawberry Plasticulture E-Advisor,* serves to "translate" weather forecast information from SkyBit Inc.'s patented Strawberry Canopy Forecast, into actionable, preventive measures—using row covers and/or sprinkler irrigation.

4:00–4:15 PM

Rowcovers in Vegetable Crops Production in Tropical and Temperate Climates

Ramon A. Arancibia*
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Rowcovers have been used primarily to extend the growing season in temperate climates, however, in tropical and perhaps subtropical areas rowcovers have been used with other purposes. The most important benefit of rowcovers in temperate areas is the increase in temperature and protection against light freezes which enhances growth early in the season. This is particularly beneficial in vine crops such as sweetpotato and cucurbits. Spun-bonded rowcovers can be used in sweetpotato to enhance production of certified propagation material early in the spring. Similarly, rowcovers allows early harvest and higher yields in cucurbits, however, there is an additional outcome of using rowcovers. Since it does not allow pollination until it has been removed, rowcovers delay fruit set allowing the plant to grow larger and produce more female flowers by the time of rowcover removal. Consequently, the plant bears more fruits, but they may become smaller than without rowcover. In contrast, other attributes such wind protection, insect/disease barrier, and reduced stress are more important in tropical and perhaps subtropical areas. In the U.S. Virgin Islands, spun-bonded rowcovers are used in vegetable crops production mainly for protection against insects, but additional protection against virus transmission is taking place. A benefit of rowcovers that has been overlooked is the role on plant–water relationships. Maximum air temperature under the rowcover can reach 45 to 50 °C in calm sunny days suggesting

extreme stress, but it seems that plants are not affected. This may be explained by the fact that evapotranspiration under the rowcover is reduced significantly allowing the plant to tolerate high temperatures and grow larger. Therefore, rowcover appears to reduce water stress also providing more favorable conditions for plant growth.

4:15–4:30 PM

High Tunnels in the Urban Enviroment of Philadelphia, Pennsylvania

William J. Lamont*
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High tunnels are being used to extend the growing season of fresh vegetables as part of the larger urban agriculture movement in many large metropolitan centers around the county. They are helping to reconnect the urban populations to their food supply, while helping to reclaim vacant land resources and eliminate "food deserts" that exist in many of these urban areas. High tunnels are allowing growers in Philadelphia, Pennsylvania, to produce crops through the winter months when outdoor production is severely limited or nonexistent. The high tunnel initiative in Philadelphia is a dynamic partnership between Penn State University, Penn State Cooperative Extension Philadelphia County, the City of Philadelphia, and numerous non-profit partners. Funding for this initiative came from two USDA Specialty Crops Block Grants. There are numerous things to be considered when erecting a high tunnel in a large city, such as Philadelphia that are not usually part of the process in erecting one in a rural environment. These will be discussed in the presentation.

Specified Source(s) of Funding: USDA Specialty Crops Block Grant

4:30–4:45 PM

Influence of Grafting on Fruit Yield and Quality of Tomatoes Grown in a High Tunnel

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There has been a large increase in the use of high tunnels for vegetable production in the United States. While high tunnels offer well-defined benefits, growers have difficulty practicing crop rotation. This increases risks of soil-borne disease. Past studies have shown that grafting tomatoes onto disease resistant rootstocks can protect plants from soil borne disease, and improve plant growth and yield. A study was conducted in research high tunnels at the Rutgers Agricultural Research & Extension Center, Bridgeton, NJ, to determine if grafting affected tomato yield and quality independent of disease pressure using a bag culture system. The trial compared four tomato cultivars (BHN589, Primo Red, Red Deuce, and Scarlet Red) grafted onto Multifort rootstock with ungrafted plants. Plant height and total marketable yield was greater for all four varieties on grafted plants than the ungrafted plants. When the data was pooled, the mean total marketable yield was 22.94 kg/8 plant plot for grafted plants and 16.71 kg/8 plant plot for ungrafted plants. There was no significant interaction for marketable yield between grafting and cultivar and grafting had no significant impact on fruit size and percent marketable fruit. The availability of using grafted tomato plants is a useful tool for high tunnel growers when unable to rotate crops and subject to disease pressure and for increased productivity in the absence of disease pressure.

4:45– 5:00 PM

Shade Level Affects Microenvironment, Plant Growth, and Plant Function in Bell Pepper (*Capsicum annum* L.)

Juan Carlos Diaz-Perez*
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The objective of this study was to determine the effects of shade level on the crop microenvironment, bell pepper plant growth, and plant function. One bell pepper cultivar ('Heritage') in Spring 2008 and four cultivars ('Camelot', 'Lafayette', Sirius' and 'Stiletto') in Spring 2009 and 2010 were grown under the following shading levels: 0%, 30%, 47%, 62% and 80%. Photosynthetically active radiation, and air, leaf, and root zone temperatures decreased with shade levels. Air temperature decreased less with shading than root zone temperature. Total plant leaf area, individual leaf area, and individual leaf weight increased while the number of leaves per plant and specific leaf weight decreased with increasing shade level. Chlorophyll index (SPAD value) was unrelated to leaf N because of differences in specific leaf weight associated with shade levels. However, chlorophyll index values normalized by specific leaf weight were related to leaf N and increased with increasing shading levels. Leaf temperature, net photosynthesis, and stomatal conductance decreased and internal CO_2 concentration and Photosystem II efficiency increased with increasing shade levels. Leaf concentrations of N, P, K, Ca, Mg, S, Al, B, Cu, Mn, and Zn increased with increasing shading levels, while those of Fe, Mo, Na, and Ni were unaffected by shading. There were relatively few differences in plant growth, leaf gas exchange and leaf mineral nutrient concentrations among cultivars. In conclusion, shade levels significantly modified the crop microclimate ameliorating heat stress and resulting in large effects on plant growth and function. Shading nets reduced light and temperature ameliorating heat stress and improving bell pepper plant growth and function. Intermediate shade levels (30% shade and 47% shade) were the most favorable for bell pepper plant growth and leaf gas exchange.

An asterisk (*) following a name indicates the presenting author.

5:00–5:15 PM

A Private Extension and Risk Management Initiative to Assist Direct Market Strawberry Plasticulture Growers in the Eastern United States

E. Barclay Poling*
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Plasticulture strawberries are expensive to grow but can be profitable with good production and risk management practices. Strawberry producers in Eastern U.S. invest over $12,000 per acre in preharvest production expenses for a crop that is exposed to significant weather risks for over six months. Affordable risk management programs, such as those available through the Federal Crop Insurance Corporation Board for agronomic crops (e.g. tobacco), are not available to strawberry growers in Eastern United States. *StrawberryDoc LLC* (www.strawberrydoc.net) was founded in December 2011, by E. Barclay Poling, Manager, in conjunction with SkyBit, Inc. to help small and mid-level strawberry farmers better manage the most important weather risks associated with strawberry plasticulture production during the critical pre-bloom, bloom, fruit set and fruit ripening periods. The *Strawberry Plasticulture E-Advisor,* serves to "translate" weather forecast information from SkyBit's patented Strawberry Canopy Forecast, into actionable, preventive measures using row covers and/or sprinkler irrigation. This new service was organized with the financial sponsorship of 5 strawberry nursery industry/plug propagation companies in the U.S. and Canada. For a nominal fee of $120/year ($10/month), commercial strawberry plasticulture growers in 12 states (AR, GA, MD, MI, MO, NC, NJ, OH, OK, SC, TX, and VA), are subscribed to a highly interactive internet-based service where they receive day-to-day guidance on production, pest and weather management issues. Also, subscribers receive a twice daily "SkyBit" *E-Weather Strawberry* forecast (via email or fax) from early February through the middle of May. Subscribers are encouraged to provide real-time feedback about the accuracy of location-specific frost and freeze forecasts by SkyBit (and AWIS). In developing advisories, the coordinator of this service interacts via email with grower/subscribers, front-line extension agents, and land-grant researchers in multiple states. Difficult problems like managing strawberry nursery stock infected with bacterial angular leaf spot (*Xanthamonas fragariae*), require very specialized expertise in plant pathology, and it is therefore critical for the coordinator to build and maintain vital relationships with mission-oriented members of the land-grant scientific community. All strawberry plasticulture growers can benefit from having timely, accurate weather forecasts, crop and pest management information. Working together with various land-grant scientists and front-line agents in multiple states, a great deal of critical expertise can be leveraged using "professional learning communities" to solve problems that would otherwise make strawberry plasticulture production unprofitable.

5:15–5:30 PM

Update on Recycling of Used Agricultural Plastics

Keith Williamson*
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Because of high soil and organic matter contamination, used agricultural plastics are notoriously hard to recycle. Several successful attempts have been made in the past 2–3 years, and examples of these will be presented and discussed. These include a full recycling process in California that includes washing systems, shipment to overseas recyclers, and incineration to provide energy for cement-making operations in Florida and Guatemala. A brief presentation will be followed by discussion. Because of high soil and organic matter contamination, used agricultural plastics are notoriously hard to recycle. Several successful attempts have been made in the past 2–3 years, and examples of these will be presented and discussed. These include a full recycling process in California that includes washing systems, shipment to overseas recyclers, and incineration to provide energy for cement-making operations in Florida and Guatemala. A brief presentation will be followed by discussion.

5:30–5:45 PM

The Effects of High Tunnels and Bio-degradable Mulch on Fruit Quality of Tomatoes Grown in Northwestern Washington

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High tunnels provide season extension by adding heat units, which increases the success of tomato production, especially in the cool, marine climate of northwestern Washington. Tomatoes are commonly grown with plastic mulch and there is interest among growers to utilize biodegradable mulch (BDM) to increase sustainability of the production system. Effects of high tunnels and biodegradable mulches (BDM) on fruit quality are not well understood. A study at Mount Vernon, WA, in 2010 and 2011 compared high tunnel and open field marketable fruit quality of tomato cv. 'Celebrity' grown with three commercially-available mulches marketed as bio-degradable: BioBag® (BB), BioTelo® (BT), WeedGuardPlus™ (WG), an experimental spun bonded poly(lactic acid) mulch fabric (PLA), polyethylene black plastic mulch (PEM), and bare ground (NM). Marketability was based on the USDA standard for fresh-market Grade 1 tomatoes in 2010, and a direct-market standard in 2011. In 2010, open field tomatoes were damaged by a severe epidemic of late blight resulting in insufficient replication to compare high tunnel and open field plots. Within high tunnels in 2010, NM (94.73%) produced

significantly more juice than BB (94.25%), WG (94.23%), PLA (94.30%) and PEM (94.12%; $P = 0.0045$); and, BT (94.55%) was juicier than PEM and WG. NM (4.25) produced significantly lower soluble solids (°Brix) than BB (4.67), BT (4.48), PLA (4.63), and PEM (4.69; $P = 0.0055$). There were no statistically significant differences in fruit firmness, pH, and titratable acidity due to mulch treatment in 2010. In 2011, there were no significant differences in fruit quality due to mulch treatment. There were statistically significant differences between high tunnel and open field for juice content (94.40% and 94.08%, respectively; $P = 0.0078$), °Brix (4.72 and 4.98, respectively; $P = 0.0007$), pH (4.17 and 4.09, respectively; $P = 0.0355$), titratable acidity (0.364% and 0.404%, respectively; $P = 0.0001$), and lycopene (10.8 $\mu g \cdot g^{-1}$ and 8.19 $\mu g \cdot g^{-1}$, respectively; $P = 0.0008$). Improved fruit quality attributes found in the open fields may have been due to increased mean photosynthetically-active radiation (PAR), which in 2011 was 299 $\mu mol \cdot m^{-2} \cdot s^{-1}$ inside of high tunnels and 387 $\mu mol \cdot m^{-2} \cdot s^{-1}$ in the open field.

Thursday, August 2, 2012 Tuttle

Environmental Effects on Whole Plant Long-distance Transport

Sponsor: Crop Physiology (CRPP) Working Group

Moderator: Martin P.N. Gent

Connecticut Agr. Expt. Station, New Haven, CT; martin.gent@ct.gov

Environment can affect both the growth and composition of plants. This workshop will focus on the effect of water stress on long distance transport of carbon and nitrogen in horticultural crops.

4:00–4:15 PM

Effect of Drought on Expression of Nitrate Transporter Genes in Apple

Carole L. Bassett*
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Robert E. Farrell
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Nitrogen transporters are members of a large superfamily, the Major Facilitator Superfamily (MFS). This family is ubiquitous and diverse and includes proteins that facilitate the transport of a wide range of substrates across the cytoplasmic or intracellular membranes. Among the proteins encoded by this group of genes are those specifically associated with transport of nitrates into the cell. In a recent analysis of genes responding to simulated drought, a High Affinity Nitrate Transporter from apple roots was identified. Bioinformatic tools were then utilized to identify the apple gene family of nitrate transporters and to compare it to *Arabidopsis* and peach. The promoters regulating expression of these genes have been identified, and the expression of these genes in apples subjected to a simulated severe drought was determined. Implications for the transport of nitrogen in plants under abiotic stress are presented.

4:15–4:30 PM

Variation Among Plant Species in Phloem Loading Strategies and Plant–Water Relations

Lailiang Cheng*
Cornell University, Ithaca, NY; lc89@cornell.edu

Plants differ in terms of water relations and phloem loading strategies, and our recent survey of 45 dicotyledonous species demonstrates a close link between phloem loading strategy and plant water transport. Most herbaceous plants have a high whole-plant hydraulic conductance (K_p), which enables efficient transport of water from soil to leaves to replenish the water loss via transpiration. This allows for the operation of active phloem loading (apoplastic loading or polymer trapping) in these species to an extent that the concentrations of sugars are lowered to a level that is just enough for turgor maintenance. In contrast, most woody plants have a low K_p value due to a low root density and a long and convoluted flow path. This low water transport efficiency requires the leaves of these species to accumulate high concentrations of sugars, which are high enough to drive the diffusion of sucrose from mesophyll cells to sieve element-companion cell complexes for long-distance transport without the need to concentrate sucrose via active loading. Because sugar alcohols (sorbitol and mannitol) have twice the osmolality per unit carbon as sucrose, it renders a potential advantage in maintaining turgor in both mesophyll cells and phloem, which is important not only for water stress tolerance, but also for phloem loading and transport, particularly in passive loading species.

4:30–4:45 PM

Diurnal Variation in Water Potential and Xylem and Phloem Transport

Martin P.N. Gent*
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A mathematical model to describe long distance transport envisions plants as organs or tissues, such as root, stem, and leaf, which are divided into the compartments: cytoplast, xylem, phloem, and apoplast. Short distance movement within each plant tissue is rapid and governed by diffusion of water and/or active transport of metabolites. This leads to a single water potential and a steady state distribution of water and metabolites within any one tissue. Long distance transport corresponds to a flux of water and solutes in xylem and phloem between organs or tissues of a plant. This movement is driven by hydrostatic pressure, related to a water potential gradient in the xylem, and to turgor pressure in the phloem. In the model plant, a conductance is defined for movement of water in xylem and phloem between each tissue. Water flux is the pressure difference between tissues times the conductance. Long-distance flux of metabolites is the concentration in xylem or phloem times the flux of water. The

model incorporated these processes as finite difference equations using the VENSIM dynamic simulation modeling tool. This model predicted a diurnal variation in both solute concentration and flow rate in the xylem. Flow of water was much greater in the light than in the dark, due to transpiration, and metabolite concentrations in the xylem were decreased, because there is a greater change in water movement than in uptake of solutes. Flow in the phloem showed an opposite variation with light. After a transition from dark to light, water potential in leaves decreased faster due to transpiration than it did in the phloem due to accumulation of sugars. Consequently, the turgor pressure decreased early in the day. If conductivity in phloem was sufficiently low, the flow varied relatively little from day to night, because sugar concentration remained high throughout. These diurnal variations in long distance transport altered the availability of nitrate in leaves and sugars in roots.

Thursday, August 2, 2012 4:00–6:00 PM
Balmoral

I Have An App for That: Introduction to Mobile Applications and Development in Horticulture

Sponsor: Computer Applications in Horticulture (COMP) Working Group

Moderator: Arthur Q. Villordon
LSU AgCenter, Chase, LA; avillordon@agcenter.lsu.edu

This workshop will provide overviews of horticulture-related mobile applications and on designing, developing, and testing mobile applications.

4:00–4:30 PM

Are There Horticulture-related Mobile Applications for Me?

Kent D. Kobayashi*
University of Hawaii at Manoa, Honolulu, HI; kentko@hawaii.edu

Mobile devices such as smartphones and tablets (tablet computers) are increasingly being used to supplement the use of laptops and desktop computers. Their compact size makes them portable and convenient to use. These devices provide horticulturists with new tools for their work. Mobile apps (applications) are software applications that run on smartphones and tablets. There are hundreds of thousands of apps available, covering a whole gamut of topics. Many apps are free, whereas others have a cost. They are easily downloaded to a smartphone or tablet, or to a computer and then transferred to mobile devices. Horticulture-related apps for research, extension, teaching, and industry are available. For example, these apps deal with food safety, geographic information systems, image enhancement, hydroponics, insect scouting, turfgrass management and weeds, plant growth regulator calculations, creating and scanning QR (quick response) codes, conservation trees, house plants, landscape design, plant and tree identification, whiteboard, agricultural retailers, crop protection product information, and industry trade publications. This presentation gives an overview of horticulture-related apps that are available out there. Are there horticulture-related mobile apps for me? Yes!

4:30–5:00 PM

Educators Guide to Developing an App

Amy Fulcher*
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Frank Hale
Entomology and Plant Pathology, University of Tennessee, Nashville, TN

William Klingeman
University of Tennessee, Knoxville, TN

Anthony Lebude
Mills River, NC

Karen Rane
Dept. of Entomology, University of Maryland, College Park, MD

Alan Windham
Dept. of Plant Sciences, University of Tennessee, Knoxville, TN

Developing an app for Extension and instruction use is generating interest among faculty, Extension agents, and university administrators. The University of Tennessee with partners at

Clemson University, North Carolina State University, University of Georgia, University of Kentucky, University of Maryland, and Virginia Polytechnic Institute and State University developed an app for professionals working with pest management and plant care of woody plants in the nursery and landscape, IPMPro, and a corresponding app, IPMLite, for the home horticulture market. The focus of this presentation is to familiarize potential educational developers and administrators with the process of developing an app from idea to testing using this development team's experience as a model. Determining the cost, both for software development as well as the subject matter experts' time and any new employees who must be hired to support app development, must be considered early in the development process as well as potential funding sources. Important first steps include developing the idea; identifying the development team members; refining the concept, app appearance, and flow from screen to screen; and establishing team and computer programmer timelines. Once the concept and team are established some of the next steps include identifying the lead institution, determining if the app will be free or fee-based, cost to end user, developing an inter-institutional agreement, as well as vetting software firms, and constructing an appropriate contract. Technical considerations from large issues such as the functionality–interactive or information presentation only and devices on which the app will operate, to smaller ones such as color scheme, font, and even how the app appears in full sun, must be made. Once the framework is built the app database must be populated. Developing an app is a dynamic process that requires detailed planning and closely coordinated collaboration. Apps can be a productive in-state or multi-state collaboration that deliver research-based information to an increasingly mobile phone-savvy clientele and reinforce that land-grant universities are a cutting edge source of information.

5:00–5:30 pm

Educators Guide to Testing, Launching and Promoting an App

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Developing an app for Extension and instruction use is generating interest among faculty, Extension agents, and university administrators. The University of Tennessee with partners at Clemson University, North Carolina State University, University of Georgia, University of Kentucky, University of Maryland, and Virginia Polytechnic Institute and State University developed an app for professionals working with pest management and plant care for plants in the nursery and landscape, IPMPro, and a corresponding app, IPMLite, for the home landscape enthusiast market. The focus of this presentation is to familiarize potential educational developers with the process of testing, launching, and promoting an app using this development team's experience as a model. Once the app is designed and fully populated it must be tested. A systematic testing procedure will be discussed. Testing the app requires volunteers who have different levels of involvement with the development of the app on each platform. The range of time required varies depending on how complex the app is and timed events such as push notifications. Launching an app, including setting up vendor accounts, preparing the required files and images, acquiring the required hardware and software, planning for the time lag during marketplace approval, and staging promotion with launch are critical to a successful release. Utilizing reviews and promotional versions of the app can be part of an effective PR campaign. App promotion should include a professionally prepared press release. How to generate a list of relevant recipients and the development team's role in promotion will also be discussed as will key pieces of information to include in your press release. Proper testing and promotion are critical to releasing a properly functioning app to the appropriate markets. Apps can be a productive in-state or multi-state collaboration that deliver research-based information to an increasingly

mobile phone-savvy clientele and reinforce that land-grant universities are a cutting edge source of information

Friday, August 3, 2012 9:30–11:30 AM
Balmoral

Foliar Nutrition to Enhance Horticultural Crop Production and Quality

Sponsor: Plant Nutrient Management (PNM) Working Group

Moderator: Bielinski M. Santos
University of Florida, Gulf Coast Research and Education Center, IFAS, Wimauma, FL; bmsantos@ufl.edu

The workshop seeks a) to provide the science framework for using foliar nutrition in vegetable and fruit crops and b) to discuss the applied conditions for its implementation. On the first objective, the physiological and environmental aspects of foliar nutrient application, absorption, and assimilation will be discussed over a broad range of crops, with especial emphasis on vegetables and fruit trees. On the second objective, the practical application of diverse molecules and fertilizer sources, application techniques, deficiency monitoring and correction, and limitations of the technologies will be presented.

9:30–9:40 AM

Introduction to Foliar Nutrition

Bielinski M. Santos*
University of Florida, Gulf Coast Research and Education Center, IFAS, Wimauma, FL; bmsantos@ufl.edu

9:40–10:10 AM

Foliar Fertilization: The Facts and the Fiction

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Foliar fertilization is an important tool for the sustainable and productive management of crops, however, current understanding of the factors that influence the ultimate efficacy of foliar applications remains incomplete. Here we provide provide an integrated analysis of the principles, both physico-chemical and biological, known to influence foliar absorption and utilization by the plant, and review the available laboratory and field experimental results to provide insights into the factors that ultimately determine the efficacy of foliar applications. Advancement in this field will require a sound understanding of the physical, chemical, biological, and environmental principles that govern the absorption and utilization of foliar applied nutrients.

10:10–10:25 AM

Properly Timing Foliar-applied Fertilizers Increases Efficacy

Carol J. Lovatt*
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Foliar fertilization efficiently meets the nutrient demand of tree fruit crops during periods when soil conditions (low temperature, low soil moisture, pH, salinity) render soil-applied fertilizers ineffective, when nutrients (e.g., phosphate, potassium, and trace elements) become fixed in the soil, and when tree nutrient demand is high. Applying nutrients directly to leaves ensures that the tree's metabolic machinery is not compromised by low availability of an essential nutrient. It should be noted that phloem mobile nutrients applied to the foliage are translocated to all tree parts, even feeder roots. Because foliar application of fertilizers can reduce nutrient accumulation in soil, run-off water, surface water (streams, lakes, ocean), and groundwater (drinking water supply), where they contribute to salinity, eutrophication or nitrate contamination, with negative consequences to the environment and humans, it is highly desirable to replace soil-applied fertilizers at least in part with foliar-applied fertilizers. However, not all nutrients are taken up through leaves and, even if taken up, some nutrients are not phloem mobile. In addition, although foliar fertilizer rates are typically lower than soil fertilizer rates, application can be more costly. The approach of my research program has been to properly time the application of foliar fertilizers to key stages of citrus and avocado tree phenology when demand for the nutrient is likely to be high and especially when soil conditions are likely to compromise nutrient uptake by roots. This approach has proven successful for increasing yield, fruit size, and grower income even when the tree is NOT nutrient deficient by standard leaf analysis. For *Citrus sinensis* and *C. reticulata*, our research has identified two stages of tree phenology when foliar-applied low-biuret urea increases yield and yield of commercially valuable large size fruit, i.e., when the shoot apical meristem becomes determined and at maximum peel thickness, respectively. Due to the poor uptake of foliar-applied fertilizers by leaves of *Persea americana* under California-growing conditions, different stages of bloom were targeted. Low-biuret urea and boron applied at the cauliflower stage of inflorescence development increased ovule viability and the number of pollen tubes penetrating the ovule, respectively. Both increased yield. In this research, earlier or later foliar fertilizer applications did not increase citrus of avocado yield or fruit size. All properly timed foliar fertilizer applications resulted in a net increase in grower income.

10:25–10:40 AM

Foliar Fertilization with Zinc: From Field Trials to Elemental Transport

Patrick H. Brown*
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Zinc deficiency is a widespread and important deficiency in horticultural crops worldwide and foliar application of Zn has become commonplace in many cropping systems. Information on the effectiveness and longevity of benefit from foliar Zn applications is scant and highly varied and evidence suggests that species, formulation, environment, crop phenology and spray methodology all have significant effects crop response. Results of a limited number of studies utilizing stable isotopes of Zn demonstrate the importance of the leaf cuticle on Zn penetration and suggest that Zn is phloem mobile if entrance into the leaf apoplast occurs. To better characterize the biological and physicochemical determinants of foliar Zn efficacy we have conducted a series of experiments in commercial fields, in controlled growth conditions, in model systems and in isolated tissues utilizing a range of formulations and methodologies. Stable Zn isotopes studies in field and model systems and high resolution micro Xray florescence of in-vivo Zn transport demonstrate that Zn enters the phloem and is transported to 'sink' tissues including fruit and roots. In general Zn formulations of low molecular weight, high solubility and high point of deliquescence are most effective at penetrating the leaf surface, increasing tissue Zn and enhancing transport of Zn to non-treated tissues. There is also a clear relationship between efficacy of the Zn foliar spray and propensity to cause phytotoxicity.

10:40–10:55 AM

Foliar Application of Nutrients and Their Impacts on Growth, Yield, and Quality in Tree Fruits

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Deciduous tree fruit yield and quality will suffer in response to insufficiency of any mineral nutrient; however, there are some elements, including nitrogen (N), calcium (Ca), potassium (K), and boron (B), that are closely tied to fruit quality. Fruit growers have applied nutrients in foliar sprays for many years to influence tree and fruit nutritional status. Sprays of macronutrients and secondary nutrients typically are supplementary to soil applications. Such sprays may be made to target specific plant organs. For example, postharvest and prebloom foliar urea sprays are applied to enhance flower bud vigor, and Ca is applied directly to fruits during the growing season to reduce fruit susceptibility to physiological disorders. Macro- and secondary nutrient sprays also are applied to quickly alleviate nutrient deficiencies that appear suddenly, such as those induced by excessive vegetative growth or elemental imbalances caused by improper applications of fertilizers or soil amendments. Sprays of K, magnesium (Mg), sulfur, and phosphorus fall into this category; however, these elements are more appropriately managed using soil applications. Over-zealous application of N, K, or Mg in foliar sprays can negate the beneficial effects of Ca by inducing elemental imbalances within fruit. Micronutrients typically are applied in foliar sprays to uniformly distribute the small quantities of these required nutrients. Fruit quality is particularly sensitive to fruit B status, with both insufficient and excessive amounts of B causing severe deleterious responses. Recent research focuses on developing foliar spray programs that enhance nutrient phytoavailability, thereby reducing nutrient requirements and minimizing release of potentially deleterious elements into the environment, and that allow safe tank-mixing of multiple nutrients, which would reduce the number of sprays required per season.

10:55–11:10 AM

Foliar Potassium Fertilization Effects on Muskmelon Fruit Quality

John L. Jifon*
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The contribution of inorganic fertilizers to crop productivity is well-established. Adequate nutrient supply with proper placement, timing, and application methods often results in enhanced nutrient use efficiency. Less well-studied, however, is the influence of fertilizers on retail quality and the nutritional and functional quality properties of foods, especially fruits and vegetables which are good sources of essential compounds (phytonutrients) that have been linked with promotion of good health and wellbeing. Sugar content, aroma, appearance, and texture are key quality traits that influence consumer preference for many fruits and vegetables. These quality traits are directly related to potassium (K)-mediated processes. However, due to cultural practices, crop properties, and environmental factors, soil-derived K alone is seldom adequate to ensure the basic consumer quality standards. Controlled environment and field studies have shown that supplemental foliar K applications can overcome this apparent deficiency. However, considerable variation exists with regards to timing of foliar K application as well as suitability of potential K salts for foliar fertilization. Multiyear greenhouse and field studies on the effects of foliar K fertilization on fruit quality parameters of muskmelons [*Cucumis melo* L. (Reticulatus Group)] revealed significant differences in timing (pre- or post-fruit set), as well as K fertilizer source (potassium chloride, potassium nitrate - KNO_3,

monopotassium phosphate, potassium sulfate, potassium thiosulfate, and a glycine amino acid-complexed K). Fruit yields were generally not affected by supplemental foliar K feeding. Several quality parameters (including fruit firmness, soluble solids concentrations (SSC), sugar contents, ascorbic acid, and beta carotene contents) were improved by supplemental post-fruit set foliar K applications. Among K sources, KNO_3 tended to have the least positive effects when applied after fruit set. These observations suggest a reassessment of fertilizer management guidelines with increased emphasis on produce quality. Supplemental foliar K feeding is a practice that growers can easily incorporate into existing foliar pesticide treatments using existing equipment.

11:10 –11:25 AM

Effective Strategies to Temporarily Correct Fe Deficiency in Florida

Monica P. Ozores-Hampton*
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Iron (Fe) deficiency in Florida vegetable crops is a frequent nutritional problem when Fe fertilizer was soil leachate, poor soil aeration, low soil organic matter and temperature, high soil pH, high soil or water bicarbonate content and/or interactions with high levels of manganese (Mn) and calcium (Ca). Characteristics Fe deficiency will be interveinal chlorosis of the base of the younger leaves near the top of the plant due to Fe immobility and poor translocation. Iron deficiency in tomato is characterized by a drastic reduction of the leaf chlorophyll content (bleached leaf) ending in necrotic spots. Iron deficiency can have a great economic impact and is depend when the deficiency occurs in the production cycle. Furthermore, the ability of the root system of tomato to acquire Fe can be influenced by genotypic variations among varieties. Since, Fe availability will be dependent on complex soil and environmental factor; no reliable soil test method can predict Fe deficiency. In soils that are calcareous or alkaline often due to over liming, Fe becomes unavailable with significant reduction of Fe at pH of 7.5. Therefore, do not use calcitic lime to raise Ca levels if pH is adequate (6.5), instead use products such as gypsum or calcium nitrate to increase soil Ca. Iron sulfate (inorganic form) is the most commonly used Fe fertilizer in Florida. Chelates Fe will be an effective, but an expensive Fe alternative. Among chelate sources FeEDDHA should be the preferred chelate fertilizer source for soil application, but the most expensive or soil acidification to lower the pH and allow for the soil Fe availability. Organic matter in animal manures and composts are an effective alternative to increase Fe with positive results in Florida tomatoes. Soil acidification can be an option that will lower the pH and allow for the soil iron to become available. However, Fe applied to the soil will be converted into unavailable forms with high soil pH, thus foliar application is recommended if Fe deficiency symptoms are early, but not late in the production cycle.

Friday, August 3, 2012 9:30–11:30 AM
Dupont

How Can We Best Support Public Sector Development of New Cultivars?—Given Scarce Resources and the Need to Support Rural Prosperity and Sustainable, Secure Food Systems

Moderator: Ann Marie Thro
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A sustained supply of outstanding new crop cultivars is critical to U.S. and global food security. Rural prosperity for growers of our crops is critical for economic and social sustainability of food security. Environmental sustainability underlies all of these. Plant breeding now has over a century of research and technology development, much of it conducted by the U.S. federal/state partnership that includes NIFA and its predecessor agencies. The workshop proposes to engage a national conversation about what are the best ways to leverage existing research and technology, both classical and new, to develop critical knowledge and germplasm, as we go forward into an era where demands are increasing for public sector development of new cultivars.

Friday, August 3, 2012 9:30–11:30 AMFlagler

Modified Atmosphere Packaging: Physiological and Modeling Limits Based on Critical Input Variables

Sponsor: Produce Quality, Safety, and Health Properties (QUAL) Working Group

Moderator: John C. Beaulieu
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Consumption of packaged and minimally processed products has significantly increased. Temperature abuse remains the number one problem regarding postharvest losses. However, optimizing and using properly designed modified atmosphere packaging (MAP) generally counteracts some handling abuse. Although just another tool in the shipping and marketing equation, MAP should be viewed carefully with regard to adequate modeling and safeguards in design to avoid common design pitfalls. Recent mathematical modeling incorporating substantial user-inputs including respiration rate, film thickness, microperforation size, published film permeability coefficients

etc. has delivered robust, incredible models. Unfortunately, the best suited or optimized "programs" are either proprietary or "in-house" and they are not readily accessible to the public. Nonetheless, real world applications continue to fail due to improper "inputs" on parameters such as actual respiration rate, true film thickness and imperfections in perforation/resin dynamics which, vary markedly from supplier to supplier and batch to batch of resin or film. This reality can occur even under ideal temperature management but, is obviously exacerbated by improper temperature logistics often encountered through the vertical supply chain. Currently, there are some programs or companies who offer clients package design help/implementation, for a fee. This workshop proposes to deliver pertinent historical background and mathematical equations through the use of a fully executable Excel-based program where several user-input variables and package designs and their potential pitfalls will be highlighted, illustrated and discussed.

9:30–9:50 AM

MAP: Background, Importance, Benefits, Effects on Produce Quality, and Some Pitfalls

John C. Beaulieu*
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Fresh fruits and vegetables are living organs with continuous within-package catabolic metabolism. Postharvest quality loss is primarily a function of respiration, over ripening, water loss, enzymatic discoloration, decay and rot, senescence and mechanical damages suffered during preparation, shipping and handling. MAP and consumption of packaged and minimally processed fresh produce has significantly increased since the 1990s. Dramatic advances have occurred regarding package technology, film/resin characteristics, packaging machinery, mathematical models, accumulation of base respiration data, and product shelf-life. Several advances have fostered a shift in the pack-n-pray mentality to a science and information-based, user input driven technology. However, numerous materials, designs and/or programming flaws still abound. For example, temperature abuse, imperfections in polymeric co-extrusion layers, thickness, and microperforation sizes, perforation blockage, low O_2 or the anaerobic threshold, and raw materials variety and quality effects skew results and efficacy. Oftentimes a packaged product may look good yet, the consumer can become disappointed based upon expected quality attributes that are not conveyed due to physiological stresses. Through our presentations, we aim to shed light on the more salient problems and deliver plausible package-design solutions based on comprehensive data inputs and programming based critical input variables.

9:50–10:10 AM

New Packaging Approaches with Impact on In-package Gas Compositions

Eva Almenar*
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Although modified atmosphere packaging (MAP) in combination with refrigeration can delay the deterioration of fruits and vegetables and their associated health risk, it is not always sufficient for maintaining produce quality and safety for the desirable marketing period. We will present new packaging approaches that have an impact on in-package gas compositions and therefore, on the quality and safety of produce. These new approaches include: a) the use of bio-based resins instead of petroleum-based ones; b) the impact of antimicrobial interventions on in-package gas composition and the interactions between these; and c) active packaging. Several examples of the effect of each of these new packaging trends on the resulting quality and safety of produce will be given for whole and fresh-cut produce.

10:10–10:30 AM

Engineering or Physiology: What Is Significant to Harness the Benefits of Modified Atmosphere Packaging in Fresh-cut Produce?

Domingos Almeida*
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Modified atmosphere packaging (MAP) is a nearly universal complement to refrigeration in fresh-cut produce. Design of MAP for fresh-cut produce requires the knowledge of gas exchange rates by the product and via the semipermeable barrier enclosing it and the temperature effects on these variables. Models relating product and package variables are available to describe and predict changes in gas composition occurring in the MAP system, at equilibrium or under dynamic conditions. Despite our understanding of MAP engineering, fresh-cut operators often neglect the optimization of gas compositions inside the packages, likely because the benefits fail to materialize in the supply chain—even if relevant under experimental condition. The perception of quality in fresh-cut produce is based on attributes that have a physiological basis. These have different kinetics and are differentially affected by the partial pressures of oxygen or carbon dioxide. Physiological restrictions to the reduction of respiration rate by MAP need to be better documented in horticultural produce. In fresh-cut produce with low Km for respiration rate as a function of oxygen partial pressure, oxygen levels in MAP are not likely to significantly reduce respiration or to prolong shelf life. Under these conditions, there is little or no benefit in optimizing oxygen levels inside the package and the role of MAP is restricted to the

protection from water loss and contamination. Evidence for the strong and differential effects of oxygen levels on individual flavor-important volatiles must also be featured in new recommendations for gas composition and MAP development. A better understanding of the physiological bases of the quality of fresh-cut fruit, including the physiological limitations to quality maintenance, will be very useful to foster innovation in the fresh-cut industry. Trial-and-error approaches can be replaced by science-based approaches based on physiological models.

10:30–11:15 AM

A Practical, User-friendly, Teaching, Research, and Design Tool for Modified Atmosphere Packaging of Fresh Produce

Randolph Beaudry*
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Published models for packaging of fresh produce have been used to describe the response of the plant material in the package or the function of the package with regard to the atmospheres generated. While these models are useful for predicting the performance of the product/package combination, they lack utility for those who design packages. Package designers know the amount of product and package dimensions based on decisions used to target specific market niches. They also know the desirable atmospheres for each commodity based on years of postharvest research, which has clarified the impact of atmospheres on fruit and vegetable storability. They also know, within limits, the temperature profile of the handling and distribution network. What they need to learn is which polymer type, film thickness, or perforation profile will generate their target atmospheres or atmospheric range for specific commodities. We will present and share with participants a model that serves as a decision support tool to specify these package design characteristics for optimal product storage.

Friday, August 3, 2012 9:30–11:30 AM
Concourse 1

What Does Horticulture Scholarship Look Like in the Digital Age?

Sponsor: eXtension (EEXT) Working Group

Coordinator: Eric Stafne
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New advances in methods to deliver teaching, research, and extension information has created uncertainty within the academic community on how to best determine its value. The participants of this workshop will be introduced to the present model of peer review and tenure and discuss how that system may change as information becomes more widely available and faster. Perspectives on digital scholarship delivered through a variety of outlets and methods will be introduced and analyzed. How digitally developed peer-reviewed information is created and its new measure of importance within the academic community with regard to papers, grants, tenure, and related issues will be covered. Structured discussion will allow for an open dialogue on the implications of digital scholarship and its delivery with an eye toward the future.

9:30–9:45 AM

Peer Review, Digital Technology, and Promotion: Putting Them Together Through Extension

Emily Hoover*
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With digital technology increasing the pace at which knowledge is disseminated, how do we in the academic community review and credential our scholarship. I will spend time discussing the history of peer review and how it has evolved within the academic community to credential scholarship. The discussion will then turn to how to credential on-line scholarship in various new formats to fulfill our academic requirements for promotion within the academy.

9:45–10:00 AM

The Concept and Implementation of the Plant Breeding and Genomics Community of Practice

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The plant breeding and genomics community of practice (PBG CoP; (http://pbgworks.org) is funded through the USDA–NIFA plant breeding and genomics competitive grants program and aims to help plant breeders translate basic research into applied outcomes. As improved technology is applied to DNA sequencing and genotyping, costs have decreased and the volume of genetic and genomic data has increased. Such data can be leveraged to improve crops, but successfully implementing genomics-assisted strategies will necessitate changes to the structure and methods used in crop improvement programs, requiring outreach efforts to facilitate adoption in an applied plant breeding context. Our content targets professional plant breeders, their staff, and associated professionals. An assessment conducted within the plant breeding community by an external evaluator revealed a need for training and tutorials demonstrating application of plant genomics tools to crop improvement. To facilitate collaborative content development, a password-protected Drupal work site was constructed. Multiple authors can jointly develop content

and use workflow tools to track progress through writing and the three-tiered review process. PBG resources are available through eXtension at www.extension.org/plant_breeding_genomics and are designed to help visitors access open-source statistical software, analyze high-throughput SNP genotype data, align next generation sequence data, and implement new strategies. The information was collaboratively developed by the Solanaceae Coordinated Agricultural Project (SolCAP), the Conifer Translational Genomics Network (CTGN), the Barley Coordinated Agricultural Project (BarleyCAP), RosBREED, and the Institute of Barley and Malt Sciences. Despite the narrow focus of our audience, more than 150,000 pages and 50,000 videos have been viewed since our launch in January 2011. This reception suggests a need for high quality original content to help put basic research into practice.

10:00–10:15 AM

Packaging Web-based Extension Materials into a Successful Tenure Package

Danielle D. Treadwell*
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10:15–10:30 AM

A View of Digital Scholarship in Extension

Eric Stafne*
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Methods to engage Cooperative Extension clientele are developing rapidly. Social media outlets such as Facebook, Twitter, videos, webinars, and blogs have opened up new venues for extension personnel to generate important information and deliver it in an expeditious manner. There is no question that these methods are found useful by the information consumers; however, many universities fail to adequately address them in the promotion and tenure process. Therefore, those in Cooperative Extension who are engaged in this area know the importance of delivering this information via digital methods to their audience, yet are unsure of the career value of the effort. Junior faculty members must decide whether or not to pursue these avenues of information delivery based on often outdated and vaguely worded promotion and tenure documents. This ambiguity has caused participation issues within eXtension communities of practice, where digital information delivery is standard practice. Traditional peer-review channels are well understood, but new, less formal, options are infiltrating academia as well. The ephemeral nature of some social media must be weighed against the preferred permanence of academic discourse. A new examination of how extension content is valued by the consumer and by colleagues within the academic arena of horticulture is warranted.

Friday, August 3, 2012 9:30 AM–12:00 PM
Gusman

HLB/ACP: Approaches to Management of Disease, Pathogen, and Vector

Sponsor: Citrus (CITR) Working Group

Coordinator: Robert R. Krueger
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Huanglongbing Disease of Citrus, caused by *Candidatus* Liberibacter spp., is considered the most economically damaging disease of citrus world-wide. In the United States, the Asiatic form associated with *C*. L. asiaticus was first reported in Florida in 2004, following the report in 1998 of its vector, *Diaphorina citri*. Since then, the pathogen and its vector have been reported from the major citrus-producing states as well as the minor citrus-producing states. This has resulted in regulatory responses at the Federal level and research into the pathogen, vector, and epidemiology. In addition, research is being carried out regarding horticultural and phyiologically-based management of the disease. This workshop will provide information on the current status of Huanglongbing Disease of Citrus and its vector, the Asian Citrus Psyllid, in the United States. In addition, presentations will be made on research approaches to management of the disease, its vector, and its pathogen.

9:30–9:35 AM

Introduction to the Workshop

Robert R. Krueger*
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9:35–9:55 AM

Unforbidden Fruits: Preventing Citrus Smuggling by Introducing Varieties Culturally Significant to Ethnic Communities

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Citrus and citrus relatives are often hosts of pests and pathogens of quarantine significance. Their fruits, leaves and propagative materials are also commonly smuggled into the United States, and this has caused grave economic harm to growers. As a complement to efforts to interdict smuggling, it can be useful to recognize when smuggling results from the unfilled demand for genotypes that are not readily available through conventional nurseries and clean plant programs. The Unforbidden Fruits project has identified several such species and varieties, and is seeking to ensure that safe pathogen-tested material is available to meet demand in California. The project's initial focus has been on curry leaf (*Bergera koenigii*), used in South Asian cooking, and bael (*Aegle marmelos*), used for Hindu ritual purposes. In both cases the leaves are the primary plant part in demand; this makes them particularly dangerous because the leaves can host the Asian citrus psyllid (*Diaphorina citri*), the vector of *Candidatus* Liberibacter asiaticus, the bacterium associated with Huanglongbing (HLB), a devastating citrus disease. No established procedures exist for the grafting and indexing of such citrus relatives, so the project is first testing seed trees for seed-transmissible diseases, and then distributing seeds to cooperating licensed California citrus nurseries. In addition, the project has acquired germplasm of citron (*C. medica*) suitable for Jewish ritual purposes, which according to religious requirements must be derived from never-grafted stock; this poses challenges to conventional germplasm methods, which rely on collection of budwood and micro-shoot-tip grafting. The project has started distributing seeds of 'Assads,' a rare, prized citron of Moroccan origin, to interested nurseries.

9:55–10:15 AM

Rescue and Preservation of Citrus Germplasm Threatened by Huanglongbing and Citrus Canker

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Richard F. Lee
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Huanglongbing (HLB) and Asiatic Citrus Canker (ACC) diseases are now endemic in Florida and are having devastating impact on the Florida citrus industry as well as the USDA citrus breeding program. HLB became established among numerous promising hybrids at the USDA–USHRL farm in St. Lucie County, FL, and in trees at the A.H Whitmore Florida Citrus Research Foundation Farm in Lake County, Florida. ACC is also present in the St. Lucie Co. site, but as yet not at the Lake Co. site. Many of the trees impacted by these diseases exist only in our populations of segregating hybrids in the field or in a virtually irreplaceable germplasm collection. Starting with the discovery of ACC at the St. Lucie county site, we began a concerted effort to rescue our most elite material from the field. This effort started with moving selected trees to an out of state location to avoid the ACC eradication effort. Following confirmation of HLB at the St. Lucie county site, we began experiments to determine if we could eliminate the HLB pathogen from trees of value to our program. We have investigated a number of protocols, including selective grafting, use of antibiotics and cryopreservation treatment. This presentation will review our successes at rescuing citrus germplasm.

10:15–10:35 AM

Use of Cryotherapy to Eradicate Pathogens from Horticultural Crops

Gayle Volk*
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Cryotherapy is method by which pathogens are eliminated from infected plant materials through the process of cryopreserving and then recovering shoot tips. It has been successfully implemented in potato, sweet potato, grapevine, raspberry, *Prunus*, and other fruit crops to eliminate pathogens that have been difficult to clean-up using traditional methods. *Candidatus* Liberibacter asiaticus (Las), the bacterium associated with huanglongbing (HLB), has been eliminated from *Citrus* using cryotherapy methods. The success of cryotherapy depends on having only cells that do not host pathogens survive the exposure to liquid nitrogen. Meristems up to 1 mm long (including about three leaf primordia) are excised, in contrast to the meristem with one leaf primordium (about 0.1 mm long) in traditional shoot tip grafting. Use of larger shoot tips increases the survival rate and makes the procedures more reproducible. Application of cryotherapy for eradication of other Citrus diseases such as viroids and Citrus tatterleaf capillovirus may provide a better alternative than traditional shoot tip grafting methods.

10:35–10:55 AM

Citrus Production Maintained in a Florida Grove using the Boyd Nutrient/SAR Foliar Spray Program

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Fruit production in Maury Boyd's Orange Hammock Citrus grove in Felda has maintained its production level since being confirmed with citrus greening disease known as Haunglongbing (HLB) in 2006. The trees have been receiving the Boyd cocktail mix of nutrients and SARs (Systemic Acquired Resistance) since HLB was confirmed. The grove is now 95% infected with HLB. The grove consists of 'Valencia' and 'Hamlin' oranges on Swingle citrumelo and Carrizo citrange rootstocks. The mean yield the six years before HLB for 'Hamlin' was 569, and after finding HLB has been 576 boxes per acre. Mean yield for 'Valencia' the six years before HLB was 460, and after HLB has been 454 boxes per acre.

10:55–11:15 AM

Inconsequential Effect of Nutritional Treatments on Huanglongbing Control, Fruit Quality, Bacterial Titer, and Disease Progress

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The use of enhanced nutritional programs (ENPs) to minimize the deleterious effects of the vector transmitted bacterial disease, citrus huanglongbing (HLB) caused by *Candidatus* Liberibacter asiaticus (Las), has been a topic of considerable discussion and debate since the discovery of HLB in Florida. Most reports of the putative effects of ENPs are either anecdotal or based on non-replicated trials lacking untreated controls or proper experimental design and analysis. Even so, Florida citrus producers use this unproven and non-validated approach for HLB management in lieu of integrated control of inoculum including roguing symptomatic trees to reduce inoculum and vector control using insecticides. The composition of the formulation of the ENPs vary considerably, but usually consist of foliar applications of standard essential micronutrients, salts of phosphite, and in some programs, methyl salicylate. Two field trials were conducted on Valencia sweet orange [*Citrus sinensis* (L.) Osbeck] to test efficacy of widely used ENPs. The first trial consisting of a randomized complete-block design with 3 blocks and 4 replicate trees/block was conducted from 2008 to 2010. All trees were PCR+ for Las at the onset, but exhibited only mild HLB symptoms. This stage of infection was chosen based on claims that the ENPs maintain health and productivity of HLB infected trees, thereby extending the orchard's commercial viability. Combinations of components were compared with a control consisting of a standard fertilization and control program for psyllids. Additional treatments consisted of phosphite with Mn-carbonate, Mn-metalosate, Cu-metalosate, or Zn-metalosate, and injection treatments using soluble copper or silver mixed with a polymer. After two seasons of three applications each, there were no significant differences in bacterial titer dynamics, fruit yield, or juice quality between treated and untreated control trees. In a second trial, consisting of six commercial citrus blocks containing 40,885 trees, where enhanced vector control and rouging of diseased trees was practiced, the ENP in three blocks was compared to conventional fertilization in three blocks. In this trial, neither yields, disease progress, nor epidemic dynamics differed between the ENP and conventional fertilization treatments. Results of the large commercial trial corroborated the experimental results of the first trial. Considering both trials together, the ENP did not sustain tree health, yield, or fruit quality of HLB-symptomatic trees. Moreover, since the nutritional supplements had no effect on Las titer, a major concern is that use of existing ENP strategies have promoted area-wide build-up of inoculum and increase disease spread.

11:15–11:35 AM

Practical Management of HLB Disease in a Florida Commercial Citrus Grove

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Huanglongbing (HLB) or greening disease of citrus was first discovered at Southern Gardens Citrus' groves in October, 2005. Southern Gardens' Southern Grove soon became known as the epicenter of the HLB epidemic in commercial groves in Florida. After nearly 7 years, traditional management practices of inspection, elimination of infected trees, vector management, and replanting with disease-free trees have been relatively successful at one large grove, and unsuccessful at another. Field research on the effects of nutritional programs, interaction of HLB with herbicide and other factors, and the development of genetically enhanced citrus trees continues. The importance of controlling the vector of HLB disease, the Asian Citrus Psyllid, is recognized, whether disease management relies on traditional methods, or on the maintenance of infected trees using enhanced nutritional programs.

11:35–11:55 AM

Chinese Way of Huanglongbing (HLB, also Citrus Greening) Management From Nutritional Approach to Heat Treatment

Yulu Xia*
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Huanglongbing (HLB) was first reported in China more than 100 years ago. Despite the long history of the disease, Chinese citrus production has been steadily increasing for the past 60 years. In this presentation, we discuss how Chinese have managed the disease over the past century. We will start with a review of the disease history in China, with an emphasis on the three-pronged approach removal of affected plants, planting disease-free seedlings, and managing insect vector, with the second half detailing "hot topics" such as nutritional approach and thermal treatment for HLB management. The presentation will present data on historical Chinese citrus production, HLB occurrence, and current HLB management practice.

Friday, August 3, 2012 11:45 AM–1:45 PM
Flagler

Vegetable Grafting for Open Field Conditions: Opportunities and Challenges

Sponsor: Propagation (PROP) Working Group

Moderator: Todd P. West
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Fruiting vegetables are amongst the most important specialty crops in the USA. Vegetable grafting, recently introduced to North America, has attracted producer and industry interest alike. Advantages of vegetable grafting include increased vigor and yield, increased abiotic stress tolerances (chilling and salt stress), as well as increasing tolerances to soil borne disease and pests. Vegetable grafting has attracted interest from greenhouse growers and organic producers and there is also great potential for developing more sustainable open-field production systems. Currently, a relatively small amount of grafted plants (~40 millions) are imported from Canada and used in U.S. greenhouse production. An issue unique to the U.S. open-field production is the large number of seedlings needed in a single shipment. Despite the potential value in U.S. fruiting vegetable production, access to grafted seedlings is limited because of the limited local propagation capacity and challenges associated with the use in open fields. Intensive labor input and complexity in logistics tend to increase the costs of grafting, while academic research results began to show the promising efficacy when appropriate scion and rootstock combination was selected. Semi- or fully-automated grafting robots have been invented by several agricultural machine industries. Existing grafting robots have limited adaptation to U.S. propagators because of the lack of flexibility (e.g., in tray size and plant size). Strategies to resolve these issues include use of highly controlled environments for producing standardized seedlings suitable for automation coupled with the incorporation of sorting and grafting robots. This workshop will bring together the leaders from academia and industry that are currently working to assist growers and propagators to adopt this technology, and to conduct problem-solving research taking a systems approach including biology, engineering, and economics. Members of ASHS will be well served and gain great insight on updated research activities and new technologies relating to the developing use of vegetable grafting in U.S. production.

11:45 AM - 12:00 PM

Overview of Vegetable Grafting to Use As IPM Tactics in U.S. Vegetable Production

Frank J. Louws*
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12:00–12:15 PM

Grafting Tomato: Its Use and Challenges to Introduce to U.S. Tomato Production

Michael G. Bausher*
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12:15–12:30 PM

Grafting Watermelon: Its Use and Challenges to Introduce to U.S. Watermelon Production

Richard L. Hassell*
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12:30–12:45 PM

Vegetable Grafting Propagation—Methods, Technology, and Logistics

Chieri Kubota*
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Friday, August 3, 2012 12:30–3:00 PM
Gusman

Good Genes from Asia: Contributions and Opportunities of Asiatic Origin Crops to U.S. Horticulture

Sponsors: Working Group and the Working Group of Asian Horticulture (WGAH) and the Association of Horticulturists of Indian Origin (AHIO)

Moderator: Yan Chen
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Many horticultural crops, including ornamentals, fruits, and vegetables in North America are of Asiatic origin. Asian germplasm resources are important to be considered for the future development of these crops. In addition, despite the long history of germplasm exchanges of many Asian and non-Asian crops over the past centuries, many crops have not been included. The globalization of economy and the increase in immigrants has opened up a market for many Asian crops that are not currently cultivated in the United States. The increased interest in Asian cuisine such as Chinese, Indian, Thai, and Japanese, has increased demand for new foods and new crops. New Asian crops also represent a possible export market for American agriculture. This workshop will review history, current status, and future development of crops with Asiatic origin, and provide an opportunity for researchers to exchange, communicate and discuss germplasm resources and regulatory issues for new crop development.

12:30–1:00 PM

Asian Germplasm in American Horticulture: New Thoughts on an Old Theme

Richard T. Olsen*
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North American ornamental horticulture includes in its cultivated flora, examples from nearly every floristic region of the globe, yet by virtue of a predominantly temperate climate relies heavily on plants derived from the Holarctic kingdom, the dominant floristic kingdom of the northern hemisphere. The historically East Coast-centric horticulture community in the United States gardens is the North American Atlantic floristic region, an area that covers most of the continental U.S. from the Atlantic to Gulf States and through the Great Plains. This floristic region is linked through a common evolutionary path to the Eastern Asiatic floristic region, which encompasses parts of Far East Russia, the Korean peninsula, Japan, Taiwan, and mainland China to the eastern Himalayas. The success of Asian germplasm in American horticulture is due in part, to this shared evolutionary history, climate matching, and pre-adaptability. The East Asiatic floristic region is one of the most diverse in the world, with a high level of endemism across taxonomic ranks and ancient relicts of a once widespread flora. From this, a large number of ornamental genera and species have been introduced, from either a long history of cultivation in Asia or directly from the wild, where they have since become fixtures in European and American gardens. With regard to woody ornamentals, about 700 have been identified for potential inclusion in the U.S. Department of Agriculture (USDA) National Plant Germplasm System (NPGS), more than 50% of these include species from Chinese, Japanese, or Korean floras. Access to these genetic resources is now governed by international treaties, particularly the Convention on Biological Diversity (CBD) and the Nagoya Protocol. Plant genetic resources within the NPGS system are open access, which requires significant vetting of newly acquired germplasm from countries that are party to the CBD. Furthermore, updated plant quarantine regulations have added an additional hurdle to the importation of foreign plant genetic resources. The newly created category within USDA Animal and Plant Health Inspection Service (APHIS) Q37 regulations, not authorized pending pest risk analysis (NAPPRA), restricts the import of plants that may harbor pests or become pests that affect American agriculture. To this end, scientists involved in the collection or utilization of Asian plant genetic resources are affected by recent changes in international and national laws.

1:00–1:30 PM

Gone Global: Familiar and Exotic Cucurbits Having Asian Origins

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Cucurbits are a group of diverse horticultural species grown worldwide. Their fruit are consumed fresh, cooked, or processed, and seeds can be eaten or used for their high quality cooking oil and protein meal. India and Southeast Asia, including China, comprise the primary and secondary centers of diversity, respectively, of cucumber (*Cucumis sativus* L.). India and central and southwest Asia comprise the primary center of diversity for melon (*Cucumis melo* L.), with China as a secondary center. Watermelon [*Citrullus lanatus* (Thunb.) Matsum. & Nakai var. *lanatus*] is important throughout Asia, although its primary center of diversity is west and central Africa. European forms of melon, cucumber and watermelon were introduced to the New World multiple times. Asian varieties of these and other cucurbits [e.g., bitter (*Momordica charantia* L.) and luffa (*Luffa cylindrical* L.) gourds] have been introduced to the U.S from the late 1800s to the present. Sustainability and improvement of U.S. melon, cucumber, and watermelon varieties have been achieved through introgression of genes from their respective Asian germplasm pools for disease and pest resistance, increased genetic diversity, productivity, and quality. Resistance to *Podosphaera xanthii* (Castagne) Braun & Shishkoff was first found in two Indian melons. Three types of resistance to melon aphid (*Aphis gossypii* Glover) were found in melons from India and Korea. *Cucumis hystrix* from China was crossed with cucumber to create the amphidiploid (*Cucumis hytivus* Chen and Kirkbride) through which novel genetic variation was introgressed to cucumber. Gynoecious sex expression in cucumber was derived from Japan. Asian watermelon accessions may be the source for canary yellow flesh, which adds unique nutritional and flavor content to our diet. Technological advancement and genetic improvement pioneered in Asia advanced cucurbit production worldwide. Research on the feasibility of seedless watermelon was initiated in Japan in the late 1920s. Today, seedless types account for a major share of the watermelon market. Grafting, which originated in Asia in 1920s, using disease- and pest-resistant, or cold tolerant rootstocks is essential for sustainable cucurbit production in many parts of the world, and holds great potential as an alternative to methyl bromide fumigation. For example, interspecific hybrids of *Cucurbita maxima* Duch. and *Cucurbita moschata* Duch. ex Poir., two New World species, are the most widely used rootstock for cucurbits in Japan and South Korea, and Indian bottle gourd (*Lagenaria siceraria* L.) introductions of Indian origin are valuable sources of germplasm for breeding multiple disease resistant rootstocks.

1:30–2:00 PM

High-value Vegetables from Eastern Asia

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The Department of Agriculture (DOA), Thailand; Asian Vegetable Research and Development Centre (AVRDC), Taiwan; ASEAN-AVRDC Regional Network (AARNET) Vegetable Science International Network (VEGINET) supported by P. N. Agricultural Science Foundation (PNASF); and the Horticultural Science Society of Thailand (HSST), jointly organized the Regional Symposium: High Value of Vegetables in Southeast Asia—Production, Supply and Demand, which was held January 24–26, 2012, at Lotus Hotel Pang Suan Keaw, Chiang Mai, Thailand. More than 200 participants from about 25 countries participated. This presentation will highlight the recommendations made by participants during the conference and opportunities for technical cooperation between Asian countries and the United States, leading to exchanges of knowledge, technology, and materials in vegetable crops.

2:00–2:30 PM

The Influence of Asian Germplasm on American Berry Crops

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The berry, the botanical fruit that has its seeds incased in fleshy pulp, has provided highly nutritive components to the human diet for millennia. The cultivated small or soft fruits, including strawberry (*Fragaria* L.) and raspberry (*Rubus* L. subgenus *idaeobatus*) have benefitted greatly from Asian heritage. In addition, some Asian berries harvested from wild stands in their native ranges are new to western culture. The objectives of this presentation will be to summarize three aspects of the influence of Asian germplasm on American berry crops: Asian genes in the evolutionary development of octoploid strawberries; Asian *Rubus* species in raspberry breeding; and, additional Asian berries with potential niches for cultivation in the United States. Taxonomists have long observed similarities between Asian berry genera and their American and European counterparts. Recent genetic work has implicated several diploid Asian strawberries as possible genome donors to the octoploid American strawberry species. The latest molecular results will be summarized. While the cultivated red raspberry has been developed primarily from European (*Rubus idaeus* L.) and American (*Rubus strigosus* Michx.) germplasm, Asia is the primary center of diversity for raspberries, subgenus *idaeobatus*. Genes from a significant number of Asian species have been identified and successfully used in raspberry breeding. Disease and pest resistance, improved heat tolerance, improved plant habit, improved fruit characteristics, and increased yield are a few of the characters influenced by Asian genes. Several Asian species such as the blue honeysuckle (*Lonicera caerulea* L.), the rock azalea (*Vaccinium praestans* Lamb.), hardy kiwifruit [*Actinidia arguta* (Siebold & Zucc.) Planch. Ex Miq.)], and magnolia vine [*Schizandra chinensis* (Turcz.) Baill.], will be profiled. These unusual berry species have potential as new crops to diversify small fruit production by American farmers.

Friday, August 3, 2012 3:00–5:00 PM
Gusman

Globalized World: Opportunities and Challenges from Asia for International Horticultural Enterprises

Sponsors: Association of Horticulturists of Indian Origin (AHIO) Working Group and the Working Group of Asian Horticulture (WGAH)

Moderator: Jayesh B. Samtani
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The Asian region presents unique marketing and collaboration opportunities to U.S. based and international horticultural businesses. With the trend of globalization, more companies are collaborating with or expanding into this market and bring significant scientific and economic impact. However, companies often face very different political, cultural, and business environments from home. The objectives of this workshop are to provide a discussion forum for U.S. and international horticultural businesses with operations in Asian countries, to present the unique opportunities and challenges for research and technology development and transfer, marketing and customer service. Topics in this workshop will provide audience the first-hand experience of international collaboration from the view of horticultural enterprises.

3:00–3:15 PM

Market Linkage and Value Chain Infrastructure—Challenge for South Asia for Value-added Horticulture

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The performance of the Indian horticultural sector is still a long way to go. India has a rich biodiversity and different agro-climatic zones suited for a value-added agricultural production system. However, the fragmentation of land and low technology inputs and poor infrastructure is crumbling the overall growth of horticulture market. The main drivers of horticulture growth would be harnessing the relevant adaptable technology, creating a subtle rural cool chain infrastructure and connectivity with efficient value chain and market. Technology transfer and adoptable agricultural processing and value chain will enhance the overall horticulture production as well the growth and linkage to the better market place. Horticulture production and market linkage will enhance farmers income, create more jobs, increase rural household income, strengthening global competitiveness and providing a wide base of platform to establish an efficient linkage of producers, processors with the markets.

3:15–3:30 PM

VFIC's Foods for Health: In the Context of Asian Fruits and Vegetables

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Fruits and vegetables are an integral part of sustaining life on the planet Earth. They are nature's bounty of energy, nutrients, vitamins, and above all an important dietary source of multitude of bioactive components. Advanced processing, storage, rapid transportation and globalization of horticultural products have led to introduction of several Asian fruits and vegetables in various parts of the world. While the driving force for the globalization of certain Asian Fruits and Vegetables could be their taste and flavor, consumer's awareness of health promoting properties is still beginning to unravel. Interdisciplinary Centers/Institutes including the Vegetable and Fruit Improvement Center's (VFIC's) foods for health have initiated research activities to provide "proof of concept" on the role of bioactive components in human health. These types of partnership efforts are critical and challenges still exist to expand to several Asian fruits and vegetables. VFIC's foods for health impact and how those activities can be used as an opportunity for Asian vegetables and fruits will be discussed.

3:30–3:45 PM

Floriculture Marketing in Asian Markets Is Not the Same Old Marketing Experience

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In Western Floriculture markets the marketing programs focus on stimulating sales of cut flowers and pot plants for gifting, while bedding plants are marketed to consumers with an in-ground gardening experience. The emerging Asian flower consumer aspires to many Western lifestyle choices but must shape these aspirations within the local experience. The main driver in shaping the Asian experience centers around housing. High-rise, high-density housing precludes consumers having an extensive in-ground gardening experience. While Europeans may have similar housing stock, they have maintained an in-ground gardening experience through the use of local garden plots. In South Korea, the lack of available land means that the gardening experience must be within the confines of the housing unit. Selecting and breeding plant material that will grow successfully in window gardens is a new use for varieties traditionally grown using in-ground culture. Teaching consumers how to successfully grow plants in a window garden is another challenge. Creating a need to include plants in the house to improve the housing environment is another driver to purchase plants. Another challenge is connecting with the extensive young consumer who has limited or no experience with plants. We will discuss the South Korean experience in establishing the Simply Beautiful brand, which not only connected with the window gardener but also the emerging GenX consumer.

3:45–4:00 PM

Working with Horticulture Research Institutions in China for Economic Impact in the United States

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China is the only country on earth that nourishes unbroken connections of all types of forests and has the most diverse flora of any country in the North Temperate Zone. Floristic and climate similarities, as well as a common latitude and similar land area, between China and the United States make it possible to grow hundreds of Chinese plants for U.S. ornamental plant markets. China has twice as many plants species, as well as three times as many woody species, than the United States. To

bring Chinese plant germplasm resources to our horticultural markets and continue its economic impact on green industries, we should understand Chinese culture and their horticultural research environment. We can achieve this by working closely with Chinese horticultural institutions and horticulturists. Plant exploration is a key to collecting new and underutilized ornamentals. We have to work with a local plant taxonomic institute or a biological department at a university and apply for a Chinese research grant to warrant Chinese governmental support. Ornamental plant research was established in China in recent years. We have to collaborate with Chinese researchers closely and establish research nurseries and trial fields for further evaluation and breeding work. It is also important that we present our collaboration work at international conferences and publish research findings in SCI journals. Early Chinese plant introductions have played, and continue to play, a crucial role for the green industry in the United States. Millions of dollars are generated annually from these plants. Today, we should further explore the potential Chinese ornamental plants and bring their beauty and economic value to our daily gardens, nurseries, and landscapes.

4:00–4:15 PM

Nutrient Enhancement with Microcarbon Technology

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Oral Abstracts

2012 Annual Conference of the American Society for Horticultural Science, Miami, Florida

Tuesday, July 31, 2012 **Windsor**

Undergraduate Oral Competition

Moderator: Tracy A.O. Dougher

1:30–1:45 PM

A Potential Solution to the Nitrogen Dilemma in Modern Agriculture

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In agricultural systems, nitrogen is a necessary component but its use comes at an economic and environmental cost. The genus *Gunnera* is the only angiosperm having evolved a symbiosis with Nostoc, a cyanobacteria capable of supplying the nitrogen needs of its host. We theorize this advantage may be transferred to crops via an integration of *Nostoc* and/or *Gunnera* symbiosis system that may supplement or replace the need for nitrogen fertilizer inputs. The symbiosis is initiated through the establishment of *Nostoc* colonies in every *Gunnera* plant. The *Nostoc* enters through a uniquely evolved gland facilitating the entrance of *Nostoc* alone. To date, our understanding of the *Gunnera-Nostoc* symbiosis is limited. Much of the published work has been conducted in controlled greenhouse and laboratory settings. To further our understanding of the phenomenon as it occurs naturally, we examined *Gunnera* populations and the *Gunnera-Nostoc* symbiosis at Cloudbridge Reserve, in Costa Rica. *Gunnera* functions as a disturbance colonizer, thus all populations examined were found on landslides. Multiple species of *Gunnera* are present in Costa Rica. At this site, we confirmed that *Gunnera insignis* is present based upon anatomical evidence. No signs of hybridization were noted, a phenomenon that has been reported in Costa Rica. *Gunnera* tissue of adult, rhizomatous plants and seedling, non-rhizomatous plants was examined *ex situ* for the presence of *Nostoc* colonies. In adult rhizomes and juvenile crown tissue, we confirmed the presence of *Nostoc*. *Nostoc* colonies were never confirmed in root, petiole or leaf tissue in any plant examined. A distinctively different morphology was noted for juvenile and adult leaves, these data will be presented.

Specified Source(s) of Funding: Environmental Protection Agency Greater Research Opportunities Fellowship

Tuesday, July 31, 2012 **Tuttle**

Teaching Methods 1

Moderator: Douglas C. Needham
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2:00–2:15 PM

The Effect of a School Landscape Project on Environmental Attitudes

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Contemporary children's gardening began in 1993 when the American Horticultural Society held its first symposium based on youth gardening entitled "Children, Plants, and Gardens: Educational Opportunities" (Sealy, 2001). Since that symposium thousands of school gardens have appeared across the country (Robinson-O'Brien and Story, 2009). In a 2005 study, Dirks and Orvis found that third grade participants in the Junior Master Gardener program significantly increased in environmental knowledge and attitudes. Those schools with a garden demonstrated more positive gains than those without. These findings are consistent with the assertion that as environmental knowledge increases, environmental attitudes improve and environmentally friendly behavior tends to follow (Acrury, 1990; Cammack et al., 2002; Newhouse, 1991). In Jan. 2009, a garden project began at Fayetteville School (FHS), a K–12 school in Fayetteville, AL. So far, an expansive children's garden and over 400 trees and shrubs have been installed. Each of Fayetteville's 650 students has had the opportunity to be a part of planting, while many have been much more involved. This study will examine the effects of the landscape project at FHS (experimental group) on middle and high school students' environmental attitudes. Drew Middle School (DMS) and Lincoln High School (LHS) will act as the control group.

2:15–2:30 PM

Articulation between Longwood Gardens' Professional Gardener Program and Institutions of Higher Education

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To expand educational opportunities for students matriculating in the Longwood Gardens' Professional Gardener (PG) Program, new partnerships are being developed with colleges and uni-

versities through articulation agreements. Students graduating from the PG Program typically entered the work force directly, but as industry demand increases for degreed employees, more students are interested in continuing their education. A recent renewal of an existing articulation with Temple University and a newly formed articulation with the University of Delaware have set precedence and provided templates for future partnerships in the region and across the country. The current articulations allow students graduating from the PG Program admission into the two respective universities to achieve a Bachelor's degree in approximately two years. Credits from the PG Program articulate differently for Temple University and the University of Delaware. Temple University grants graduates a block of 52 credits for their program and provides a structured curriculum toward a BS Degree in Horticulture. With the University of Delaware, each course taken by the PG graduate articulates directly toward a BS in Agriculture and Natural Resources. This agreement allows PG graduates with strong academic knowledge and experience in professional horticulture to focus in areas such as agriculture education, economics, communications, or various other foci within the College of Agriculture and Natural Resources. Negotiations are currently underway with Pennsylvania State University, Rutgers University, and the University of Maryland for articulation. The ultimate goal is to expand learning opportunities with institutions in the region and across the country to allow PG graduates additional areas of focus for their BS program.

2:30–2:45 PM

Campus Sustainability—How to Engage Service-learning Students in Programs That Promote Sustainability on Campus

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In Spring 2009, a seminar/projects class was developed as an initiative to engage students and facilitate their involvement in increasing sustainability on the LSU Campus. Service-learning students identified potential campus sustainability projects, and developed project protocols and plans of action. The first semester students developed several topics including: campus composting, a student farm and local food initiative, a campus green waste assessment, and identification of sustainability courses and curricula. The course has been taught for 4 semesters with a succession of students and projects and varying credit (1–3 credits). The community partner for the service-learning projects has been the Manager of Campus Sustainability and many of the projects are directly oriented to support the activities of this staff position. Several of the student led projects have developed to various stages and one has come to fruition. In Spring 2012, a pilot project was implemented to collect waste from the Vet School for composting and students are developing a new student organization and developing plans for a student farm. Overall, the class has been successful in engaging students and student government, generating projects and increasing human capacity, while facilitating change on campus.

2:45–3:00 PM

Genesis of a Sensory Garden: Designing a Place for Everyone

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Horticultural therapy workshops have been conducted at Oklahoma State University for many years. However, instructors lacked adequate facilities to offer an accompanying laboratory section. In order to address this need, a sensory garden was ultimately constructed as a result of funding from the Oklahoma Developmental Disabilities Council (ODDC). The sensory garden, approximately 6000 sq. ft., was designed with a "gathering room" (meeting room frequented by all visitors before dispersing to individual sensory rooms) and five additional rooms each designed to showcase the five human senses; taste, touch, hear, smell and sight. Any given sense was represented by both labeled plant materials and also interactive elements such as a fountain, kaleidoscope and other features. Each room also has its own interpretive signage suggesting plant materials known to enhance or interact well with the respective sensory modality. Sensory garden walls, walkways, etc. were constructed as per American with Disability Act Accessibility Guidelines (ADAAG). Besides listening sessions, garden personnel elicited input from a wide range of people with varying abilities and disabilities to gain unique perspective(s) to further bolster credibility and practicality of design and subsequent usage. With the advent of the OSU Sensory Garden, a myriad of outreach opportunities can now be realized. Besides formal workshops, sensory garden personnel designed the sensory garden via signage and other visual and textural cues to enable self-guided tours which have proven to be the norm for everyday use of the facilities. Due to the nature of specific plant materials and other features within, the OSU sensory garden is open to the public year round with noteworthy features for all four seasons. Future opportunities such as outreach activities and potential enhancement features of the sensory garden will be discussed.

Specified Source(s) of Funding: Oklahoma Developmental Disabilities Council

3:00–3:15 PM

Leadership Development for Life Scientists

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The mission statement of many colleges and universities contain

the words "to train the leaders of tomorrow," yet there are few to no opportunities to formally access leadership skills, consider the scholarship behind leadership models, or practice such skills before being assigned leadership responsibilities in the workplace after graduation. Graduate students, in particular, are usually well-prepared to conduct the science demanded of them, but are often unprepared to manage the human interactions associated with the job. Even graduate programs that contain the word "leadership" in the title often consist mostly of science-intensive courses. We have developed a leadership course for life scientists for the purpose of preparing graduate students for some of the leadership challenges they will encounter after graduation. The course has been taught for 6 years by a team representing a department chair and two specialists in university organizational development. It is held once a week in a 3-hour block to facilitate graduate student schedules. Such a block of time allows one to present background and theory, engage in discussion, and practice a particular skill within one class period. The course begins with an assessment of what it means to be a leader. Assignments include an autobiography of one's own leadership experiences and a biography of someone the student considers a leader. Students take several personality tests such as Myers–Briggs, StrengthFinders and Emotional Intelligence, use these to discover one's own strengths and capabilities, and learn why others are different. Subsequent topics include gender and cultural issues related to leadership, team building, group dynamics, conflict resolution, and optimizing team performance. For the latter half of the semester, students work in small groups to present additional topics related to leadership such as strategic planning, ethics and leadership, building social networks, academic and business etiquette, motivation, shaping a culture, and others of their choice. Role playing is a critical element of the course, as well as small group exercises from which students learn various techniques and implications for their actions and decisions. The course attracts between 20 and 30 students from across the college, but more from those fields that involve a human element such as natural resources, food science, or horticulture. Students have found this course to be quite useful when learning is applied to their interactions with faculty, peers, students, and family.

3:15–3:30 PM

Project-based Education in Public Horticulture

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The Longwood Gardens Professional Gardener Program is a two-year, curriculum-based education in public horticulture, which was established in 1970. Experiential learning is a hallmark of the PG Program, where students are engaged in 12-week blocks of rigorous academic coursework and rotational internships throughout the nearly 1100-acre garden and its 4.5 acres of greenhouses and conservatories. One unique component of the PG Program is the Student Exhibition Garden. The Student Exhibition Garden opened in 2010 as one of Longwood's newest display gardens, and it features the creativity and horticultural expertise of the Professional Gardener students. The concept for the SEG was to integrate team-based and project-based learning directly into the PG students' landscape design curriculum. During the first year of the PG Program, students are enrolled in LAND 1612 Introduction to Landscape Design, where, as teams, they interview their clients about Longwood's theme for the next year, conceptualize and design their four SEG display gardens to the specified budget and theme, and present their designs to a high-level review panel for final approval. During the second year of the PG Program, students continue working on the SEG project through the course LAND 2653 Landscape Design and Construction, where they complete construction documentation, procure plants, develop interpretive materials, and begin installation of the hardscape and hardy plants. The SEG project culminates with the course LAND 2693 Capstone Garden Project, where the PG students finalize the installation of their four display gardens, maintain them throughout the growing season, and communicate through interpretive materials and garden seminars the successes and failures of their gardens with Longwood's over one million guests.

3:30–3:45 PM

Using Student-generated Videos as Learning Tools for Both Horticulture and Collaboration Skills

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New forms of communication and media are used to transfer horticultural information such as internet-based videos. A project was assigned to students in an introductory level horticultural sciences course to develop and display videos as a means of learning and communicating horticulture. The objectives of the project assignment were three-fold; 1) to have students learn specific horticulture information and/or technology of their interest, 2) to translate that information into a consumer level video product, and 3) to have students work in collaboration to accomplish a task and achieve a goal. Students were self-assigned into groups of three to five and given the assignment to work collaboratively to plan, develop and produce a 3- to 6-minute self-operating video on a horticultural topic. A list of 25 example topics was given to each group and each group self-selected the topic. Benchmarks for project achievement were submissions of topic selection, key references to be used in project development, project outline, a script for the project, and a finished project. Students had 5 weeks to complete the task and were given three 50-minute class periods in which to work on projects. Out-of-class activity was required to complete projects. All video projects were submitted and viewed by the class. The projects were evaluated within each team assessing group participation and contribution to project

completion. Projects were evaluated by the class rating videos, and selecting videos for awards in several categories including best production, most useful information, and best visual presentation. Evaluations indicated students enjoyed the nature of the project and enjoyed viewing class projects. Student's self-evaluations indicated students learned information about their topic area in the development and production of the video. Students indicated that, overall, this was a valuable learning experience.

3:45–4:00 PM

Marketing GMO Carnations in Floral Design Shops: Student-designed Policy Formulation

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Genetically-modified organism (GMO) crops provide new trait(s) with market value that may benefit breeder, producer, distributor, and retailer firms as well as consumers for potted, or garden flower and foliage crops in the horticultural distribution chain. Only a limited array of GMO cut flower cultivars exist in the floral markets worldwide, namely carnations, *Dianthus caryophyllus* (9 cultivars, Florigene Moonseries: 'Moonshadow™', 'Moonvista™', 'Moonlite™', 'Moonshade™', 'Moonaqua™', 'Moonique™', 'Moonpearl™', 'Moonvelvet™', 'Moonberry™') and roses, *Rosa ×hybrida* (1 cultivar, SUNTORY blue rose 'Applause'). Unlike in the European Union, labeling of GMO flower products in the U.S. is not required. As a result, many distributors, brokers, wholesalers, floral designers, and most consumers are not aware that GMO flowers exist. To test the acceptance of GMO cut flowers with potential new floral designers, n = 121 students enrolled in Floral Design Class (Hort 1013) during 5 years (2005–2007, 2009, 2011), designed with commercially available standard and mini 'Moonseries' cultivars in the laboratory. Each student created a Hogarth or S-curve design with both types of carnations and assembled a price sheet for their designs. Students examined the differences between GMO lavender/purple carnations and those created with classic methods of spraying, dipping, or infusion. Market cost factors were also presented as considerations for floral designers and their customer base. Each year, students were given an identical question on a midsemester examination to determine their position on GMO cut flowers, including development of a floral shop policy to inform their customers. In 2009, students were also assigned to write a marketing paragraph about their GMO floral design. Student exam question responses ranged from not carrying the GMO products, offering GMO/non-GMO carnation options to the consumer or only selling GMOs. In several instances, consumers were not to be informed of the GMO nature unless they queried about the higher price point. Similarly, marketing paragraphs did not uniformly highlight the GMO nature of the flowers. Implications of these findings for the floral market will be highlighted.

Pomology 1

Moderator: Todd Einhorn
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4:15–4:30 PM

Impact of Groundcover Management Systems (GMSs) on Tree Growth and Yields, and Soil Erosion and Runoff in a Hillside Avocado Orchard

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Potential environmental problems associated with hillside avocado (*Persea americana*) production in Chile include increased erosion and runoff when native vegetation is removed from hillsides, and herbicide applications eliminate groundcover vegetation. Herbicide and fertilizer residues in runoff water may also contaminate water resources in downslope areas. We evaluated four GMSs in a steep hillside orchard typical of new avocado plantings in central Chile: 1) bare soil (BS), a combination of pre- and post-emergence herbicides; 2) vegetation strip (VS), post-emergence herbicide applied in a 1-m-wide strip centered on the tree row plus a groundcover mixture seeded between tree rows; 3) a complete groundcover (GC), the same groundcover as in the VS treatment covering the entire surface of the plots. Three years after tree establishment, trees in the BS plots were significantly bigger and produced more fruit than trees in the two groundcover treatments. Soil bulk density was significantly higher, and soil macroporosity and aggregate stability were lower in BS than the VS and GC systems. Total soil nitrogen (N) and carbon (C) content, C : N ratios, and essential plant nutrient availability were higher in the GC soil than in other GMSs by the end of our study. Runoff volumes, soil losses, PO_4-P, total N (TN), and dissolved organic carbon (DOC) losses were consistently higher in runoff from the BS than VS and CG treatments during the rainy seasons; no detectable runoff was observed in the GC and VS plots during subsequent years. The use of groundcovers is a viable management practice to residue soil erosion and degradation, runoff, and nonpoint-source pollution of drinking water sources in avocado hillside orchards. However, negative effects on tree growth and productivity during orchard establishment explain the reluctance of avocado growers to adopt these GMS practices. Groundcover establishment between tree rows, combined with non-residual herbicide applications within tree rows during the growing season, might provide an optimal combination of soil conservation and tree performance during establishment years in these orchards.

4:30–4:45 PM

Jujube—Chinese Date, a Potential Fruit Crop in New Mexico

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Late frost is the number one issue challenging the fruit industry in central and northern New Mexico. For most fruit growers without frost protection equipment, there was no crop or minimal crop produced in both 2010 and 2011. Good alternative crops are needed for New Mexico and other states with similar weather conditions to give growers more reliable annual revenue. Jujubes, also called Chinese dates, originated in China and have been cultivated there for over 4000 years. Jujubes leaf/bud out 4–6 weeks later than most tree fruit crops, allowing them to avoid late frosts. Jujubes also tolerate a wide range of weather and soil conditions with pH ranging from 5.5 to 8.5. Mature jujube trees can tolerate –20 °F in winter. In addition, Jujube flower buds initiate, bloom, set fruit, and mature within one growing season, which contributes to its reliable crop each year. Although jujubes are a novelty crop to most New Mexicans, there are existing trees scattered across the state from La Mesa and Las Cruces near the south border, Silver City, South Valley, Los Lunas, Albuquerque, Tucumcari, to Alcalde in northern New Mexico. All of the existing trees have been growing and producing reliable crops under the hot and semi-arid New Mexico climate conditions. So far, jujubes are disease and pest free, which makes them easy for organic production in New Mexico. Jujube fruit itself is very nutritious; it contains 200–500 mg of vitamin C per 100 g of fresh fruit 100 times higher than apple and peach. Jujubes are very popular in China and people consume them for both nutritional and medicinal purposes. Fresh jujubes can be eaten raw and are very sweet and crisp; dried fruits can be eaten alone or cooked in porridge or broth to add flavor. Besides being eaten fresh and dried, jujubes are also processed into candied fruit, smoked fruit, juice, jam, wine, mixed beverages, powders, and tea. In addition, jujube paste is widely used as pastry filling and is one of the most popular moon cake flavors in China. With its late leaf-out date, wide adaptation, reliable crop, and nutritional benefits, jujube would be a great fruit producing and ornamental tree. It also has big potential for commercial production in New Mexico. Detailed research is needed for cultivar selection, cultivar compatibility, culture management, and marketing strategies.

4:45–5:00 PM

Effect of Calcium Sources on the Occurrence of Bitter Pit of 'Gamhong'/M.9 Apple Cultivar in Korea

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The 'Gamhong' apple cultivar bred by RDA in Korea has interested customers and farmers with its big size and high soluble solid contents. The cultivar, however, is very sensitive to bitter pit, and many farmers dislike cultivating them. This experiment was carried out to reduce bitter pit in 7-year-old 'Gamhong'/M.9 cultivars using different calcium sources. Treatments consisted of the control, soil application of limestone (200 kg/10 a), foliar sprays of 0.3% and 0.5% $CaCl_2$ (applied 2 and 4 times), and 2% $CaCO_3$ (applied 4 times). Foliar spray of calcium was applied at 1-week intervals from 45 days after full bloom. Results showed that the leaf calcium content significantly increased when applied 4 times with 0.3% and 0.5% $CaCl_2$, when compared to the control. The index of bitter pit (0 to 5) significantly decreased when applied 4 times with $CaCl_2$ at 0.3% (0.86) and at 0.5% (0.82) compared to 2.25 of the control. Meanwhile, the soluble solid content of fruit was decreased more 4 times than 2 times in 0.5% $CaCl_2$. Results also showed that there was more significant reduction in the soluble solid content when 0.5% $CaCl_2$ was used as compared to 0.3%.

5:00–5:15 PM

Cell Wall Composition and Ethylene Synthesis Are Altered in Transgenic Apple with Decreased Sorbitol Synthesis

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In transgenic 'Greensleeves' apple trees with decreased sorbitol synthesis, sucrose accounts for a larger proportion of the carbon exported from leaves to fruit whereas leaf photosynthesis remains largely the same. In response to this increased sucrose supply, sucrose metabolism is up-regulated in fruit, leading to homeostasis of both fructose and sucrose but much higher concentrations of glucose and galactose at harvest. However, it is not known whether cell wall composition and fruit

ripening are affected. In this study, fruit samples were taken at regular intervals from 5 weeks before harvest to 3 weeks after harvest to measure cell wall composition, fruit firmness, internal ethylene concentrations and the expression levels of key genes involved in ethylene synthesis. Compared with the untransformed control, transgenic fruit had greater firmness, but higher levels of internal ethylene. These corresponded to higher concentrations of cellulose and semicellulose, and higher expression levels of both ACC synthase 1 (*ACS1*) and *ACS3* and ACC oxidase 1 (*ACO1*). These results indicate that enhanced sucrose metabolism in apple fruit alters cell wall composition and ethylene synthesis, thereby affecting its firmness and ripening process.

5:15–5:30 PM

Suppression of the Expression of C Type Sucrose Phosphate Synthase via RNAi Decreases Sucrose Synthesis without Altering Photosynthesis in Apple Leaves

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Both sorbitol and sucrose are synthesized in the cytosol of mesophyll cells as end-products of photosynthesis in apple leaves. Our previous work has shown that antisense inhibition of sorbitol synthesis leads to an increased starch synthesis in the chloroplast during the day and enhanced starch degradation for sucrose synthesis at night, thereby maintaining leaf photosynthesis. It was hypothesized that an analogous mechanism operates with regards to sucrose synthesis in apple leaves. In this study, we decreased the expression of C type sucrose phosphate synthase (SPS), the main isoform of SPS, in apple leaves via RNAi to test this hypothesis. The expression level of C type SPS was decreased to approximately 30% to 40% of that in the untransformed control. Correspondingly, leaf sucrose concentrations were decreased to 30% to 40% of the control level. Leaf starch levels were elevated in the leaves of transgenic trees at the end of the day and starch degradation was enhanced at night. Leaf sorbitol concentration was similar between transgenic plants and the control during the day, but was higher in the transgenic plants at night. Leaf photosynthesis and plant growth were not altered. These data along with the results obtained previously on transgenic plants with decreased sorbitol synthesis indicate that presence of two branches for end-product synthesis in the cytosol of apple leaves, along with starch synthesis in the chloroplast, enables the system to compensate for an interruption of either branch without affecting photosynthetic carbon acquisition.

5:30–5:45 PM

Applications of Stimplex™, an Extract of *Ascophyllum nodosum*, Improve Apple Yield under Both Water Stress and Fully Irrigated Conditions

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Limited water for agricultural production is becoming more of a commonplace. Water can be less available due to drought, or reduced water availability due to other demands. The objective of this study was to evaluate the effect of a commercial extract of *Ascophyllum nodosum* (ANE) (Stimplex™ ,Acadian Seaplants Limited) on yield and fruit quality of apples under full irrigation and water stress conditions. The experimental orchard was a block of 'Top Export Fuji' at the University of Idaho Parma Research and Extension Center. ANE treatments consisted of control, ANE foliar, and ANE foliar plus soil applications. Both ANE treatments received foliar applications at tight cluster, petal fall, and 5–10 mm fruit. The foliar plus soil treatment received additional soil applications, once per month, throughout the growing season. Beginning with the first irrigation in May, trees received irrigation at either 100% or 65% crop evapotranspiration (ETc). Tree growth, yield, and fruit quality data were collected. There were no statistically significant differences in shoot growth and most quality attributes between the controls and ANE treatments under either irrigation level. However, under water stress, ANE foliar + soil treated trees had numerically longer shoots than the water stressed controls. Individual fruit weight was similar across all treatments. Water stress reduced total yield per tree, by reducing fruit number, not individual fruit weight. In both 100% and 65% ETc, ANE treatments significantly improved yield. ANE treated trees under 65% irrigation had total fruit weights per tree similar to the fully irrigated trees, while control trees were lower. Applications of ANE may have resulted in a reduction of "June drop" or reduced the effect of environmental stress leading to increased fruit set. The increased set did not result in a decrease in fruit size. There were no differences in fruit color across any treatments, however there were some differences in soluble solids and starch degradation pattern. Previous studies have shown that ANE can reduce water stress and wilting as well as improve plant growth and water status under water stress in potted herbaceous and woody plants. This trial extends the benefits of ANE applications under water stress to yield in a commercial production system, and also supports previously demonstrated benefits non-stressed apple production systems.

5:45–6:00 PM

Cold Hardy Quince Identified in the USDA Germplasm Collection: Potential Rootstock Candidates for Pear

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Quince (*Cydonia oblonga* Mill.) clones are a preferred rootstock for pear due to their size controlling influence on the scion, but lack cold hardiness for northern latitude sites. We evaluated cold acclimation, minimum hardiness, and freeze tolerance of phloem, cambium, and xylem of 56 clonal quince accessions and two intergeneric hybrids in an in-situ collection located at the USDA clonal genebank in Corvallis, OR. Seven *Pyrus* accessions ranging from sensitive to hardy, including leading commercial U.S. rootstock clones, were used as standards. Additionally, we evaluated three *Amelanchier* sp. clones from the Bavarian Center for Fruit Crops, Hallbergmoos, Germany. One-year-old shoot samples were screened monthly, September through March (2009–12). Samples were loaded into a programmable freeze chamber [in 4 replications (1 per day)], frozen at 4 °C per hour and removed following 1 hour at each of five treatment temperatures (0 °C, –10 °C, –20 °C, –30 °C, and – 40 °C). Following a 7-day incubation period (20 °C), samples were sectioned transversely and observed under a stereomicroscope for percent oxidative browning of phloem, cambium, and xylem. In all years, peak hardiness was attained in December/January, irrespective of the accession. At peak hardiness, tissue browning of 22 of the 56 quince accessions and both intergenerics was <50% following exposure to –30 °C (based on 3-year means). All Amelanchier clones were hardy to –40 °C. None of the pear accessions tested, including 'OHxF 87' and 'OHxF 97', *Pyrus ussuriensis,* and several scion clones were hardy to temperatures below –30 °C. Beginning in mid-late January, deacclimation was evident as tissue injury was observed at higher temperatures. We observed greater browning in the cambial zone throughout the measurement period, especially in early fall, and late spring, followed by xylem. Phloem developed the greatest hardiness in mid-winter. Differential thermal analysis (DTA) data confirmed these observations. In mid-winter, low-temperature exotherms were not observed for phloem tissue at temperatures to –50 °C. Cold acclimation and minimum hardiness levels will be discussed relative to ambient temperatures (minimum and mean) recorded at the genebank. A novel grafting system to evaluate regrowth relative to oxidative browning and DTA data will be presented.

Wednesday, August 1, 2012 Balmoral

Plasticulture

Moderator: Christine M. Bradish
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8:00–8:15 AM

Comparison of Health-beneficial Secondary Metabolites in Red Raspberry Grown under Field and High Tunnel Production Systems

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High tunnels offer numerous benefits and have been adopted for wide usage in raspberry production in the United States, primarily with fall-fruiting primocane cultivars. Use of high tunnels extends the harvest season, increases yields, and improves overall fruit quality with minimal economic inputs. Marketable yields are also significantly increased with fewer pesticide inputs because fruit is protected from moisture, frost, and wind. The effect of high tunnel production on the production of plant secondary metabolites is less well defined. In this study, anthocyanins, ellagitannins, and carotenoids were measured using high performance liquid chromatography (HPLC) for three fall-fruiting red raspberry cultivars ('Autumn Britten', 'Caroline', and 'Nantahala') grown at three locations in North Carolina in field and under high tunnel cultivation. At 520 nm, HPLC detected either four or eight anthocyanins (measured as mg/g cyanidin-3-glucoside equivalents), depending on cultivar. Eight anthocyanins each were detected in 'Autumn Britten' and 'Caroline', and four anthocyanins in'Nantahala'. Using HPLC wavelength at 280 nm, two phenolic acids (measured as mg/g ellagic acid equivalents), specifically ellagitannins, were identified in all three cultivars. Using ANOVA, the primary contributing factor to variation in anthocyanin concentration was cultivar, with no significant differences in content found for most of or the majority of detected anthocyanin and phenolic acid compounds between field and tunnel grown fruit samples. The exception was cyanidin-3-glucoside, where samples grown under field cultivation (4.061 mg/g) had significantly higher ($P = 0.008$) levels than those grown under tunnel cultivation (3.440 mg/g). This is consistent with our related research, where cyanidin-3-glucoside levels increased as exposure to temperatures over 29 °C increased during the harvest period. Our results suggest that the sheltered environment of the tunnel has a cooling effect on the fruit, which may in turn affect the accumulation of cyanidin-3-glucoside. Additionally, the carotenoid profile was determined for these berries and production components. Only cultivar significantly affected values, with 'Nantahala' having less beta and alpha carotene than 'Autumn Britten' or 'Caroline'. Our findings show that germplasm had the strongest effects on the type and content of secondary metabolites in raspberry fruit.

Specified Source(s) of Funding: USDA–NIFA Kannapolis Scholars Program

8:15–8:30 AM

Season Extension Strawberry Cultivar Trial in Two Climatically Diverse Regions in Arkansas

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To determine the feasibility of off-season strawberry production under high tunnels, a cultivar trial was established in Fayetteville and Hope, AR (northwest and southwest region, respectively). In Sept. 2010, at Fayetteville, two cultivars, 'Albion' and 'Strawberry Festival', were planted on two planting dates. In 2011, 'Elyana' and 'Radiance' were added to this trail. At Hope (2011 only) trial included 'Albion', 'Strawberry Festival', 'Elyana', 'Camino Real', and 'Radiance'. Data collected at both locations included plant survival, crown number, total and marketable yield, average berry weight, and pest susceptibility. In Fayetteville, for both years, fruit harvest began at the end of November and in Hope, the harvest began at the end of October. Production continued throughout the winter at both locations. Yields in Fayetteville were relatively low. The average winter harvest yield per cultivar ranged from approximately than 600 lb/A to 1,500 lb/A the first year and from 800 lb/A to 1800 lb/A the second year. In Hope, the average yields ranged from 1,800 lb/A to 3,300 lb/A. In Fayetteville, 'Albion had the highest yields both years, with significant differences between it and the other cultivars. In Hope, Albion had lower yields than all cultivars except 'Elyana' though the difference was only significant with 'Radiance.' 'Radiance' had significantly higher yields than all other cultivars in Hope. In all cases, earlier planting dates yielded higher than the later planting date. 'Strawberry Festival' did not have the highest yields, however it was rated the best performer at both locations because of its lower pest suceptibility and consistent production. Although 'Radiance' had the highest yields in Hope, and 'Albion' had the highest yields in Fayetteville, they both had significant pest problems. We conclude that winter yields in southern Arkansas are sufficiently high to recommend this production system for commercial production.

Specified Source(s) of Funding: Arkansas Agriculture Dept.

8:30–8:45 AM

High Quality Winter Strawberry Production in High Tunnels

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Strawberries have long been a high value crop and have become an increasingly popular crop for high tunnel production using an annual plasticulture system. Annual plasticulture allows for high quality, increased yields, earlier harvests, soil warming, weed control, moisture conservation, and ease of harvest. In addition to an earlier spring harvest, high tunnels offer the ability to harvest strawberry fruits for an additional season in temperate climates. Growers are able to use high tunnels as a marketing tool when field production has not yet begun. The objective of this study was to compare variety performance and fruit quality for winter versus spring production in high tunnel and open field plots. This study was conducted in the subtropical southeast (Knoxville, TN), characterized by mild winters and hot, humid summers. Three June-bearing ('Albion', 'San Andreas', and 'Seascape') and three day-neutral ('Chandler', 'Radiance', and 'Strawberry Festival') varieties were tested for their production performance. Fruit quality indicators measured included color, firmness, soluble solids, titratable acidity, and shelf-life. The high tunnel system produced high quality berries and yields during the winter production season, while no fruit was produced in the open field during the winter. During the spring production season, yields increased in both the open field and high tunnels but berries had lower sugar and firmness levels compared to the fruit from the winter production season. Low sugar and firmness levels may have been caused by the unusually high temperatures experienced during March—the hottest March on record in Tennessee. These findings may allow growers to maximize profits with out-of-season production and higher fruit quality.

8:45–9:00 AM

Row Cover and Planting Date Interaction in High Tunnel Strawberry Production

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The objective of this study was to determine how late strawberries could be transplanted without adversely affecting yield following high tunnel tomato production. In this 2-year study, 'Chandler' strawberry transplants were set on four different dates in high tunnels and outside in a field immediately adjacent to the tunnels. Planting dates were randomly allocated to the beds and row cover usage was randomized and applied as a strip across all rows on one half of the plots. Plants were spaced 14 inches apart in double rows, 12 inches apart on black plastic mulch-covered beds, spaced 42 inches center to center. White spun-bonded polypropylene row cover (1.25 oz/yd,

70% transparency) was applied in late November and removed in late March both years. Harvest began in late April in the tunnels and late May outside. Yield was determined by weighing marketable fruit from each 10 ft plot at 2–5 day intervals. The data was analyzed as a strip-split plot with each year analyzed separately. High tunnels were the whole-plot, row cover the strip-plot and planting date was the sub-plot factor. There was no significant interaction among tunnels, row cover and planting dates for total yield in 2007. High tunnels increased total yield from 15.70 lb/plot (outside) to 38.04 lb/plot (in tunnel) and row covers increased total yield from 24.32 lbs/plot to 29.43 lb/plot, but planting date had no effect. In 2008, there was a significant three-way interaction and a significant tunnel by row cover interaction. Overall the latest planting date had lower total yield except when grown inside a high tunnel and covered with a row cover. Tunnel interacted with row covers for the three early planting dates in that outside row covers increased total yield from 9.23 to 17.96 lb/plot, while in the high tunnels row covers decreased yield from 19.98 to 14.75 lb/plot. In 2007, the median harvest occurred 9 days earlier in the high tunnels than outside (DOY 150 vs. 141) and row cover median harvest date was four days earlier than without cover (DOY 144 vs. 148). Median harvest date was earlier in 2008 with row cover outside (DOY 152 vs. 154), but later in the tunnels (DOY 143 vs. 140). The latest planting date had an earlier median harvest date than the other three planting dates. There were no differences among any other planting dates.

9:00–9:15 AM

We Grew Tomatoes in January without Heat, but Don't Tell the Farmers

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Three years of studies have been conducted at Crystal Springs, MS, to assess the value of secondary row covers for additional climate modification in high tunnels. The system includes unheated high tunnels, with manual ventilation controls and row covers that are placed over the row covers on cold nights or during particularly cold days. The covers are placed or removed, and the tunnels opened or closed based on a detailed protocol based on actual and forecast air temperatures in and outside the tunnels. Crops are sown in the fall, grown through the winter, and terminated in late winter or early spring. The model vegetable crop in the system was tomatoes. In the first season, unusually cold weather killed the crop before any fruit could be produced. In the second and third year, tomatoes were produced and harvested in January and February in treatments with the row covers, despite air temperatures outside the tunnels falling below –7 °C for at least one night. From these results, we conclude that row covers can extend the range of crops that can be grown in southern U.S. high tunnels. Although the system has produced valuable information on tunnel temperature behavior and the potential for broadening the range of crops grown during colder portions of the winter, we believe the system of internal covers and crop selection and timing needs further refinement and local testing by research and outreach professionals. We are not ready to recommend the system to growers as a commercial tomato production practice at this time.

Specified Source(s) of Funding: USDA–NIFA Small- and Medium-Sized Farm Prosperity Program

9:15–9:30 AM

Lessons Learned Field Testing Low-cost High Tunnels in West Virginia

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High tunnels protect, accelerate and expand the season for specialty crops and permit growers to continue field activities during inclement weather. Limited adoption of this technology in WV by growers was due to lack of exposure to the concept and uses of a high tunnel, as well as cost and transportation of materials to rural areas. A local grower inspired to build his own high tunnel proposed to develop an alternative solution to "off-the-shelf" kits that could be constructed with mostly locally available materials for other growers to see if a high tunnel fit into their operation. Our project included requesting applications, conducting site visits with growers at the sites, constructing high tunnels to field-test the concept and developing a construction manual to produce a 20 ft × 48 ft tunnel for under $1,000. Applications were reviewed and sites visited before the first tunnel was built in 2010. Finding suitable sites was a challenge in a mountainous state. Some growers were more motivated than others to help with construction and/or put the structure to use. Growers differed in what seasons they use the structure based on their markets. Others that helped with construction or have seen the structures have been inspired build their own. We also developed a demonstration version to use in workshops which could be converted to a

small greenhouse. Additional education on high tunnels is necessary but our project has raised grower's exposure to high tunnels allowing them to expand locally produced food in their markets.

Specified Source(s) of Funding: Specialty Crop Block Grant from the West Virginia Department of Agriculture

Wednesday, August 1, 2012 Sevilla

Viticulture and Small Fruits 1

Moderator: Mark Ehlenfeldt
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8:15–8:30 AM

Stone Cell Frequency and Cell Size Variation of Crisp and Soft Textured Fruits from Nine Southern Highbush Blueberry Cultivars

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The microstructure of southern highbush (*Vaccinium corymbosum* L.) blueberry fruit with crisp and soft texture was investigated by light microscopy. The frequency of stone cells and variation in epidermal and hypodermal cell size was measured. Stone cells, which are sclerified cells having a thick and lignified secondary cell wall, are known to vary in number between cultivars of northern highbush and rabbiteye blueberry species, and may contribute to fruit firmness. Cell size can also contribute to differences in fruit firmness. Fruit from nine cultivars determined by sensory and instrumental analysis to vary in fruit texture were harvested at two developmental stages: green and mature blue. Tissue was fixed in FAA, trimmed to a 3 mm equatorial thickness, dehydrated using a graded solvent series, infiltrated and embedded in paraffin, sectioned to 12 μm, and stained with Safranin O and Aniline Blue for light microscopy. Stone cells within ≈1200 μm of the epidermis were counted and cell height and width was measured in the epidermal layer and 3 layers beneath the epidermis of the fruit. The average number of stone cells in a single berry ranged from 0 to 95 between cultivars. Significant differences in the number of stone cells just below the epidermal layer and in cell size within the exocarp were detected between cultivars, but did not correspond to sensory and instrumental measures of fruit firmness, crispness, or skin toughness. These results suggest that cell size and increased stone cell formation beneath the fruit skin does not have a significant affect on berry texture, and that firmness differences across blueberry cultivars may be better explained by other factors affecting fruit texture such as cell wall composition/disassembly, cell membrane integrity, and/or turgor pressure.

8:30–8:45 AM

Reproductive Growth and Yield of Three Southern Highbush Blueberry Cultivars Obtained from Micropropagation and Softwood Cuttings in Two Florida Locations

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The objective of this study was to evaluate reproductive growth and yield of southern highbush blueberry plants derived from micropropagation and softwood cuttings during the initial field establishment years. The experiment was conducted at two locations with different average chill hour accumulation per season (temperatures from 0 °C to 7 °C): Citra, FL (420–540 chill hours) and Haines City, FL (110–220 chill hours), respectively. 'Emerald', 'Jewel' and 'Primadonna' were planted in March (Citra) and April (Haines City) 2010 in a completely randomized block design, with five replications. Two plants per replication were selected and total number of canes, total shoots, and flower buds per plant were recorded in Dec. 2010 (Haines City) and Jan. 2011 (Citra). The same plants were harvested from 28 Mar. to 6 June 2011, and total fruit yield and berry weight were calculated. One plant per replicate was selected the second year, and total flower buds per plant were estimated by counting the flower buds on two to four representative major canes and visually estimating what percentage of the whole plant the sample represented. Results were evaluated by analysis of variance and treatments were compared using Tukey's HSD test at a 5% significance level (SAS 9.2). Location by propagation was not significant and means compared are averages of both sites. Micropropagated 'Emerald' plants had significantly more flower buds during the first reproductive season. Propagation method had no effect on flower bud numbers for the other two cultivars. Micropropagation resulted in 42% and 58% yield increase for 'Emerald' and 'Jewel' plants, respectively. Total number of shoots per plant and yield of both micropropagated 'Emerald' and 'Jewel' plants were significantly greater than for softwood cutting- derived plants, with no significant effect of propagation type on yield of 'Primadonna'. Linear regression analysis showed a positive correlation between total number of shoots per plant and yield for 'Emerald' and 'Jewel' in both locations and for all three cultivars in Haines City. Location did not significantly affect total flower buds per plant during the second reproductive season, but there was a significant location by cultivar interaction: in Haines City, 'Jewel' and 'Emerald' had more flower buds per plant than 'Primadonna', with no significant difference between cultivars in Citra. 'Emerald' and 'Jewel' micropropagated plants had significantly more flower buds than plants derived from softwood cuttings, with no effect of propagation method on flower buds for 'Primadonna'.

8:45–9:00 AM

Rootstock and Scion Interactions in Newly Grafted Highbush Blueberry Plants

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Three highbush blueberry cultivars, 'Draper', 'Liberty', and 'Aurora', were grafted onto two wild *Vaccinium arboreum* rootstocks from Texas and Oklahoma sources. The whip-tongue grafting was performed under greenhouse conditions in January with 1-year-old dormant scion wood. The average greenhouse temperature was at 180 °C with supplement lighting to provide 16 hours of more than 600 μmol·m^{-2}·s^{-1} photosynthetically active radiation. Grafting take rate was over 90% regardless cultivars and rootstock types. Ten grafted plants from each cultivar and rootstock combination were chosen as single plant replicate and arranged in a complete randomized design in the greenhouse. Misting irrigation was provided to maintain a relative humidly of 80%. No rootstock and scion interactions were observed during a 4-month growing period. While there were no differences in shoot numbers produced between two rootstock types, later cultivar 'Aurora' had 35% more shoot numbers than early cultivar 'Draper'. Grafted plants with Texas rootstock produced 30% more total shoot growth than those with Oklahoma rootstock during the first month of growth. This rootstock differences in total shoot growth dissipated with the time of growth period. Total shoot growth among three highbush cultivars was not different for all weekly measurements. These grafted plants will be transplanted to field plots for further studies.

Specified Source(s) of Funding: SCRI

9:00–9:15 AM

Daylength and Temperature Effects in the Development of Cold-hardiness, Acclimation, and Deacclimation in Diverse Blueberry Germplasm

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The timing and rate of acclimation and deacclimation was measured in seven blueberry genotypes with different amounts of diverse species germplasm in their backgrounds. Primary differences observed among the genotypes were differences in maximum acclimation/hardiness levels and the date at which they were reached, and differences in the date at which maximum acclimation levels were no longer sustained and deacclimation commenced. 'Bluecrop', 'Legacy', 'Tifblue', and two rabbiteye-hybrid derivatives, US 1043 and US 1056, all reached maximum or near maximum cold acclimation by late December with LT_{50} temperatures in a range from –22 to –27 °C. After reaching their maximum acclimation in late December, 'Legacy', 'Tifblue', and US 1043 began a sustained and relatively linear deacclimation, despite a continued decrease in ambient air temperatures over the next several weeks. Conversely, US 1056, 'Bluecrop', 'Northsky' and 'Little Giant' sustained their acclimation for longer intervals, and 'Bluecrop' and US 1056 did not begin to deacclimate until early March, and 'Little Giant' and 'Northsky' until late March. The differences suggest cold acclimation and the retention of cold hardiness have both daylength and temperature regulation. The ability to select for sustained cold acclimation in southern-derived materials should allow the expansion of this germplasm into many areas where it could not previously be used. As concerns of climate change increase, the ability to develop germplasm tolerant to greater extremes and greater fluctuations will prove increasingly valuable.

9:15–9:30 AM

Identification of Changes in the Glycome Profile of Cell Walls during Blueberry Fruit Abscission

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Abscission is a highly coordinated and regulated process which responds to developmental cues, and various biotic and abiotic stresses. Organ separation occurs at abscission zones (AZs) and involves the breakdown of cell walls. The spatial and temporal regulation of the dissolution of primary cell wall polysaccharides and middle lamella is not completely understood. Previous studies have indicated that the loss of pectins and other polysaccharides from the middle lamella and the primary cell wall is associated with abscission. The focus of this study was to obtain a comprehensive view of the changes within the cell wall during blueberry fruit abscission. In blueberry, fruit abscission occurs primarily at the pedicel-peduncle junction (BAZ). Abscission agents, such as methyl jasmonate (MJ) and ethephon, induce abscission at the BAZ. Rabbiteye ('Briteblue') blueberries were given 3 treatments: Control (only adjuvant), Ethephon (1000 ppm + adjuvant) and MJ (20 mM + adjuvant). Approximately 50% of the berries abscised in response to Ethephon and MJ within 48 h. BAZs and adjacent pedicel tissue (PZ) were collected at 24 h after treatment. These samples were used to perform plant cell wall glycome profiling using over 200 glycan-directed monoclonal antibodies. Overall, the glycome profiles of the control and treated samples from BAZ and PZ were similar in the glycan compositions. However, some dif-

ferences were notable between BAZ and PZ. For example, the oxalate extractable homogalacturonan (HG) epitopes and HG backbone-1 are significantly higher in the PZ. Also, notably more hemicellulosic polysaccharides were extracted by carbonate in the PZ compared to the BAZ. Two specific differences associated with abscission agent application were: 1) hemicellulosic polysaccharides in the carbonate fraction: more Xyloglucan (XG) epitopes were released in MJ treated tissues of BAZ, suggesting that loosening of XG is a BAZ specific phenomenon brought about by MJ mediated mechanisms; and 2) the relative abundance of hemicellulosic epitopes (Xylan and XG) released in the chlorite extract of treated walls was reduced, potentially as a result of reduced lignin-hemicellulose association within the cell walls of the active abscission zone under the induction of abscission by ethephon and MJ. Together, these data indicate that blueberry fruit abscission is mediated by specific changes in the composition of the cell walls.

Wednesday, August 1, 2012 Flagler

Plant Nutrient Management 1

Moderator: Guodong Liu
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8:00–8:15 AM

Influence of Vermicompost on Growth, Antioxidant Content, and Nitrate Concentration of Greenhouse Grown Spinach

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Vermicompost (VC) as an alternative fertilizer source may increase the ascorbic acid content of fruits and vegetables and reduce nitrate accumulation in important leafy vegetables such as spinach (*Spinacia oleracea* L.). Nitrates tend to accumulate in spinach leaf petioles and may possibly form carcinogenic N-nitrosamines, especially when nitrogen rates are increased under standard inorganic nutrient management plans. Ascorbic acid has been shown to inhibit the formation of these compounds in several studies, but unfortunately, in spinach grown with an inorganic N fertilizer source, ascorbic acid content is often reduced. Therefore, a study was conducted to determine if the use of VC (from coffee grounds) as a fertilizer source can maintain ascorbic acid content regardless of nitrate concentration of early spring greenhouse grown spinach. VC was added to a 1:1:1 (peat, soil, and sand) media by volume (0%, 25%, 50%, 75%) in 4.5-L clay pots and seeded with 'Bloomsdale Longstanding' spinach. Three plants were grown per pot with the experiment terminated at 5 weeks after seeding. Ascorbic acid, nitrate, leaf area and fresh leaf weight increased in a linear manner, with 75% VC higher than 0% VC. Ascorbic acid and nitrate content in spinach leaves were correlated ($r = 0.43$, $P = 0.0054$), and both increased linearly up to 62 mg/100 g and 6587 mg/kg, respectively, at 75% VC. These results suggest that VC may help maintain ascorbic acid content despite nitrate accumulation in spinach, thus making it a possible alternative or addition to inorganic fertilizers for improved human nutrition.

Specified Source(s) of Funding: Illinois Dept of Agriculture-Sustainable Agriculture Grant Program

8:15–8:30 AM

Abnormality Analyses of Ammonia Volatilization from Nitrogen Fertilized Soils for Commercial Potato Production

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Ammonia (NH_3) volatilization from agricultural soils is a common problem in commercial potato or other crop production. It is closely associated with and positively related to NH_4^+ concentration in the soil. Following the application of NH_4^+ forming or containing N fertilizers, the fate of NH_4^+ include plant uptake, volatilization, and nitrification. Therefore, NH_4^+ concentration decreases considerably within a few days after fertilization. Typical trend in ammonia volatilization from agricultural soils is not a normal distribution. To estimate the abnormality of NH_3volatilization probability distribution, this study was conducted with four soils, three incubation temperatures (11, 20, and 29 °C), and four fertilizers (ammonium sulfate, ammonium nitrate, urea, and potassium nitrate) plus a control without fertilization under two soil water regimes (20% and 80% field capacity). The soils evaluated include: Krome Gravelly Loam and Biscayne Marl Soil sampled from Florida and Quincy Fine Sand and Warden Silt Loam from Washington State. Based on the Jarque-Bera test, abnormality index (A) of distribution can be defined as: A = n/6[S^2 + 1/4(K - 3)^2], where n is the number of observations, S is the sample skewness, and K is the sample kurtosis. A typical normal distribution has a zero value for either S or K and hence a zero value for A as well. However, the A values for this study were 1001.8 and 895.9 for 20% and 80% field capacity soil water regimes, respectively. The K value is up to 10 and skewness up to 3. This means that the probability distribution of NH_3 volatilization from N fertilized soils is positively peaked and right skewed as compared with a typical normal distribution. These results indicate that any management practices to minimize NH_3 volatilization from fertilized soils should be implemented at a very early stage after the application of ammonium containing or forming N fertilizers due to the positive kurtosis and right skewness of NH_3 volatilization.

Specified Source(s) of Funding: USDA–ARS

8:30–8:45 AM

Mineral Nutritional Status and Yield of Swiss Chard in Hydroponic Culture as Influenced by Nutrient Solution Management and Seed Propagation Substrate

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The influence of nutrient solution renewal (*RNWL*) versus replenishment of depleted nutrients (*RPLN*), and seed propagation substrate (*SBSTR*) on leaf mineral nutrient content and yield of Swiss chard (*Beta vulgaris* L. 'Lucullus'), were evaluated in a Nutrient Film Technique (NFT) hydroponic culture. Seedlings at the second true-leaf stage were transferred into NFT culture and grown with a soluble fertilizer solution (15N–2.2P–12K) at 200 mg·L^{-1} of N. The treatments comprised of two *SMGMT* techniques (*RNWL* and *RPLN*), and two seed propagation substrates (Oasis™ or Rockwool cubes). Laboratory leaf analysis at 63 days after transfer (DAT) into NFT culture indicates significant ($P = 0.05$) *SMGMT* × *SBSTR* interaction for leaf nitrogen (N) and manganese (Mn) only. With *RNWL*, leaf N was higher in Rockwool than Oasis, whereas with *RPLN* N was highest in Oasis ($P \leq 0.05$). Compared with Oasis, Rockwool increased leaf phosphorus (P), calcium (Ca) and magnesium (Mg) with *RPLN* ($P \leq 0.05$), but not potassium (K) and sulfur (S). Besides N, *SBSTR* had no effect on leaf macronutrient content with *RNWL*. Across *SBSTR,* while leaf K was increased ($P \leq 0.01$) by *RPLN*, leaf Ca was highest with *RNWL* ($P \leq 0.05$); *SMGMT* did not affect the other macronutrients. Across *SMGMT* Rockwool increased leaf Mg ($P \leq 0.02$) compared with Oasis, but no other macronutrient was affected by *SBSTR*. Of the micronutrients only leaf iron (Fe) content was affected by *SBSTR* within *RNWL*, being higher ($P \leq 0.05$) in Rockwool than Oasis. Within *RPLN* Rockwool increased ($P \leq 0.02$) the other micronutrients over Oasis, except copper (Cu) and molybdenum (Mo). With the exception of zinc (Zn) and Cu (*RPLN* > *RNWL*; $P \leq 0.003$), *SMGMT* had no effect ($P \leq 0.05$) on the other micronutrients across *SBSTR*. Across *SMGMT* Rockwool increased leaf Fe, Mn, boron (B) and Al content over Oasis ($P \leq 0.02$). Leaf growth and yield at 63-DAT indicates significant ($P = 0.05$) *SMGMT* × *SBSTR* interaction for leaf fresh- and dry weight (LFW, LDW [g]), but not leaf count (LC) and leaf area (LA; cm^2) per plant. Within *SMGMT* LFW and LDW were higher in Rockwool than Oasis with either *RNWL* or *RPLN* ($P \leq 0.01$). Across *SBSTR, RNWL* increased LC and LA over *RPLN* ($P \leq 0.01$). Similarly, across *SMGMT*, LC and LA were higher in Rockwool than Oasis ($P \leq 0.01$). These observations suggests that *RNWL* with Rockwool substrate provided better growing conditions for optimum mineral nutrition and yield of Swiss chard in NFT hydroponic culture under the conditions of this experiment.

Specified Source(s) of Funding: This study was supported by USDA-NIFA Grant No. MOX-HYDROPONICS-05. Lincoln University in Missouri.

8:45–9:00 AM

Estimating Nitrogen Fertilization Requirement for Grafted Tomato Grown in the Field

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Grafting with interspecific rootstocks has been observed to enhance growth and fruit yields of tomato plants. It is likely that fertilizer inputs may be adjusted in grafted tomato production as compared with the current recommendation for non-grafted tomato plants. Because the crop nutritional requirement for N for grafted tomato plants has not been established for drip-irrigated tomato production, the purpose of this study was to determine a mathematical function of applied nitrogen that can best describe the expected marketable fruit yield of grafted tomatoes. Non-grafted and grafted 'Florida 47' tomato with interspecific hybrid rootstocks 'Multifort' and 'Beaufort' were grown in Spring 2010 and Spring 2011 with the combinations of two irrigation regimes (50% and 100%) and six N rates (56, 75, 148, 224, 298, and 372 kg·ha^{-1}) in sandy soils in Live Oak, FL. The marketable fruit yield data were fitted to quadratic, square root, linear plateau, quadratic plateau, and exponential functions. The goodness of fit of the regression models was compared based on the coefficient of determination (R^2), the Akaike information criterion (AIC), and the root mean squared errors (RMSE). The exponential model provided the best fit of the marketable fruit yields of both grafted and non-grafted plants as a function of the N rates. Using the exponential model, estimated minimum N fertilization rates to reach maximum marketable fruit yields ranged from 175 to 269 kg·ha^{-1} of N for the grafted plants in the 2010 study, depending on the irrigation regime. For the non-grafted plants in the 2010 study, the estimated N rates were in the range of 113 to 176 kg·ha^{-1} of N, indicating that higher N fertilization rates were needed to maximize the marketable fruit yields of grafted plants as compared to the non-grafted plants. The corresponding maximum marketable fruit yields were also higher in grafted tomato production ranging from 57 to 67 Mg·ha^{-1} in comparison with 42 to 50 Mg·ha^{-1} for non-grafted plants. The 95% confidence intervals associated with the estimated N rates were considerably wide, suggesting that care should be taken in formulating N recommendations for growers. The results suggest that higher N rates were required to optimize the marketable fruit

An asterisk (*) following a name indicates the presenting author.

yield of grafted 'Florida 47' tomato with vigorous interspecific rootstocks than the N requirement for non-grafted plants in field production.

9:00–9:15 AM

Biochemical Properties of Compost Tea Associated with Compost Quality and Effects on Pak Choi Growth

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This study investigated the links between variability in compost quality, the biochemical characteristics of their extracts (compost tea) and plant growth indicators through a series of experiments. Five composts that varied widely in feedstock and production methods were selected for quality evaluation. They were: 1) chicken manure-based thermophilic compost; 2) green waste thermophilic compost; 3) food waste vermicompost; 4) aged chicken manure-based vermicompost; and 5) fresh chicken manure-based vermicompost. Compost teas were prepared from each compost using aerated extraction method with compost to water ratio of 1:10 (v:v), and were applied weekly for 4 weeks to pak choi (*Brassica rapa* cv. Bonsai, Chinensis group) grown in a peat-perlite medium. The results demonstrated that compost quality generally impacted: 1) nutrient extraction efficiency; 2) microbial activity; 3) phytohormones; and 4) total nutrient content of the extracts. These differences in extract quality similarly impacted growth and mineral nutrient status of pak choi. The positive influence on plant growth was largely associated with mineral N and gibberellin (GA_4) present in the teas. In vitro cultivation of pak choi with different GA_4 concentrations (0–3200 $ng \cdot L^{-1}$) confirmed a direct positive effect of GA_4 on growth. These findings suggest that either vermicompost or thermophilic compost can be used for the production of compost tea but the tea quality and its effect on plant may be predicted based on compost quality.

Specified Source(s) of Funding: Western Sustainable Agriculture Research and Education

9:15–9:30 AM

Development of Nitrogen Fertilization Best Management Practices (BMPs) for Potatoes in Florida

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With approximately 25,000 acres of winter and spring potatoes, Florida is an integral part of the supply chain for freshly harvested potatoes in spring in the United States with a crop value of $135 million in 2007. BMPs are being developed to increase nitrogen (N) use efficiency for potato production and to reduce N losses to the environment. The objective of this study was to determine an optimal N fertilizer rate for commercial chipping potato production in northeast Florida. Field experiments were conducted during Spring 2011 in Hastings, FL. The study was performed on three commercial farms growing 'Atlantic' potato. Water was supplied through seepage irrigation into furrows 60 feet apart, thereby raising the water table to the rootzone. A randomized complete-block design with 4 replicates included total N ranging from 112 to 335 kg N/ha from ammonium nitrate, wherein all treatments received 56 kg N/ha at fumigation 30 days before planting. At emergence, N was sidedressed at 0, 56, 112, or 168 kg N/ha from liquid urea ammonium nitrate (UAN). Subsequently, a second sidedress of 56 or 112 kg N/ha from UAN was applied at the 6–8 inch growth stage. Total and marketable yield, specific gravity, plant dry weights, and N accumulation in the plants, tubers, leaves/stems were evaluated. Soil N content was recorded throughout the season. Plant tissues (leaves/stem and tubers) accumulated from 101 to 157 kg N/ha. No difference in potato yields were observed between N rates at any location. Total marketable potato yield ranged between 250 and 320 cwt/ac. There were no differences in potato yield and tuber specific gravity between N rate of 56 or 112 kg/ha applied at 6–8 inch growth stage. In two out of three locations, significant increase in tuber specific gravity was achieved with N fertilizer rates above 112 kg N/ha from the "at emergence" application. The preplant N fertilizer application did not increase soil N availability at plant emergence, with soil N content averaging 26 kg/ha which is similar to the soil N content at pre-plant. Reduced soil N content coincided with recent heavy rainfall events.

9:30–9:45 AM

The Effect of Biochar on Sweet Corn Production and Nitrate Leaching

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The rising operational cost and the environmental impact of agriculture are current concerns of agriculturalists and environmentalists. Nitrogen fertilizers are costly and are lost easily through leaching. Effective methods to increase nitrogen-use efficiency are needed. Biochar, also called activated carbon or black carbon, has gained attention because of its potential environmental advantages and economic value as a soil amendment. A 2-year field experiment was conducted to determine the effect of biochar on sweet corn production and on nitrate leaching. Two treatments (no biochar, biochar) were used. Treatments were replicated four times in a randomized complete-block design. All blocks were fertilized with a chemical fertilizer (15N–3.5P–12K) to provide 120 kg N–28 kg P–80 kg K/ha. In year 1, biochar at 12 Mg/ha was applied. No biochar was applied in year 2 to determine the residual effect of biochar. Samples of soil from all blocks were collected, four times (on four different dates) in year 1 and once in year 2. Soil samples were collected from three different depths, 0 to 20, 20 to 40, and 40 to 60 cm from the soil surface. Samples were tested for nitrate concentration. Nitrate from the 40 to 60 cm depth was considered as leached N. At harvest, a random 2 m^2 from each block was used to collect data on yield and plant growth parameters. Plant height, number of plants per hectare, number of ears per hectare, and total fresh weight of ears per hectare were determined. Biochar had no effect on yield or plant growth parameters in the first year but resulted in a slight increase of plant height the second year. Small decreases in nitrate leaching occurred with biochar treatment in both years. Our data suggest that biochar may increase nitrogen use efficiency.

Specified Source(s) of Funding: Massachusetts Experimental Station

Wednesday, August 1, 2012 **Sevilla**

Vegetable Crops Management 1

Moderator: Kelly Young
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10:15–10:30 AM

Bacterial Spot (*Xanthomonas cucurbitae*): An Emerging Disease of Pumpkins in the Midwest

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During 2009–11, bacterial spot, caused by *Xanthomonas cucurbitae*, occurred widely in pumpkin fields in the Midwest. Yield losses up to 90% forced some growers to abandon pumpkin production. A study in 2009 showed that the disease occurred in all 17 commercial pumpkin fields surveyed in Illinois. Another Illinois survey in 2010 showed that the disease occurred in 40 of 50 commercial pumpkin fields with bacterial spot symptoms on 34% of fruit. During a survey in 2011, *X. cucurbitae* infected fruit were observed in 95 of 111 pumpkin fields in the Midwest (Illinois, Indiana, Iowa, Kansas, Missouri, Nebraska, Ohio, and Wisconsin). In all surveys, the severity of the disease on fruit (percentage of surface area of the fruit with bacterial lesions) ranged from 1% to 20%. *X. cucurbitae* was isolated from infected fruit on nutrient agar medium. The identity of the *X. cucurbitae* isolates was confirmed by conducting Gram staining; colony growth on yeast extract-dextrose –CaCo3 agar (YDC) at 33 °C and morphology on YDC; and oxidative and fermentative (O/F), oxidase, catalase, nitrate reduction, starch hydrolysis, sculin hydrolysis, and motility tests. Further confirmation of the identity of the isolates was achieved by using primers RST2 and RST3. Koch's postulates for representative isolates of *X. cucurbitae* were carried out on 'Howden' pumpkin in greenhouse and field studies. Bacterial inoculum was cultured on Laura Broth agar medium and suspension of 10^8 cfu/mL of sterile-distilled water (SDW) was prepared. Leaves and fruit of 'Howden' pumpkin were spray-inoculated. A positive control was inoculating pumpkin leaves and fruit with a known *X. cucurbitae* isolate. Also, a negative control using SDW was included. The severity of bacterial lesion on the leaves and fruit was assessed 3, 10, and 21 days after inoculation. *X. cucurbitae* was isolated from all leaves and fruit inoculated with the bacterial isolates. *X. cucurbitae* infection also was observed and confirmed on all winter squashes grown near pumpkin fields visited.

10:30–10:45 AM

Celery Black Streak Disorder Is Promoted by High Temperatures

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Since 2005, a new physiological disorder known as "black streak" has affected celery (*Apium graveolens*) quality in Michigan. Plants displaying black streak appear to be healthy; however, when trimmed, sporadic petioles will display black streaks that either extend throughout the entire petiole, or are dispersed irregularly within the petiole. This defect makes the entire crop unmarketable, resulting in significant losses to growers. The incidence of the problem has generally been high following hot weather, suggesting that high air temperatures may be implicated in its occurrence. Therefore, this study was conducted to test the impact of temperature on the occurence of black streak in celery under field conditions. The celery cultivar Dutchess (the most succeptible cultivar) was used for the studies in 2010 and 2011. Treatements included no heat stress, and heat stress imposed at 5, 6, 7, 8, 9, and 10 weeks after transplanting (WAT). Heat stress was created by covering the entire bed with perforated polyethylene row covers supported by hoops. The heat stress was maintained for one week after which the row covers were removed. Temperature and humidity sensors were placed within each treatment to monitor climatic conditions. At havest, the celery was assessed for the presence of black steak symptoms

in the petioles. The row covers succesfully increased maximum air temperature above 90 °F in all years. The number of plants and petioles affected by black streak was significantly higher in treatments that received heat stress. This is a clear indication that hot temperature are implicated either directly or indirectly in the occurrence of black streak in celery. Incidence of the disorder varied with celery growth stage. Symptoms increased with time, reached a maximum and then declined. Maximum incidence was at 9 and 8 WAT in 2010 and 2011, respectively. These results suggest that the growth stage when high temperatures occur is as important as temperature for development of black streak. Identifying environmental conditions that promote the occurrence of back streak in celery is only the first step in understanding this disorder. Current management recommedation is to avoid growing susceptible cultivars during the hottest period of the season.

Specified Source(s) of Funding: Michigan Celery Research Inc.

10:45–11:00 AM

Use of Drip Irrigation for Table-stock and Chipping Potato Production in Florida Sandy Soils

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Potatoes are the leading vegetable crop in the United States, contributing to about 15% of farm sales receipts. In 2010 the Florida potato was valued at $135 million, ranking Florida 11th in total value and producing one-third of winter/spring crop season. Seepage (sub-surface) irrigation is the predominant irrigation method for potato production in the state. Although inexpensive, it has a low irrigation efficiency (<50%) and requires a large volume of water to maintain the high water table. Irrigation techniques with higher delivery efficiency, such as drip, have the potential to save water with application directly to the root zone, and increase the potential to reduce N-leaching. The objective of this 2-year field study was to assess the feasibility of drip irrigation as alternative irrigation method for potato production in Florida sandy soils. Field experiments were conducted during spring of 2011 and 2012 in Hastings, FL. The design was a split plot with irrigation treatment as a whole-plot in a randomized complete-block with 4 replicates; potato varieties were applied to sub-plots. Irrigation treatments included: SUR-surface drip irrigation with drip installed above seed; SUB-subsurface-drip irrigation with drip tape installed below 5-cm the seed; and SEP seepage. The potato varieties were 'Atlantic', 'Fabula', and 'Red LaSoda'. The average daily irrigation volume applied using drip was 3.8 mm, while seepage required application on the order of 15.5 mm/day to maintain the high water table. There was an interaction between irrigation and variety treatments for marketable yield For 'Atlantic' and 'Fabula', there was no marketable yield difference between SUR and SEP irrigation; the varieties yielded 24.8 and 15.9 Mg/ha, respectively. The use of SUB resulted in reduced yield by 20% and 25% for 'Atlantic' and 'Fabula', respectively. On the contrary, marketable yield of 'Red LaSoda' was 51% and 37% higher when SEP (26.0 Mg/ha) was used compared to SUR and SUB, respectively. Low yields of 'Red LaSoda' under SUR and SUB treatments indicated that alternative irrigation scheduling needs to be investigated for this variety. Drip irrigation positively affected tuber internal quality, as SUR and SUB showed lower incidence of growth cracks, misshapen and brown center for all tested varieties, and reduced internal heat necrosis for 'Atlantic'. It is concluded that appropriate use of SUR can sustain profitable yields for 'Atlantic' and 'Fabula' varieties while saving irrigation water in soils with low water-holding capacity.

11:00–11:15 AM

Limiting Irrigation of the Chip Potato 'Atlantic'

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Western Nebraska undergoes periodic severe and prolonged droughts. Recently irrigation restrictions were enacted in several areas to preserve the aquifer. These restrictions limit the amount of seasonal water to be pumped from wells. A 4-year study began 3 years ago to determine when, during the potato production season, would reducing irrigation by 15 cm have the least impact on marketable yield of the potato (*Solanum tuberosum*) chip cultivar Atlantic. Trial results to date will be presented. Planted in May, 'Atlantic' was exposed to full irrigation, 61 cm total adjusted for rain, or to a limited irrigation regime when 15 cm of water were withheld in the first half of the season, second half of the season, and some at the start and some at the end of the season. Plots were subdivided by three N levels, 101, 168, and 235 kg/ha. Soil water was directly correlated to irrigation regime. Soil N and petiole N were higher under reduced irrigation indicating low N uptake and low N use. Vine growth was inhibited when water was limited but partially recovered when full watering returned; N level showed no mitigating influence. Tuber yield was reduced by all three limiting regimes but less so when the 15 cm were withheld between 8 and 13 weeks after emergence (WAE). Stress between 3 and 8 WAE resulted in the greatest yield loss. Increased N partially overcame yield losses. Limiting water between 5 and 8 WAE resulted in lower tuber specific gravity, darker chips and greater incidence of common scab. These results will promote a better understanding of water and N interaction on market yield of potato in semi-arid environ-

ments. Growers forced to reduce irrigation of potato will know better how to manage the available water.

Specified Source(s) of Funding: USDA, Specialty Crop Block Grant

11:15–11:30 AM

Evaluating Unconventional Leafy Greens for Summer Production in the Southwest Desert

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Leafy greens, such as lettuce, spinach, and kale do not perform well during the hot weather of late spring and summer in the Southwest deserts of the United States. Market growers and home gardeners are advised against planting any greens for fresh or cooked consumption between March and September. This project evaluates hot weather leafy green crops that are common to cuisines in Africa and Asia, but are relatively unknown in the United States. Varieties were selected from 13 cultivated plant species and planted at the University of Arizona Cooperative Extension garden in Phoenix, and in backyard gardens of 10 Master Gardeners in Apr. 2011. Observations on germination, heat tolerance, and plant vigor were made until harvest in August. After harvest, 17 people participated in a taste test of raw and cooked greens. Taster perceptions of flavor, texture, and appearance for each plant were recorded. Of the 13 species tested, *Cochorus olitorius* (jute leaves), *Portulaca oleracea*, (purslane), *Amaranthus tricolor* (red leaf amaranth), *Salsola komarovi* (land seaweed), *Basella alba* (Malobar spinach), *Ipomoea batatas* (sweet potato leaf), and *Hibiscus sabdariffa* (Jamaica leaf) germinated and grew in sufficient quantities for the taste test. All were palatable for fresh consumption, with the exception of *A. tricolor*, which was too bitter for most testers. All but *H. sabdariffa* demonstrated improved flavor and texture with cooking, which became sour and took on an unappetizing color when exposed to heat.

11:30–11:45 AM

Management of Common Blight Disease Caused by *Xanthomonas axonopodis* pv. *phaseoli* by Using the Plant Growth-promoting Rhizobacteria (PGPR) and Some Plant Extracts

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Plant growth promoting rhizobacteria (PGPR) are a group of bacteria that actively colonize plant roots and increase plant growth and yield. Promising plant extracts for the management of plant diseases are environmentally safe, long-lasting and extracts of certain plants contain alkaloids, tannins, quinones, coumarins, phenolic compounds, and phytoalexins. The aim of this study was to evaluate the effectiveness of 5 PGPR and 15 plants extract on bean plants against *Xanthomonas axonopodis* pv. *phaseoli*, the causal agent of common blight of bean, and their effects on plant growth in glasshouse conditions. The disc diffusion method with a minor modification was used for testing of inhibitory activity. The minimum inhibitory concentration (MIC) values were determined by using modified disc diffusion method at five different concentrations and streptomycin sulphate was used as control chemical. Rhizobacteria strains isolated from rhizospehere and phyllosphere of some healthy plants were applied with a suspension of 10^8 cfu/mL after sowing at 3, 5, and 10 days and a virulent strain of *X. a.* pv. *phaseoli* (Xap12) was inoculated by inserting a hypodermic needle. Some growth parameters (plant height, fresh and dry matter weight) were determined 30 days later after applications and the disease symptoms were evaluated by 0–5 scale in the experiments. As a result of all experiments, applications of PGPR and some plant extracts suppressed the bacterial disease of bean and increased growth parameters. This study indicated that PGPRs and some plant extracts may be used in prevention programs to combat the common blight disease.

Specified Source(s) of Funding: This study was supported by Selcuk University Scientific Researches Coordinators

11:45 AM–12:00 PM

Comparative Effects of Chili Thrips on Eleven Pepper Varieties on Field and Greenhouse Environments in South Florida

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Effects of chili thrips, *Scirtothrips dorsalis* Hood (Thysanoptera: Thripidae) on pepper, *Capsicum* spp. 'Agriset 4108', 'Fresno 6022', 'Hot Tormenta', 'Hot San Ardo', 'Cheyenne', 'Hot Habanero Orange', 'Red Devil Cayenne', 'Numex Big Jim', 'Astry', 'Hot Fatalli', and 'Jamaican Yellow', were tested at the Tropical Research and Educational Center, Homestead, FL, in 2011 and 2012 in greenhouse and laboratory environments. When plants were treated with Spinetoram or untreated in a greenhouse, flower buds, cut pedicels, and total of pedicels, flowers, and fruits per plant each had no interactions between variety and treatment, while numbers of fruit and canopy volume had interactions. Flower buds, pedicels, and total differed between varieties with 'Astry' and 'Agriset 4108' having the highest and 'Hot Habanero Orange' and 'Hot Fatalli' the low-

est; Spinetoram increased numbers of pedicels and total when varieties were pooled. 'Hot San Ardo' was highest and 'Hot Fatalli' lowest for treated canopy volume, and 'Fresno 6022' was highest and 'Hot Fatalli' lowest for treated fruit. 'Numex Big Jim' was least helped and 'Fresno 6022', 'Hot Tormenta', 'Cheyenne', 'Astry', and 'Jamaican Yellow' most helped by Spinetoram application. A greenhouse choice test indicated 'Hot Tormenta', 'Hot Fatalli', 'Numex Big Jim', and 'Jamaican Yellow' had the fewest thrips per plant, and 'Astry' and 'Red Devil Cayenne' had the most. In a choice of varieties in Petri dishes in laboratory growth chambers, 'Hot Fatalli', had the fewest nymphs per leaf disk and 'Agriset 4108' had the most. 'Hot Fatalli' attracted the fewest thrips, hence was the most resistant variety across three experiments, though it had the smallest plant size and lowest yields; Spinetoram improved yields of productive varieties like 'Fresno 6022', which may be more feasible to grow than 'Hot Fatalli'.

Wednesday, August 1, 2012 Trade Room

Fruit Breeding 1

Moderator: Rachel A. Itle
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10:15–10:30 AM

Genetic Parameter Estimates for 12 Fruit and Vegetative Traits in the Florida Strawberry Breeding Population and Implications for Breeding and Selection

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The University of Florida strawberry (*Fragaria ×ananassa* Duch.) breeding population has been continuously improved via recurrent selection since 1968. However, there is a lack of information on genetic parameters which may inform breeding decisions. Parameters were estimated in this population using 19 full-sib families from a 5 × 4 factorial mating design plus six additional biparental crosses and 13 parental genotypes. During the 2010–11 season, four clonal replicates of each seedling and parental genotype were distributed within and among two field locations in west-central Florida. Twelve commercially important traits were measured including fruit chemical traits (soluble solids content and titrateable acidity), other fruit and yield traits (average fruit weight, early and total marketable yields, proportion of total cull fruit, proportion of misshapen fruit, proportion water damaged fruit, and shape score), and vegetative traits (plant height and total runners). Heritabilities, genotype by environment interactions and multiple correlations (phenotypic, genotypic, and genetic) were estimated using general mixed model analyses. Narrow sense heritabilities varied from low to moderate ($h^2 = 0.13$ to 0.32) except for shape score ($h^2 = 0.06$) and average fruit weight ($h^2 = 0.52$). Broad-sense heritabilities were larger ($H^2 = 0.18$ to 0.53). Large amounts of non-additive variance for some traits show the potential for gains from clonal selection, such as for titrateable acidity ($d^2 + i^2 = 0.23$) and total runners ($d^2 + i^2 = 0.20$). In contrast, no non-additive genetic variance was estimated for average fruit weight. Genotype by environment interaction was minimal across the locations for all traits, suggesting that testing in one location may be sufficient. Large genetic correlations were found for some traits, most notably between soluble solids content and early marketable yield (-0.68 ± 0.22). This indicates that there may be a tradeoff between soluble solids concentration in the fruit and the total fruit load on the plant. Genetic gains for this pair of traits based on a Monte Carlo simulation showed that moderate gains can be made in both traits using the appropriate index coefficients.

10:30–10:45 AM

Heritabilities of Foliar Powdery Mildew (*Podosphera aphanis*) Resistance in the University of Florida Strawberry Germplasm

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The Florida strawberry industry supplies the eastern United States and Canada with strawberries from November through March. An annual, highly intensified growing system gives rise to cultural challenges including fungal disease control. One such ubiquitous, wind-spread disease is powdery mildew (PM) caused by the obligate parasite *Podosphera aphanis*. To control PM, multiple applications of fungicides are applied each season. Planting resistant cultivars would reduce the need for chemical controls; however there are no commercial cultivars with PM resistance for Florida. To date, there have been no published reports on powdery mildew resistance in the Florida strawberry breeding population. In 2010, clonally replicated individuals from seven bi-parental crosses arising from 11 parents were included in a field trial designed as a modified Latin square with four replications. Seedlings were evaluated visually for percentage of coverage of PM mycelium over the leaf surface on a scale of 0 to 6. The overall population mean was 2.8 with individual family means ranging from 1.8 to 4.0. Broad and narrow sense heritabilities for PM resistance were estimated as 0.51 and 0.50, respectively. In 2011, crosses were

made from parents selected from the 2010 population. From six out of seven families, one resistant and one susceptible genotype were selected as parents from within the top and bottom 10% in order to perform divergent selection. A mating design consisting of a partial, circular half diallel was constructed for both classes of parents. Seedlings were field planted in Fall 2011 in a randomized complete-block design with four replications and rated for PM. The means for the seedling populations arising from the resistant and susceptible classes of parents were 1.8 and 3.7, respectively, which equates to 36% and 32% changes over the base population. Heritability estimates in both the broad and narrow sense for the resistant subpopulation were 0.68, and for the susceptible subpopulation the estimates were again the same and were 0.61. In 2012, a second generation of parents were divergently selected and subjected to the same mating design for further analysis of response to selection; seedlings will be evaluated during the 2012–13 season. Considering the moderate to high heritability estimates and clear response to selection, we conclude that resistance to PM is genetically controlled through mostly additive effects. Through field selection based on natural infection and traditional breeding techniques, good progress can be made toward developing strawberry cultivars with resistance to PM for Florida.

10:45–11:00 AM

Interspecific–Interploid Crosses among *Hylocereus* Species (Cactaceae) for the Selection of Improved Cultivars

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Hylocereus species, night blooming vine cacti endemic to the Americas, use the Crassulacean acid metabolism (CAM) photosynthetic pathway, and bear large, attractive and edible fruits. Taken together, these characteristics of *Hylocereus* species indicate their high economic potential as perennial fruit crops in arid and semi-arid regions where water is scarce. To improve *Hylocereus* fruit traits and yields, therefore, a breeding program was begun two decades ago at Ben-Gurion University of the Negev, Israel. Initial homoploid- and interploid-interspecific crosses produced improved diploid and allopolyploid hybrids. A second cycle of crosses was carried out using two elite, semi-fertile allotriploid hybrids (named S-75 and 12-31) as the female parent. The crosses included a first back-cross (BC_1), interploid crosses between the allotriploid S-75 and the diploid *H. undatus* (F_1), and selfing of the allotriploid 12-31 (F_2). A total of 109 putative hybrids were studied. Fruit traits (including, peel and flesh color, fruit shape, potential yield, and self-compatibility) were evaluated. Ploidy level was estimated using flow cytometric analysis. Molecular tools, such as nrDNA internal transcribed spacers (ITS) and simple sequence repeats (SSR), were employed to establish the genetic relationships and to define the similarity/dissimilarity between the hybrids and the parental lines. The resultant hybrids showed variety in peel color, which was dark pink, red, purple, or yellow, and their flesh color varied from white, and light-purple to purple. Moreover, fruit shapes constituted a range from round to elongated–ellipse. The weights of hybrid fruits, intermediate between the fruit weights of the parental lines, were from 119 to 273 g. About 19% of the hybrids were self-compatible. A comparison between the hybrids and the parental lines indicated that co-dominance was observed in most of the traits studied. Flow cytometric analysis revealed that the hybrids were diploid, triploid, tetraploid or hexaploid. The sequence variation in ITS samples from a subset of hybrids showed a single, well-supported clade with only one exception, a hybrid that was similar to the male parent. The SSR analyses showed wider polymorphism among the hybrids studied. Of the 109 putative hybrids studied, six belonging to the F_1—a cross between the allotriploid S-75 as the female parent and the diploid *H. undatus* as the male parent—showed the best performances in terms of fruit quality and potential yields. Those six hybrids are currently being evaluated in several commercial orchards under different environmental conditions.

Specified Source(s) of Funding: This research was supported by Research Grant No. IS-4017-07 from BARD, the United States–Israel Binational Agricultural research and Development Fund.

11:00–11:15 AM

Marker Validation for *Rpf1* Red Stele (*Phytophthora fragariae*) Resistance in *Fragaria* for Use in Marker Assisted Breeding

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Red stele (*Phytophthora fragariae* var. *fragariae*) is a devastating root rot disease in strawberries (*Fragaria*) in most regions of the world where soils stay cool and moist. Several sources for genetic resistance are exploited in breeding, and several race-specific R-genes have been distinguished. Recently, a tightly linked SSR marker was found for the *Rpf1* gene at Wageningen-UR, The Netherlands. As part of the "RosBREED: Enabling Marker-Assisted Breeding in Rosaceae" project, 900 strawberry genotypes representing the breadth of relevant diversity used in breeding the domesticated strawberry have

been planted in Oregon, Michigan, California, Florida, and New Hampshire. To carry out the validation and discovery of new sources of resistance, a subset of 155 genotypes from this group with known and unknown response to *P. fragariae* were chosen to test in response to two races of this disease in bench tests: Canadian race 4 (A-3) isolate ONT-3, and Cdn-5 (A-5) isolates BC-23 and NOV-77. SSR marker genotyping after capillary electrophoresis separation of the PCR products indicated presence of the marker allele associated with resistance to the *Rpf1* gene in 52 individuals. This marker allele was absent in 103 individuals of the 155 selected for validation. A majority of genotypes lacking the *Rpf1* marker allele are wild species and known to have some resistance to *P. fragariae*. These are expected to show resistance to both race A-3 and A-5 indicating additional factors for the resistance to this disease. Validating this marker for diagnosing the presence of the *Rpf1* gene for resistance will allow this marker to be integrated into marker-assisted breeding and its future use in pyramiding resistance genes.

Specified Source(s) of Funding: Specialty Crop Research Initiative Competitive Grant 2009-51181-05808 of the USDA's National Institute of Food and Agriculture

11:15–11:30 AM

QTL Mapping in an F_1 Tetraploid Blueberry (*Vaccinium corymbosum* L.) Population

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Worldwide demand for highbush blueberry (*Vaccinium corymbosum* L.) is rapidly growing, due in part to high consumer demand for its many health benefits. Marker assisted breeding techniques are currently being developed to aid in more efficient development of improved cultivars with increased nutritional content and overall plant fitness in varying chill environments. To study the relationship of many commercially important traits, a cross between northern highbush 'Draper' and southern highbush 'Jewel' was made to produce a segregating F_1 population of 105 individuals. The population was clonally propagated and planted at four U.S. locations in 2009; Interlachen, FL; Manor, GA; Corvallis, OR; and Grand Junction, MI. Eighteen traits were evaluated in 2011 using objective measures and subjective scores for segregating characteristics relating to winter chilling, overall plant characteristics, flowering times and fruit quality traits. Analysis of segregation was performed on 'Draper', 'Jewel', and 90 F_1 individuals. The draft map of 'Draper' resulted in 287 loci composed of 158 co-dominant SSRs and 129 SSRs scored as dominant markers. Cluster analysis in TetraploidMap was used to construct the current 15 linkage groups, and a multipoint analysis was used to order the groups and calculate LOD scores and recombination frequencies between loci. Genstat was used for a preliminary QTL analysis using phenotypic data generated in Florida and Georgia. Multiple putative QTLs were identified for pedicel scar size, soluble solids content, and total titratable acids at $P < 0.01$; and berry weight, plant width, overall yield, and proportion of vegetative buds that broke at $P < 0.001$. The QTLs identified in this study will be confirmed across different locations and years for the 2011 and 2012 data. After QTL regions are confirmed, increased marker coverage will be targeted to these areas to identify genes controlling these traits. The molecular breeding tools developed from this research will be disseminated to blueberry breeders in the academic and industrial sectors to assist in more efficient development of improved cultivars.

Specified Source(s) of Funding: USDA–NIFA Specialty Crop Research Initiative Award Number 2008-51180-04861

11:30–11:45 AM

Vaccinium Hybrids with the Species of Section *Hemimyrtillus*

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Section *Hemimyrtillus* species are part of the tertiary gene pool of *Vaccinium* and by taxonomic indications should be extremely difficult to hybridize with conventional blueberry materials. Two species of Section *Hemimyrtillus*, native, respectively, to the Portuguese islands of Madeira (*V. padifolium* Smith), and the Azores (*V. cylindraceum* Smith) have features of notable value to conventional blueberry breeding; among these, upright structure, strong growth, abundant flowering and fruiting, good self-fertility, acceptable fruit quality, inflorescence structure suited to mechanical harvesting, and

repeat flowering. Among these two one is deciduous and one evergreen. Another Section *Hemimyrtillus* species, *Vaccinium arctostaphylos* L., is a native of the Caucasus region and is closely allied to *V. padifolium*. *V. arctostaphylos* has many similar characters, but a valuable difference of greater cold hardiness. Although these species appear distantly related to conventional blueberries, notable initial progress has been made at incorporating these species into forms compatible with *V. corymbosum*-based blueberry cultivars, and further evaluations are being made of both parental material and the derived hybrids.

11:45–12:00 PM

Phenotypic Characterization of the First Backcross Generation between Southern Highbush Blueberry and *Vaccinium arboreum*

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Introgression of traits from wild *Vaccinium arboreum* into *Vaccinium corymbosum* germplasm has been a goal of the University of Florida blueberry breeding program for over two decades. Two strategies have been used to further this goal: hybridization with diploid species from section *Cyanococcus* that produce unreduced gametes to create a bridge for crossing tetraploid highbush blueberry, and generation of tetraploid *V. arboreum* plants by colchicine treatment for use in crossing directly with tetraploid highbush blueberry. The cultivar Meadowlark was a result of the first methodology; however, seedling recovery rate using this strategy was low because of low rates of unreduced gamete formation. Hybridization of tetraploid *V. arboreum* with highbush blueberry was first reported by Lyrene in 2011, and nearly 4,000 backcross seedlings between these hybrids and additional highbush blueberry parents have been made. Two backcross half-sibling populations were selected for further analyses. Population A resulted from a cross between 'Southern Belle' and FL 08-467 (*V. corymbosum* × *V. arboreum* hybrid), and population B from the cross 'Abundance' × FL 08-467. The objective of this research was to study the introgression of vegetative and reproductive traits from *V. arboreum* into cultivated *V. corymbosum* germplasm. In both populations, anther awns were present on all individuals that have had flowers, a trait characteristic in *V. arboreum* and other species within section *Batodendron*. After two years, survival was dramatically different between the sibling populations, with a survival rate of 80% and 39% in population A and B, respectively. In general, the means for vegetative and reproductive traits measured in both backcross populations were less than the recurrent *V. corymbosum* parent. For example, the average unpruned height of 72 cm and 70 cm for population A and B, respectively, while the southern highbush parent of population A and B averaged 92 cm ('Southern Belle') and 157 cm ('Abundance'). Two years after planting, 85% and 58% of the surviving individuals in populations A and B had flowers. Pollen germination assays indicated a general increase in pollen viability compared to FL 08-467 (27%), with a mean pollen germination rate of 68% for both populations A and B. Fruit maturity for all individuals in both populations was earlier than FL 08-467, and the majority of individuals in both populations reached 50% fruit maturity earlier than the *V. corymbosum* recurrent parent.

Specified Source(s) of Funding: USDA–NIFA–SCRI Award Number 2009-51181-06021

12:00–12:15 PM

Developing the Genomic Infrastructure for Breeding Black Raspberry

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Over the last 75 years, the black raspberry (*Rubus occidentalis* L.) industry in the United States has steadily declined due to a lack of adapted and disease resistant cultivars. The high anthocyanin content of black raspberry and associated health benefits have revived interest in production and breeding new cultivars. Wild black raspberries were recently collected in their native range from more than 130 locations across 27 U.S. states and two Canadian provinces. Evaluation of this wild germplasm led to the identification of four sources of aphid resistance, two of which were introgressed into the elite breeding pool in two mapping populations. Funding was recently obtained from the USDA's Specialty Crops Research Initiative (SCRI) to develop the genomic infrastructure for breeding improved black raspberries. The objectives of this project include: 1) the development of genomic tools for breeding black raspberry; 2) maintaining or enhancing primary and secondary metabolites in selections; and 3) assessment of consumer preferences and identification of factors that can enhance fresh and processing market expansion. We have begun constructing a linkage map, assembling a draft genome, and generating new microsatellite markers and EST sequences from different black raspberry tissues. The mapping populations have been propagated and will be planted in four different production regions across North America. Phenotypic and genotypic information will be used to identify quantitative trait loci important for breeding objectives. The results will inform decisions regarding germplasm value and usage, crossing, and selection through marker-assisted breeding and phytochemical quality, and will be useful for breeding programs across the U.S.

Specified Source(s) of Funding: USDA–NIFA–SCRI

Wednesday, August 1, 2012 Tuttle

Produce Quality, Safety, and Health Properties

Moderator: Claire H. Luby
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10:15–10:30 AM

Assessing Types and Variation of Vitamin E (Tocochromanol) Compounds throughout the Carrot Life Cycle

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Carrot roots produce vitamin E (tocochromanol) compounds but little is known about their kinds and amounts. We are seeking to classify and quantify tocochromanols present in carrot root. Vitamin A (carotenoid) compounds are an important and well-studied nutritional component of carrots. Carotenoids and tocochromanols share a common biochemical precursor. However, despite the nutritional importance of tocochromanols, they have not been well classified in carrot root and variation among germplasm accessions has not been studied. We are interested in: 1) determining which of the eight tocochromanols (α-, ß-, γ-, and δ-tocopherols and tocotrienols) are present; 2) if there is variation across germplasm accessions; 3) if there is a relationship between quantity of tocochromanols and carotenoids; and 4) what portion of the recommended daily intake value for vitamin E is satisfied by a serving size of carrot. Twelve germplasm accessions including commercial carrot cultivars and breeding lines were grown in field conditions in Markesan, WI, in Summer 2011. Carrots were harvested and analyzed for the levels of individual tocochromanols and carotenoids. To assess changes in tocochromanols throughout the life cycle, carrots from this harvest were vernalized for 3 months at 5 °C and planted in the greenhouse. Roots were sampled at flowering and seed maturity. In order to analyze changes in these compounds over storage life, another set of roots were placed in cold storage and sampled in November, January, and March. Samples were analyzed for tocochromanol and carotenoid compounds simultaneously using HPLC with fluorescent and UV detections, for tocochromanols and carotenoids, respectively. Of the eight tocochromanol compounds, we detected α-, and the combined peak for ß- and γ-forms of tocopherols and tocotrienols. Both δ-tocopherol and tocotrienol were below our detection limit. Variability among germplasm accessions and throughout the vernalization period and life cycle will be discussed.

10:30–10:45 AM

Orange-fleshed *Cucumis melo* Melons: Determinations of Beta-carotene Bioaccessibility and Bioavailability

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β-carotene from melon (*Cucumis melo)* is an important dietary antioxidant and precursor of vitamin A, but its bioaccessibility/bioavailability is unknown. We compared β-carotene concentrations from previously frozen orange-fleshed honey dew and cantaloupe melons grown under the same glasshouse conditions, and from freshly harvested field-grown, orange-fleshed honey dew melon to determine β-carotene bioaccessibility/bioavailability. β-carotene concentrations were determined by HPLC and/or HPLC-MS, β-carotene bioaccessibility/bioavailability was determined by in vitro digestion and Caco-2 cell uptake, and chromoplast structure was determined by electron microscopy. The average β-carotene concentrations (μg/g dry weight) for the orange-fleshed honey dew and can-

taloupe were 242.8 and 176.3, respectively. The average dry weights per gram of wet weight of orange-fleshed honey dew and cantaloupe were 0.094 g and 0.071 g, respectively. The bioaccessibility of field-grown, orange-fleshed honey dew melons was determined to be 3.2 ± 0.3%, bioavailability in Caco-2 cells was about 11%, and chromoplast structure from orange-fleshed honey dew melons was globular (as opposed to crystalline) in nature. The bioaccessibility/bioavailability of β-carotene from orange-fleshed melons was comparable to that from carrot (*Dacus carota*).

Specified Source(s) of Funding: U.S. Department of Agriculture, Agricultural Research Service

10:45–11:00 AM

LED versus HPS Supplemental Lighting Effects on Fruit Quality of Greenhouse Tomato

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Seasonal variation in solar daily light integral (DLI) makes it logistically and financially burdensome to produce greenhouse-grown tomatoes during the winter in a northern climate. A study is underway investigating interactions among light quantity and spectrum, fruit yield, flavor development, and composition of tomato fruit comparing supplemental lighting from energy-efficient LED intracanopy lighting vs. traditional overhead high-pressure sodium lighting vs. unsupplemented controls. Two tomato cultivars, 'Success' and 'Kommeet', were grafted onto the rootstock 'Maxifort' and grown in soilless slab culture within a greenhouse using high-wire trellising. A tomato-production experiment was conducted from late January to late June 2012 with increasing solar DLI combined with a constant supplemental DLI of 9 mol·m^2 per day. Fruits were harvested at the vine-ripe stage, counted, and weighed. Quality metrics were selected that are standard in the Horticultural and Food Science Industries. Objective measures of fruit quality included total soluble solids, titratable acidity, pH, electroconductivity, chromatic index, lycopene, and anti-oxidant contents. These attributes were linked to consumer acceptance via subjective organoleptic taste panels. Both hedonic (indicating preference) as well as absolute scales of evaluation (without indicating preference) were used to evaluate tomato fruit for flavor characteristics including sweetness, acidity, texture, aroma, bitterness, aftertaste, color, and overall approval. Both subjective and objective metrics of fruit quality were correlated with type of supplemental lighting used, total DLI, cultivar, and time of year when harvested. Results from the first fruit-production experiment conducted in 2012 will be presented. This project is supported in part by NIFA SCRI grant 2010-51181-21369.

Specified Source(s) of Funding: NIFA SCRI grant 2010-51181-21369

11:00–11:15 AM

Mineral Properties and Dietary Value of Stinging Nettle (*Urtica dioica* L.) Grown as a Specialty Vegetable

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Stinging nettle (*Urtica dioica* L.) is a species with a long history of usage in all regions of the world. Currently it is receiving renewed research attention as an alternative source of textile-grade fiber, and for clinically proven medicinal and nutraceutical applications. In many cultures, nettle is also eaten as a leafy vegetable and is recommended as a substitute for spinach in recipes. The Alternative Crops Program at Virginia State University (VSU) is working to establish *U. dioica* agronomic and husbandry requirements as a first step toward exploring its economic potential. The present study focused on nettle yield (edible portion) and processing effects on nutritive and dietary values. Actively growing shoots were sampled from experimental plots at the VSU Randolph Farm and leaves separated from stems. After rinsing in tap water, leaf portions (200 g) were further processed by blanching (1 min at 96 to 98 °C), or cooking (7 min at 98 to 99 °C) with or without salt (5 g·L^{-1}). Samples were cooled in ice water immediately after cooking and kept in frozen storage prior to analysis. Proximate composition, mineral, amino acid, and vitamin contents were determined following Association of Official Analytical Chemists (AOAC) methods, and nutritive value (% Daily Values) was estimated based on 100 g serving portions in a 2000 calorie diet. Results show that processed nettle can supply 80% to 100% of Vitamin A (including Vitamin A as *β*-carotene). One of our objectives is to have it documented as a low-calorie nutritious food beneficial to human health and a valuable source of minerals and vitamins in vegetarian and other specialized diets.

11:15–11:30 AM

Influence of Household Processing Techniques on Grapefruit (*Citrus paradisi* var. Macfad.) Bioactive Compounds

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Grapefruits (*Citrus paradisi* var. Macfad.) are a good source of bioactive compounds that may potentially reduce the risk of certain diseases. While certain parameters of postharvest factors effect on bioactive compounds are known, the role of house processing techniques such as blending, juicing and squeezing are not studied. Therefore, mature Texas 'Rio Red' grapefruits were processed by blending, juicing and hand squeezing techniques and analyzed for their phytochemical content by high performance liquid chromatography (HPLC). Results suggest that grapefruit juice processed by blending had significantly ($P < 0.05$) higher levels of flavonoids (narirutin, naringin, hesperidin, neohesperidin, didymin and poncirin) and limonin compared to juicing and hand squeezing. Ascorbic acid and citric acid were significantly ($P < 0.05$) higher in juice processed by juicing and blending, respectively. Furthermore, hand squeezed fruit juice had significantly higher content of dihydroxybergamottin (DHB) than juice processed by juicing and blending. Bergamottin and 5-methoxy-7 gernoxycoumarin (5-M-7-GC) were significantly higher in blended juice compared to juicing and hand squeezing. Therefore, consuming grapefruit juice processed by blending may provide higher levels of bioactive compounds. In contrast, juice processed by hand squeezing and juicing provides lower levels of limonin, bergamottin and 5-M-7-GC. In conclusion, household processing techniques significantly influence the levels of phytochemicals and processing grapefruits by blending is an ideal technique for obtaining optimum levels of health beneficial bioactive compounds.

Specified Source(s) of Funding: This project is based upon the work supported by the USDA–CSREES # 2009-34402-19831 and USDA-NIFA # 2010-34402-20875, "Designing Foods for Health" through the Vegetable & Fruit Improvement Center, Texas AgriLife Research.

11:30–11:45 AM

An Index of Fresh Vegetable Nutritional Value That Incorporates Biomass Yield and Crop Composition

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Consumer interest in foods, including vegetables, with properties that benefit human health (e.g., minerals, dietary fiber, and secondary metabolites) is rising. Many, including farmers, desire to increase the dietary health value of fresh vegetables but they face three challenges. First, there are few, if any, accepted on-farm processes and/or metrics to describe and manage fresh vegetable composition, especially as it relates to dietary health value. Second, data suggest that primary and secondary metabolism may compete for metabolite pools, thus creating the scenario in which growth or health-related secondary metabolite accumulation is favored, but not both. And, third, fresh vegetable producers are rarely directly compensated based on the composition of their crop. Therefore, we developed and are testing a "nutritional yield" index that combines biomass and various composition factors specifically to address the first and second obstacles to increasing the nutritional value of the fresh vegetables named above. We use fresh biomass and antioxidant potential of a leaf lettuce (*Lactuca sativa*) crop produced in spring and fall seasons in Ohio and data from the literature to describe an "antioxidant yield" index. Together, these data suggest that antioxidant yield: 1) is sensitive to genetic and environmental production factors and 2) may be useful in describing changes in crop production and valuation that would be needed to enhance the use of fresh vegetable production systems as more focused and purposeful instruments of human nutrition and health.

11:45–12:00 PM

A Calcium/Calmodulin–Binding UDP-Glycosyltransferase Is Required for Anthocyanin Biosynthesis in Strawberry Fruit

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Strawberry is an economically important horticultural crop. Strawberry fruit contain high levels of antioxidants such as anthocyanins and flavonoids. These antioxidants are beneficial for human health. However, the accumulation of these phenolic compounds in plant cells depends on biochemical modification, most commonly glycosylation. UDP-glycosyltransferases (UGTs) catalyze the transfer of sugar moieties to a wide range of acceptor molecules, including anthocyanins and flavonoids. UGT-mediated glycosylation can increase solubility and accumulation and regulate bioactivity of these compounds. We have identified a gene encoding a calcium-regulated UGT, *FvCUGT1*, in the diploid strawberry *Fragaria vesca* var. Ruegen. Calcium/calmodulin specifically binds to the recombinant FvCUGT1 protein. RT-qPCR analysis indicated that *FvCUGT1* is a fruit specific gene in 'Ruegen' and also in the commercial octoploid strawberry. Expression of the gene is developmentally regulated; the *FvCUGT1* transcript level is low in green fruit, peaks at the white stage, and remains high through to the red stage. The gene expression levels are correlated with the accumulation

of anthocynanins in fruits. Nearly no *FvCUGT1* expression is detected in *F. vesca* var. YW5AF7, which bears yellow fruit and contains only about 4% of pelargonidin 3-O-glucoside as compared to 'Ruegen' in ripe fruit. These results indicate that calcium/calmodulin-binding *FvCUGT1* is an important regulator of anthocyanin biosynthesis and accumulation in strawberry fruit.

12:00–12:15 PM

Mineral Nutrient Density of Tomato in Response to Cultivar Selection and Nutritional Regimes

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Mineral nutrient deficiency in vegetable-based foods is a substantial concern in human diets. Depleted soil fertility and high-yielding cultivars have been associated with low nutrient contents in vegetables. Research is needed to develop systems that introduce nutrient-dense crops to the markets. This study explored if mineral nutrient densities of tomato (*Lycopersicon esculentum* Mill.) can be increased through selection of cultivars and nutritional regimes. Twenty-four cultivars with different phenotypes of heritage and modern origins were studied in field experiments. Conventional fertilizer (10–10–10), compost, and an organic fertility regime of soybean meal, bone meal, and potassium sulfate were assessed. Compost was applied at 40 Mg/ha, and chemical or organic fertilizers provided 75 kg N–75 kg P_2O_5–75 kg K_2O/ha. Elements in tomato fruits were determined by plasma spectrophotometry. Modern cultivars had about 12% higher Ca and about 21% lower Fe concentrations than heritage cultivars with no differences occurring for most of the other elements. Chemical and organic fertility regimes resulted in about 13% higher K and 29% higher Ca than compost fertilization with no differences occurring among most of the other elements. Differences among individual cultivars for each element were large with some cultivars having nearly twice the concentrations of nutrients of others and with considerable uniformity in cultivar rankings among the elements. No interactions occurred between nutritional regimes and cultivars or genotypes. This work suggests that cultivars and nutritional regimes can be selected for production of nutrient-dense tomatoes.

Specified Source(s) of Funding: Massachusetts Experimental Station

1:45–2:00 PM

Using Hawaii's Locally Produced Organic Material to Improve Quality of Vegetable Seedlings

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Vermicompost, coconut coir, and thermophilic compost based growing media were evaluated as alternatives to peat for vegetable transplant production. Four greenhouse trials were conducted using eggplant (*Solanum melongena* var. *esculentum*) and pak choi (*Brassica rapa* var. *chinensis*). Media were: peat:perlite (9:1 v/v)= (P); Peat amended with 0.7 g CaCO/liter of medium= (PAM); coconut coir= (C); thermophilic compost= (TC); vermicompost= (VC); P, PAM, C with weekly applications of soluble N–P–K (19-19-19) synthetic fertilizer= (PS), (PAMS), (CS); P:VC, PAM:VC, C:VC, TC:VC at rates of (75:25, 50:50 and 25:75 v/v); P, PAM, C, TC, P:TC (50:50 v/v), TC:VC (50:50 v/v) amended with tankage at rates of 5, 10, 12, 15, 20, and 25 g per liter of medium; P with weekly applications of soluble organic fertilizer comprised of fish emulsion N–P–K (5–1–1) and seaweed extract N–P–K (0.10–0.10–1.5) = (PO). The physical and chemical properties of media were determined and the effect of treatment on tissue nutrient content and seedling growth were evaluated. The total pore space and water holding capacity of the peat and vermicompost used in our study were not significantly different from each other. The pH, EC, nutrient content and C/N ratio of vermicompost was more ideal for seedling growth than that of peat and amendment of peat with vermicompost improved growing media chemical properties. Amending peat, coconut coir and thermophilic compost with vermicompost increased seedling shoot tissue nitrogen content and seedling shoot dry weight, with the greatest shoot dry weights obtained from 100% vermicompost. Thermophilic compost amended with tankage up to a rate of 15 g/L of medium also increased seedling tissue nitrogen content and seedling shoot dry weight relative to the control and was the most cost effective media comprised 100% of local materials.

Wednesday, August 1, 2012 **Sevilla**

Organic Horticulture

Moderator: Amjad Ahmad
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2:00–2:15 PM

The Effect of Locally Produced Organic Substrates on Germination and Development of Habanero Pepper (*Capsicum chinensis* Jacq.) Seedlings

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Habanero pepper (*Capsicum chinensis* Jacq.), the culturally most relevant horticultural crop of the Yucatan Peninsula, has a rising commercial potential. In the state of Quintana Roo, production has increased 137 times since the year 2000. Thanks to this boom, there is also a growing market interest for organically grown habaneros. Greenhouse and small-scale outdoors producers face several limitations in meeting this demand: low productivity, lack of capacitated staff, few certification organizations, and weakly developed networks with potential buyers abroad. The most limiting factors are high prices and restricted access to commercial organic products and pepper seedlings. Costly conventional seedlings, which growers have to buy in remote cities, commonly show low quality. Some producers elaborate their own substrates using local soils; including clay rich oxisols, poor in organic matter but with favorable water retention and sandier vertisols, containing more organic matter but easily drying out. However, both are poor in macronutrients and boron and result in unsatisfying germination rates of less than 80%. In 2011 a trial in José María Morelos, in central Yucatan Peninsula, evaluated the effect of eight different substrates (made of local low-cost materials) on habanero pepper seedling (variety 'Jaguar'). All compared substrates contained a 50 Vol. % vertisol. The other 50% differed per variant: 1) 50% vertisol; 2) 25% vertisol and 25% ash; 3) 25% vertisol and 25% cow manure; 4) 25% cow manure and 25% ash; 5) 50% oxisol; 6) 25% oxisol and 25% ash; 7) 25% vertisol, 12.5% oxisol and 12.5% cow manure; and 8) 25% oxisol, 12.5% cow manure and 12.5% ash. Seedlings were grown in a plastic greenhouse. Temperature was held constant at 30 °C. 100-cell seedling trays were used (45 mm depth). Irrigation was manual. Pest prevention was achieved using a garlic extract and establishing repellent plants. Fungi prevention was based on copper-containing treatments. The evaluation was based on germination rate, leaf and root development. Results showed satisfactory seedling output in the variants with vertisol soils combined with ash and mixed with oxisol; both with a germination rate of 100%. Substrates containing ash and oxisol tended to have a positive effect on germination; those with manure underperformed. For organic producers of habanero pepper seedlings, which can't rely on costly commercial products, substrates based on local vertisols and easily available ingredients are a promising alternative. Ash is a recommendable component. Cow manure should not be used.

Specified Source(s) of Funding: CONACYT

2:15–2:30 PM

Production of High Quality Potted Organic Violas (*Viola tricolor*) in Peat and Compost Based Substrates Supplemented with Liquid Fertilizers

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As organic foods become ever more popular, there has been increased interest in expanding organic production to include specialty crops. Viola flowers are sold as culinary garnishes or salad components so there is the potential for marketing organic viola flowers as a niche market crop. This factorial study included 3 Organic Materials Review Institute (OMRI) certified organic peat-based substrates with compost added as a source of organic nutrients (Fafard FOF 30, Fertrell special mix, and Sunshine #1 natural & organic) and 3 OMRI certified liquid fertilizers which consist of proprietary blends including oilseed-extract, fish hydrolysate, fish emulsion, and/or kelp extract (Daniels Pinnacle 3–1–1, Drammatic K 2–5–0.2, and Fertrell Liquid #1 4–1–1). A control group which received no fertilizer was planted in each substrate. Conventional control groups were included in a conventional peat-based substrate (Fafard 2) with or without conventional fertilizer (Peter's 20–10–20). In all fertilized treatments 150 $mg \cdot L^{-1}$ nitrogen was supplied as a constant liquid feed. Organically produced viola seed (*Viola tricolor* 'Helen Mount') were sown directly into 4-inch pots on 21 Sept. Substrate pH and electrical conductivity (EC) were measured every 14 days. At the end of the experiment each plant was rated for quality on a 1 to 5 scale and shoot fresh and dry weights were recorded. All treatments which received either organic or conventional fertilizer were deemed marketable (a rating of 3 or higher) at the termination of the experiment 82 days after sowing. The shoot fresh and dry weights of plants grown with organic substrate and fertilizer combinations were not different from those grown with conventional fertilization with one exception. Plants grown in the Fertrell substrate and fertilized with Fertrell Liquid #1 were 13% heavier than the conventional control plants by both fresh and dry shoot weight. All plants grown without fertilizer were not of marketable quality. This indicates that the incorporated nutrient sources in the substrates are not sufficient for viola production. The pH and EC values were consistent for the duration of the experiment. For all fertilized treatments the pH and EC ranged from 5.75–6.60 and 1.13–2.75 mS/cm, while unfertilized treatments ranged from 6.50–6.60 and 1.01–1.40 mS/cm, respectively. These data indicate that organic viola plants of comparable size and quality can be produced on the same schedule as their conventionally fertilized counterparts.

2:30–2:45 PM

Screening Hawaii's Locally Produced Composts for Their Nitrogen Release and Plant Growth Response under Different Soils

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Variability in compost stability and maturity limits utilization

of these potentially beneficial plant growth promoting local amendments by Hawaii growers. Lab incubation and greenhouse experiments were conducted to screen locally produced composts for their nitrogen release and plant growth response in different soils. Eleven different composts were selected to be studied at different application rates (0, 5, and 10 t/ha for the lab incubation, and 0, 10, and 30 t/ha for the greenhouse trial) in two soils (Mollisol and Oxisol). Both experiments had complete randomized design (CRD) with three replicates. Lab incubation was carried out for 2 months. Soil and composts were mixed thoroughly and moisture was maintained at field capacity through out the experiment period. Sub-samples were taken at 0, 1, 2, 4, 6, and 8 weeks. Samples were analyzed for pH, Electrical Conductivity (EC) and Nitrate (NO_3-N) content. The greenhouse trial was conducted using Chinese cabbage (*Brassica rapa* var. *chinensis*). Seedlings were transplanted after 2 weeks of seeding, and plants were harvested a month after transplanting. Plant height, fresh and dry weights were recorded. Mineralization varied (50% to 70% of total N). Differences in C:N ratio explain some but not all. NO_3-N and EC showed a positive significant correlation ($R = 0.78$). Cabbage dry weights were significantly different under the application of different composts and rates of application.

Specified Source(s) of Funding: Western SARE

2:45–3:00 PM

Herbicides Derived from Natural Products and Their Role in the Integrated Management of Weeds in Organic Vidalia® Sweet Onion

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Timely cultivation with a tine weeder is the primary tool for successful weed control in organic Vidalia® sweet onion. Vidalia® sweet onion is a cool-season crop and weather conditions frequently arise that delay cultivation. These delays are often caused by excessive rainfall. Herbicides derived from natural products are suitable for use in certified organic crop production and may have a role in Vidalia® sweet onion production when conditions delay the initial cultivation. Herbicides initially evaluated from 2007 through 2010 were clove oil, *d*-limonene, and lemongrass oil. Control of cutleaf eveningprimrose and swinecress was better using clove oil or *d*-limonene compared to control from lemongrass oil. It was observed in these early trials that weed size directly affected overall weed control with any of these herbicides. In addition, sprayers were reconfigured with sprayer output changing from 25 gal/A to 60 gal/A and overall weed control was improved by the higher-output sprayer. There are few OMRI-approved spray adjuvants and these were evaluated for improving clove oil efficacy in 2010 and 2011. Adjuvants composed of saponins or citric acid plus garlic extract improved weed control from clove oil compared to clove oil alone. Despite the improved overall performance of herbicides derived from natural products when applied at a high spray volume and used with an appropriate adjuvant, the overall conclusion from all experiments was weed control was strongly influenced by weed size. Cutleaf eveningprimrose and swinecress at the seedling stage were effectively controlled by clove oil and *d*-limonene, while control of larger weeds was inconsistent. When conditions were optimum, applications of clove oil or *d*-limonene supplemented the tine weeder and were a useful component in an integrated weed control system in organic Vidalia® sweet onion.

3:00–3:15 PM

Current Status of Biodegradable Plastic Mulches in Certified Organic Production

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There are currently no biodegradable plastic mulch (BDM) products allowed for use in U.S. certified organic production. Petroleum-derived polymers included in BDM formulations render these mulch products unacceptable for certification. To be acceptable, BDMs must be 100% derived from biologically-based polymers like polylactic acid (PLA) and/or polyhydroxyalkanoates (PHA). Although PLA is a biologically based polymer, it may be considered a synthetic since only the monomer is derived from renewable resources and is chemically polymerized. In PHA, microorganisms produce the polymer itself, not the monomer. Mulches must also undergo mineralization within a reasonable time period, and the ultimate fate of degraded polymers must be acceptable to the National Organic Program (NOP) standards. The E.U. and Canada organic standards allow the use of BDMs that contain an additive prohibited in the U.S. With the recent equivalence arrangement of organic standards for export between the U.S., Canada and the E.U., there is a question if these BDMs will eventually be allowed in organic production in the U.S. Additionally, the Biodegradable Products Institute has recently petitioned the National Organic Standards Board (NOSB) requesting the addition of BDMs currently allowed in Canada and the E.U. under section § 205.206 (c) "Biodegradable Plastic Mulch Made from Bioplastics: without removal at the end of the growing or harvest season." In an ongoing USDA Specialty Crop Research Initiative (SCRI) study in Washington State, Texas, and Tennessee, researchers are evaluating tomato production with plastic mulch and commercial mulch products advertised as "biodegradable." The study is testing the ability of existing and emerging BDM products to completely biodegrade in the soil environment. To better understand the impact of BDMs on soil systems, more studies are needed to test for the presence

or absence of residues and/or toxic intermediates and co-products as well as physical and temporal impacts on soil ecology and plant health. Long-term studies on the impacts of biodegradation of BDM products will help promote new information, product development, and may help producers conform to NOP standards. Insight into the current NOP standards prohibiting the use of BDM, the E.U. standards permitting it, and the most up to date results from the USDA SCRI study on the biodegradability and impact BDMs have on soil quality will be discussed.

Specified Source(s) of Funding: USDA–SCRI

3:15–3:30 PM

Bioactive Compounds and Antioxidant Activity in Acerola Fruits from Brazilian Varieties Growing under Traditional and Organic Conditions

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Acerola or Barbados cherry (*Malpighia emarginata*) is characterized by high vitamin C content, which is many times higher than other fruits that could be considered good sources, such as guava, cashew apple and citrus. Besides its consumption as a fruit, acerola presents a wide potential to be used in different products rich in bioactive compounds, as it has been described in several works. The species, originally from the Antilles, can be found from South Texas, through Mexico and Central America to northern South America and throughout the Caribbean, being Brazil nowadays the world's largest producer, consumer and exporter. For this reason in the last twenty years were developed and adapted several acerola varieties in the country. In this study were analyzed bioactive compounds (vitamin C, anthocyanins, yellow flavonoids, carotenoids, and polyphenols) and antioxidant activity in edible portion of fruits from different acerola varieties (AC26, AC69, AC71, Apodi, Barbados, Cereja, Flor Branca, Florida Sweet, FP19, Frutacor, I6 / 2, II 47 / 1, Mineira, Monami, Okinawa, Roxinha, and Sertaneja) growing under traditional and/or organic cultivation. All fruits were harvested at the same stage of maturity, i.e. ripe. The acid ascorbic content ranged from 350.45 to 2530 mg/100 g. The overall average for ascorbic acid content was 1367.47 mg/100 g. Besides vitamin C, acerola fruits were rich in polyphenols (from 560.59 to 1803.11 mg/100 g). Acerola fruits from varieties under organic cultivation showed the highest levels of these bioactive compounds and consequently for antioxidant activity. Additionally, fruits from the majority of the varieties could be considered as good source of anthocyanins, flavonoids and carotenoids. In general the results show that acerola is an excellent dietary source of natural antioxidants, not only vitamin C, and their consumption as fresh and processed fruits should be encouraged.

Specified Source(s) of Funding: Embrapa, CNPq and CAPES

Wednesday, August 1, 2012 Trade Room

Temperate Tree Nut Production/ Growth Regulators in Fruit and Nut Production

Moderator: Thomas J. Molnar
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2:00–2:15 PM

Assessment of Host Resistance to Eastern Filbert Blight (*Anisogramma anomala*) in New Jersey

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Over 190 clonal accessions of *Corylus* L., including species and various interspecific hybrids of *C. avellana* L., *C. americana* Marshall, *C. heterophylla* Fisch., *C. colurna* L., and *C. fargesii* (Franch.) C.K. Schneid were assessed for their response to the eastern filbert blight (EFB) pathogen, *Anisogramma anomala* (Peck) E. Müller, in New Jersey, where the fungus is native. Plants were obtained from the USDA–ARS National Clonal Germplasm Repository and Oregon State University, both in Corvallis, OR, the University of Nebraska, Lincoln, and the National Arbor Day Foundation. Plants were also acquired from the Morris and Holden Arboreta and from nurseries in Amherst, NY and Niagara-on-the-Lake, Ontario, Canada. Accessions were chosen based on their resistance to EFB in Oregon, a region where *A. anomala* is not native, or anecdotal reports suggesting resistance to the disease. Trees were planted in the field from 2002 through 2009 where they were exposed to EFB yearly through field inoculations and natural spread. In Jan. 2012, they were evaluated for the presence of EFB. Cankers were measured and the proportion of diseased wood was calculated for susceptible trees. Results showed most accessions reported to be resistant to EFB in Oregon maintained a useful level of tolerance in New Jersey, with a number remaining free of disease. However, several accessions developed small to medium-size

cankers and showed branch die-back, including offspring of *C. avellana* 'Gasaway'. Most *C. americana* and *C. heterophylla* accessions remained free of EFB, although variation in EFB response was found in hybrids of these species with *C. avellana*. Nearly half of the *C. colurna* × *C. avellana* hybrids developed cankers, while all *C. fargesii* accessions and most grower selections developed in eastern North America remained free of EFB. The results document the existence of a wide diversity of *Corylus* germplasm that expresses resistance or tolerance to EFB in New Jersey and confirms previous reports that *C. americana* is resistant to the disease. Interestingly, most *C. heterophylla* and all *C. fargesii* were also found to be resistant, despite originating in Asia where *A. anomala* is absent. The various interspecific hybrids show the potential for incorporating EFB resistance from wild species through breeding. The results provide further evidence of differences in disease expression in Oregon and New Jersey, where isolates differ and disease pressure may be higher.

Specified Source(s) of Funding: New Jersey Agricultural Experiment Station, the Rutgers Center for Turfgrass Science, and USDA Specialty Crops Research Initiative Competitive Grant 2009-51181-06028

2:15–2:30 PM

Strategies for Limiting the Spread of Asian Chestnut Gall Wasp in North America

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Asian gall wasp (*Dryocosumus kuriphilus* Yasumatsu) is a major pest of chestnut trees in China, Japan, and Korea and was introduced into Georgia in 1974. Species affected by the gall wasp include *Castanea dentata* (American chestnut), *C. mollissima* (Chinese chestnut), *C. crenata* (Japanese chestnut), *C. sativa* (European chestnut), and *C. pumila* (chinquapin). Since the gall wasp was introduced into North America, it has become established in eleven states in the eastern United States. Gall wasps are distributed by the transport of infested chestnut seedlings to new areas and by the exchange of infested scion wood used to graft new trees. Gall formation on trees adversely affects foliar and terminal shoot growth and chestnut production. Some of the strategies for limiting further infestations of this pest have been the implementation of plant quarantines by some states, planting resistant chestnut cultivars, and using sources of clean scion wood from gall wasp-free sites. Hot water submersion and heat treatments using a magnetic field have been tested as methods to eliminate overwintering larvae in dormant scion buds. Both techniques have limitations and grafted trees must remain in quarantine to determine the efficacy of disinfestation treatments because larvae are not easily detectable before budbreak.

2:30–2:45 PM

Managing Vivipary in Pecan

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Crop loss due to vivipary (i.e., premature germination of nuts) is a major profit-limiting problem for certain pecan (*Carya illinoinensis*) farming operations. There is need for orchard management tools and strategies enabling better control over the incidence of vivipary. Field research assessing the influence of irrigation and nitrogen (N) management, and certain bioregulators {i.e., fluridone [an inhibitor of abscisic acid (ABA) biosynthesis] and ABA} exposure on incidence of vivipary, found that the incidence of vivipary can be influenced by any one of these factors. In 'Cheyenne', that relatively high soil moisture and high plant N concentration during mid- and late-summer increases the incidence of vivipary. In 'Sumner', fruit exposure to fluridone during development triggers earlier germination than non-treated fruit; and in 'Oconee' treatment of developing fruit with either fluridone increases vivipary and ABA treatment decreases vivipary. This indicates that crop loss to vivipary can be reduced by altering water and N management strategies so that trees experience some degree of water stress and are not excessively N fertilized during the mid- to late-stages of fruit development. There is also the possibility of regulating vivipary via timely use of certain plant bioregulators.

2:45–3:00 PM

Effects of Abscisic Acid and Abscisic Acid Analogs on Bud Break

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Spring freeze damage is a significant risk for tree fruit and grape growers. Warm spring weather promotes bud break in woody perennial fruit crops and subsequently reduces bud cold hardiness. A freeze event following the bud de-hardening often leads to damage and even death. The plant hormone abscisic acid (ABA) plays a critical role in dormancy induction and maintenance. Researchers at Valent BioSciences Corporation and university cooperators have recently tested the effects of exogenous application of ABA and ABA analogs on delaying bud break of grapevines and fruit trees. Spray or soil drench application of ABA in the spring prior to bud break delayed bud break, but the effect was inconsistent and the delay was not as long as desired. Efficacy of applied ABA for bud break delay is likely limited in part because of poor ABA uptake. For a leafless eco-dormant plant, spray application uptake is limited to penetration of the water repellent bud scales and drench application uptake is limited by poor vascular movement from roots to the dormant buds. In a study on potted Concord grapevines, a 1 L soil drench application of 1000 ppm ABA or 100 ppm ABA analog (PBI-429) was made in the fall prior to the onset of leaf abscis-

sion and dormancy. The potted vines were held outside over the winter with the pots buried in bark mulch to protect the roots from freezing. In the spring the vines were pruned and bud break was monitored. The ABA treatment failed to delay bud break, however the ABA analog treatment did significantly delay bud break. In a study on mature Cabernet Franc vines in the field, a post-harvest, pre-leaf abscission, foliar application of 300 ppm ABA analogs (PBI-429, PBI-524) significantly delayed bud break in the following spring. In the spring following treatment the grapevines on a vertical shoot positioning trellis were pruned and bud development was monitored and rated using the BBCH system. Bud break of the ABA analog treated vines was delayed by about 21 days. Research is continuing to determine whether ABA or ABA analog can be used to consistently improve bud cold hardiness and/or delay bud break.

3:00–3:15 PM

Influence of 1-Aminocyclopropane-1-Carboxylic Acid (ACC) on Abscission and Fruit Quality of 'Mcintosh' Apples

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The search is ongoing to identify compounds that can effectively thin apples. Emphasis is frequently placed on naturally occurring compounds because they may be easier and less expensive to register and consumers are demanding more naturally occurring products be used in the production of fruit and vegetables they purchase. ACC is a naturally occurring compound that is the immediate precursor in the biosynthetic pathway of ethylene. ACC was evaluated over the past two years at rates between 200 and 400 mg/L and at two different times of application 10 mm and 20 mm fruit size. Unlike most thinners, ACC appears to have the greatest thinning activity when applied at the 20 mm rather than the 10 mm fruit size. The 10 mm stage it caused some leaf yellowing and abscission, whereas the later time of application caused little or none. Fruit treated with ACC had high amounts of ethylene production the day after application. Elevated levels of ethylene were detected for several days after. More ethylene was given off by fruit at the 10 mm stage than at the 20 mm stage. Fruit from trees treated with A CC were generally larger and had higher flesh firmness. These fruit also had a lower starch index suggesting that ripening was delayed. ACC appears to be a promising new apple thinner, especially since there are so few options available to thin apples at larger fruit sizes such as at the 20 mm stage.

3:15–3:30 PM

Improving Fruit Set in 'Regina' Sweet Cherry with Aminoethoxyvinylglycine (ReTain) Is Facilitated by Delayed Stigmatic Senescence

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Yields of sweet cherries, particularly of 'Regina', are very variable from season to season. Poor set is often due to unfavorable weather conditions for pollinator activity. Efforts have been made to extend the receptive period of the stigma by external control of ethylene evolution, and thus to improve pollination efficiency, and to ultimately increase fruit set. In this study, laboratory and field trials were set up to investigate the efficacy of 250 or 500 ppm aminoethoxyvinylglycine (AVG, ReTain®) applications on flowering phenology, floral biology and fruit set of 'Regina' sweet cherry. Both 250 and 500 ppm AVG treatments delayed whole flower and stigmatic senescence evidenced by a delay in the occurrence of flowering phenological stages of both detached and attached flowers, and by scanning electron microscopy imaging of the stigmatic surface. AVG treatments did not affect floral biological characteristics (intrafloral nectar production, nectar refraction, pollen production, and pollen viability) of cherry flowers, and therefore did not influence the attractiveness of flowers to insect pollinators. Ethylene evolution of detached cherry flowers and fruit drop were significantly decreased. While fruit set was significantly increased, significant differences in fruit quality (fruit size, color, soluble solids concentration) were not observed between control and AVG treatments. As it is proven in this study, increasing floral longevity by external application of aminoethoxyvinylglycine, a plant growth regulator that inhibits ethylene biosynthesis, can be a powerful tool to improve pollination efficiency and fruit set of sweet cherries, and possibly other crops, under unfavorable weather conditions.

Wednesday, August 1, 2012 Balmoral

Vegetable Crops Management 2

Moderator: Will Neily
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2:00–2:15 PM

A New Composition for Solid Matrix Priming of Seed

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Seed priming is a technique that improves germination percentage, rate of germination, germination uniformity, and/or stand establishment. During a priming protocol, physiological processes are initiated but radicle emergence is prevented by altering surrounding osmotic (osmotic priming) or matric (solid matrix priming) potential. In the present study, a novel composition of arboretum and greenhouse waste compost and hydrogel plus distilled water was used for solid matrix priming. Processed and sieved arboretum and greenhouse waste compost was combined with fine-grade hydrogel (SuperSorb·F; Aquatrols Corp., Paulsburo, NJ) and distilled water to obtain a seed priming composition that was

flowable with high moisture content (115% to 228%, dry weight basis) generating water potentials of –1.6 to –0.5 MPa. The composition exhibited negligible osmotic potential and maintained matric potential of –1.0 MPa throughout 7 d priming of carrot (*Daucus carota* L.) seed incubated at 15 °C. Solid matrix priming increased germination rate (time to 50% germination) of carrot by up 74% but this was dependent on cultivar type and ratio of seed-to-priming component. Benefits of solid matrix priming using compost and hydrogel versus osmotic priming using polyethylene glycol include enhanced uniformity of water potential during the procedure and less chemical disposal issues. Its renewable nature distinguishes it from other solid matrix priming materials and, specifically, the ability to generate sufficiently high water content at appropriate matric potentials distinguishes the new composition from other compost priming methods.

2:15–2:30 PM

Nitrogen Management for No-tillage Zucchini Squash

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Although fertility management in no-tillage (NT) systems is important to maximize productivity, little information is available on fertilizer recommendations [especially nitrogen (N)] for vegetable crops grown in this type of production system. A field study was conducted at a grower location in southern Illinois to determine the effect of N application rates in NT zucchini squash production following the herbicide burn-down of a wheat cover crop in early spring. The amount of available N in soil was 86 kg/ha following burn-down; and, soon thereafter, a maintenance preplant fertilizer mix (18 kg N + 10 kg P_2O_5 + 132 kg K_2O/ha) was applied prior to transplanting squash into the residue. When plants had 8 to 12 true-leaves, N was sidedress applied [1:3 blend of NH_4NO_3 and $Ca(NO_3)_2$] at 6 rates: 0, 17, 34, 67, and 134, and 201 kg/ha. Results indicated that the maximum total squash fruit yield was achieved at 34 and 67 kg N/ha sidedress rates. Although plant growth was maximized at 134 and 201 kg N/ha, the overall total yield was less compared to the 34 and 67 kg N/ha rates. It appears that if excess nitrogen is available, squash plants will use N for plant foliar growth rather than for fruit production. Therefore, the N rate needed to maintain adequate plant growth and provide maximum yields over a growing season was between 138 and 171 kg N per hectare. Many vegetables are inefficient users of nutrients and high fertilizer rates are often used by growers that exceed crop demand to insure high yields. However excess amounts of applied fertilizers will not only increase grower input costs and cause potential N runoff problems, but this research indicates that too much N can lead to reduced crop yields.

2:30–2:45 PM

Commercial Extract from the Brown Seaweed *Ascophyllum nodosum* (Stimplex®) Improves Earliness and Yield of Hydroponically Grown Tomatoes

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Tomatoes are the leading greenhouse vegetable grown in North America and the world. Almost all greenhouse tomatoes are produced hydroponically, using computerized production systems and grown in medias such as rock-wool or coconut fiber. In the United States and Canada, growers normally transplant new plants into their greenhouses in December and the first ripe tomatoes are produced in late March. A greenhouse experiment at the Dr. James S. Craigie Research Center in Cornwallis, Nova Scotia, was designed to test the effects of Stimplex® (a proprietary extract from the brown seaweed *Ascophyllum nodosum*) on earliness and yield of hydroponically grown greenhouse tomatoes. Stimplex® treatments in combination with a standard hydroponic fertilizer were applied to the root systems of tomato plants (*Lycopersicon esculentum* Mill. var. Trust) through the irrigation system. The growth, flowering and fruit production of the Stimplex®-treated plants was compared to grower fertilizer only treated plants. Fruit set of Stimplex®-treated plants was shown to increase by 78% during the first 5 weeks after transplanting. Stimplex®-treated plants exhibited earlier fruit ripening with a 51% increase in the fresh fruit harvested 8 weeks into production. A 19% increase in yield and a 5% increase in fruit weight were achieved 15 weeks into production. These results suggest that Stimplex® applications improve the earliness of fruit set and ripening that result in increased yields during the early stages of greenhouse tomato production.

2:45–3:00 PM

Fertility Management for Tomato Production on an Extensive Green Roof

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Tomato (*Solanum lycopersicum*) is a widely cultivated vegetable crop that serves an important role in urban agriculture. The

increasing demands for fresh, healthy, local foods in urban environments is challenging and green roofs may play a part in providing vegetable products to urban markets. However, adequate fertility to maximize plant growth is often lacking in green roof media, especially after several years of intensive production. Therefore, four fertility treatments were applied weekly to 'Bush Champion II' tomato grown in a three inch extensive green roof media mix on the Southern Illinois University campus. The fertility treatments evaluated were: 1) vermicompost tea (from coffee grounds; 12,600 mg/kg N), 2) Miracle-Gro fertilizer (Scotts Miracle-Gro Products Inc., Maryville, OH; 16,100 mg/kg N), 3) Organic Miracle-Gro fertilizer (Scotts Miracle-Gro Products Inc; 6,900 mg/kg N), and 4) no fertilizer (0 mg/kg N). The green roof media mix contains various gradations of expanded lightweight clay aggregate with 4% to 5% organic matter. Although our analysis indicated that the vermicompost tea had a relatively high amount of N, most was in the organic form and was not readily available for plant uptake. Water was applied through drip irrigation applied daily and fertility treatments were applied in 1.9 L of water for each plant once a week from transplant to the end of harvest. Ripe tomato fruit were harvested eight times from June to August. Plant vigor, chlorophyll content, and marketable yields were greater ($P \leq 0.05$) when Miracle-Gro and Organic Miracle-Gro were used as the fertilizer source. Subsequently, the no fertilizer and vermicompost tea application resulted in less production as lower fertility in these treatments reduced tomato plant vigor and fruit yield. This study indicates that acceptable tomato yields can be achieved in a 3-inch extensive green roof with adequate fertilizer applications.

3:00–3:15 PM

Nitrogen Fertilization Rate and Plant Population Affect Yield and Quality of Drip-irrigated Bell Pepper

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The effect of nitrogen applied at 180, 270, or 360 kg·ha^{-1}, with plant populations of 30750, 46125, or 61500 plants/ha of 'Galaxy' bell pepper (*Capsicum annuum* var. *annuum* Grossum group) was examined in a complete factorial experiment. Plants were set in the field with 2, 3, or 4 rows/bed, with a single drip tape in the center of the 2-row beds and drip tape centered between outer 2-rows of the 3- and 4-row beds. Drip tapes with different delivery rates were used to maintain an equal water application rate/plant in all plots. Plant leaf area and dry matter accumulation decreased linearly as plant population increased from 30750 to 61500 plants/ha. Total N concentration was not influenced by plant population, but plant N uptake decreased linearly as population increased. Plant N concentration increased linearly as N rate increased from 180 to 360 kg·ha^{-1}; no other parameter was influenced by N rate. At the second harvest, fruit concentrations of N, P, K, and S were not affected by plant population, but increased linearly as N rate increased from 180 to 360 kg·ha^{-1}. Fruit mineral uptake, however, increased linearly as population increased, but was not influenced by N rate. Efficiency of N utilization (N used/N applied) increased linearly as plant population increased, but decreased linearly as N rate increased. Fruit yield in all categories increased linearly as plant population increased. Yield of USDA Fancy pepper fruit was not influenced by N application rate, but fruit yields in all other categories decreased as N rate increased. Maximum yield and N-use efficiency for 'Galaxy' bell pepper are achieved with N applied at 180 kg·ha^{-1} with a plant population of 61,500 plants/ha.

3:15–3:30 PM

Planting Materials Affect Asparagus Performance in a Replant Situation

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Replant suppression is one of the major threats to asparagus (*Asparagus officinalis*) production worldwide. This is a phenomenon which prevents asparagus from establishing well in a site that has previously been planted in asparagus. Unfortunately, virgin land is limited in most asparagus-growing regions in the U.S. Traditionally, new asparagus fields in Michigan and other regions are established with 1-year-old crowns. If the crown nursery is infested, then the crowns may spread diseases, and wounds created during the crown digging process may serve as entry ports for soilborne diseases. Alternative planting materials that are disease-free could be used as a component of disease management for improved plant performance. Therefore, the goal of this research was to compare the performance of asparagus fields established with 1-year-old crowns (CR) with that of fields established with greenhouse grown transplants (TP) in a replant situation. Field experiments were established at the Asparagus Research Farm in Oceana County, MI, in 2005 and 2007 using asparagus cultivar Guelph Millennium. Based on preliminary studies, the transplants were produced in the greenhouse using trays with 72 cells. One-year-old crowns were provided by a commercial crown grower. After 3 years of harvest (2005 trial) and 2 years of harvest (2007 trial), asparagus yield was consistently higher in TP treatments compared to CR treatments. The average yield increase was greater than 50% for the 2007 study. Differences in yield were mainly attributted to a greater number of spears in the TP treatments. During the fern growth stage, the TP treatment also produced more shoots than the CR treatment. These preliminary results suggest that TP should seriously be considered as an alternative planting material for the establishment of new fields. However, the use of TP will require significant changes in the production system, especially during the first years of field establishment, since biotic and abiotic stresses have more impact on TP than CR. Transplants will need be hardened off adequately and irrigated

immediately after transplanting. They should not be sprayed with potentialy phytotoxic products.

Specified Source(s) of Funding: NIFA-PMAP

Wednesday, August 1, 2012 Trade Room

Plant Nutrient Management 2

Moderator: Robert Mikkelsen
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4:00–4:15 PM

Nitrogen Source Affects Free Chlorine Concentration and Oxidation Reduction Potential

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Irrigation water treated with free chlorine (hypochlorous acid and hypochlorite ion) at 2 mg·L^{-1} and pH range of 6 to 7.5 can control zoospores of *Pythium* and *Phytophthora* spp. The objective was to quantify the effect of water soluble fertilizers on concentrations of free chlorine level in a sodium hypochlorite solution. Chlorine from sodium hypochlorite (Clorox® regular bleach) was applied at 2.6, 10, and 20 mg·L^{-1} of free chlorine into deionized water only (control) and 11 fertilizer treatments with 200 mg·L^{-1} of nitrogen. Fertilizer treatments included reagent-grade ammonium sulfate $(NH_4)_2SO_4$, ammonium nitrate (NH_4NO_3), potassium nitrate (KNO_3), urea salts, and seven commercial blended N–P–K water-soluble fertilizers, with macro- and micronutrients. Commercial fertilizers contained ammonium-N at 0 to 50% of total-N, urea-N at 0 to 14% of total-N, and nitrate-N at 50% to 93% of total-N. Measurements of free chlorine (mg·L^{-1}), total chlorine (mg·L^{-1}), and oxidation-reduction potential (ORP, in mV) were recorded after 2 min and 60 min after chlorine was applied, to quantify the oxidative strength of the solution. Combined chlorine was determined from the calculated difference between the total and free chlorine measurements. All solutions were maintained at pH 6 at 25 °C during the analysis. In the control solution, the applied 2.6 mg·L^{-1} of free chlorine decreased to 2.5 mg·L^{-1} after 2 min or 2.2 mg·L^{-1} after 60 min. Treatments of $(NH_4)_2SO_4$ and NH_4NO_3 had decreased free chlorine levels to below 0.1 mg·L^{-1} after 2 min or 60 min. Urea reacted more slowly than ammonium salts, whereby free chlorine decreased to 2.3 mg·L^{-1} after 2 min and 0.4 mg·L^{-1} after 60 min. In contrast, KNO_3 had less impact on free chlorine, with 2.4 mg·L^{-1} free chlorine available at both 2 min and 60 min. With all commercial fertilizers tested, after 2 min, free chlorine decreased to below 0.1 mg·L^{-1}. Total chlorine was above 2 mg·L^{-1} after 60 min in all treatments, indicating that the majority of chlorine was in a combined form for ammonium and urea salts and commercial fertilizers. The ORP of commercial fertilizer blends and ammonium-containing salts was lower than 600 mV, whereas deionized water, KNO_3, and urea treatments had ORP levels above 650 mV. Fertilizer containing ammonium or urea required 20 mg·L^{-1} or more of applied chlorine to maintain residual free chlorine above 2 mg·L^{-1}. Research on the disinfestation strength and phytotoxicity risk of combined chlorine forms such as chloramines is needed.

4:15–4:30 PM

Evaluation of Conventional and Alternative Nitrogen Fertigation Methods in Highbush Blueberry

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A 0.3-ha study was planted in Oct. 2008 to determine the effects of nitrogen (N) fertigation using conventional and alternative drip irrigation systems on shoot growth and early fruit production in six cultivars of northern highbush blueberry (*Vaccinium corymbosum* L.). The cultivars included 'Earliblue', 'Duke', 'Draper', 'Bluecrop', 'Elliott', and 'Aurora'. The conventional drip system consisted of two laterals of drip tubing, with 2 L·h^{-1} in-line emitters spaced every 0.45 m, placed on each side of the row, at a distance of 0.2 m from the base of the plants. The alternative system was called KISSS (kapillary irrigation sub surface system) and consisted of a single lateral of drip tape covered with geo-textile fabric that dispersed water and nutrients along the entire length. A single KISSS lateral was placed along the row near the base of plants. Liquid urea was applied at rates of 100 and 200 kg·ha^{-1} N with conventional drip and 200 kg·ha^{-1} N with KISSS. Fertigation was done weekly from early May to mid August during the first year after planting in 2009 and from mid April to mid August the following 2 years. Irrigation was scheduled every 1–3 days to replace 100% crop evapotranspiration. Plants were cropped beginning the third year after planting. Shoot growth differed among cultivars each year and between irrigation systems the first 2 years but was not affected by irrigation system the third year or by N rate and treatment interactions in any year. In the first year after planting, fertigation with KISSS produced an average of 1.8–2.0 cm/shoot more growth than conventional drip fertigation. The following year, the opposite occurred and fertigation with conventional drip produced 3.2 cm/shoot more growth than KISSS. By the third year, shoot growth and plant size were similar between irrigation systems. Fruit yield also differed among cultivars the third year and averaged 3.4–9.7 t·ha^{-1}; however, like shoot growth in year 3, yield was unaffected by irrigation system, N rate, or any interactions. Plant growth and yield were not a function of leaf N concentration, as leaf N was consistently lower each year with 100 kg·ha^{-1} N than with 200 kg·ha^{-1} N and similar between drip and KISSS fertigation with 200 kg·ha^{-1} N. Overall, plant establishment differed little between the two fertigation methods, and 100

kg·ha^{-1} N or less was sufficient to maximize early fruit production in each cultivar.

Specified Source(s) of Funding: Oregon Blueberry Commission

4:30–4:45 PM

Early Season N Fertilization Management Strategies in Strawberry Production

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Annual strawberry (*Fragaria ×ananassa* Duch.) production is a major industry in the Salinas Valley of central California, an area with widespread NO_3-N impairment of both surface water and groundwater. Pending environmental water quality regulation will require more efficient utilization of N fertilizer. Seasonal N application averages approximately 230 kg·ha^{-1}; about half is applied in a controlled release N (CRN) form prior to crown planting in October–November. The remainder of the seasonal N is fertigated through drip irrigation during the subsequent spring and summer. Because strawberry is usually grown in rotation with lettuce and other leafy greens, residual soil NO_3-N at the time of crown planting often exceeds 15 mg·kg^{-1}. Winter rainfall provides N leaching potential while cool temperatures limit crop growth until March. These circumstances call into question the value of a large preplant N application. To investigate the efficiency of pre-plant CRN application, trials were initiated in Fall 2010 in three commercial fields comparing the growers' standard CRN application with a half rate (all fields) and no CRN application (field 3 only). Full rate CRN application was 121 (fields 1 and 2) and 86 kg·ha^{-1} (field 3). All treatments received all in-season N fertigation applied by the growers. Above-ground plant biomass, biomass N, and soil NO_3-N were determined in monthly sampling. By early April, plant biomass N averaged < 20 kg·ha^{-1}, with no significant effect of preplant CRN rate in any field. Biomass N in fields 1 and 3 averaged 177 kg·ha^{-1} by mid-August, again with no significant effect of preplant CRN rate. Seasonal marketable fruit yield in fields 1 and 3, which averaged 1.55 and 2.00 kg per plant, respectively, were also unaffected by preplant CRN rate. In field 2, a transient but statistically significant reduction in biomass N was observed in the half rate CRN treatment in the June sampling, at which time soil NO_3-N was < 1 mg·kg^{-1}. Marketable fruit yield in the half rate CRN treatment, which until that time had been equivalent to the full CRN rate, fell progressively behind and finished the season 10% lower than the full rate treatment. We conclude that a large preplant CRN application is an inefficient practice in this production system. This study suggests that reducing preplant CRN rates while monitoring soil NO_3-N to guide in-season N fertigation, could improve N fertilizer efficiency.

4:45–5:00 PM

Mapping Crop Nutrient Use and Removal in the U.S

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There is a need for a systematic examination of current nutrient use in the United States. Knowing the status of nutrient use and crop removal provides a basis for identifying regions for improvements in management and potential areas for water and air quality improvement. The "Nutrient GIS" (NuGIS) database creates county-level estimates of N, P, and K applied to the soil in fertilizer and livestock manure, and removed by harvested agricultural crops. Geospatial techniques are used to estimate balances for 8-digit hydrologic units using the county-level data. The current version makes estimates for 5-year periods, coinciding with the USDA Census of Agriculture, from 1987–2007. A version that can be updated annually for non-Census years is under development. The following major conclusions are evident: Crop nutrient removal in the United States is increasing faster than nutrient use. Great variation exists across the country in major nutrient (N, P, K) balances. The most positive P balances are found in the South Atlantic Gulf, New England, and California watershed regions. Much of the Corn Belt has negative P balances and the entire western half of the country has highly negative K balances. Removal to use ratios appear unsustainably high in some regions and unsustainably low in others calling for intensive monitoring of soil fertility and more intensive nutrient management. Substantial uncertainty exists in such aggregate data and points to a need for farm-level measurement of nutrient balance and removal to use ratios as a basis for indicating progress in nutrient management.

5:00–5:15 PM

Effect of Microbial Inoculants on Peat-based Substrate Microbial Activity and Bedding Impatiens Growth with Conventional or Organic Slow-release Fertilizers

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As the number and availability of microbial inoculants for use in soilless production systems increases, their effects on substrate microbial activity and plant growth need to be evaluated. In

a greenhouse experiment, *Impatiens walleriana* 'Super Elfin XP White' plugs were grown in a peat-based substrate with 13 treatments consisting of variations of three microbial status (autoclaved peat, no innoculant, and two rates of SubCulture™ with bacterial and/or mycorrhizal inoculants) and three pre-plant fertilizers (conventional Osmocote™, and organic feathermeal or blood meal). Substrate CO_2 respiration, pH and electrical conductivity were measured throughout the production cycle, and impatiens growth was evaluated at mid- and end-crop. Organic blood meal treatments resulted in larger plants than feathermeal or Osmocote. Use of microbial inoculants did not result in more plant growth when used in conjunction with bloodmeal or Osmocote, but contributed to increased plant dry weight within feather meal treatments when a 5× rate of inoculants was used ($P = 0.026$). Autoclaving peat generally resulted in decreased plant dry weight compared to non-autoclaved treatments. Seven and 14 days after transplant (DAT), substrate microbial CO_2 respiration was greater with the two organic fertilizer sources, regardless of the presence of inoculants. By 21 DAT, microbial CO_2 respiration was similar across treatments and increased dramatically at days 30 to 50 DAT. Presence of inoculants did not significantly increase microbial CO_2 respiration compared to uninoculated treatments. These results provide information about the function of microbial inoculants in soilless production systems.

Specified Source(s) of Funding: Fred C. Gloeckner Foundation

5:15–5:30 PM

Amino Acid Fertilization of Fraser Fir (*Abies fraseri*), Red Pine (*Pinus resinosa*), and Hybrid Poplar: Effect on Foliar Chemistry and Nutrient Dynamics

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Plants have the ability to assimilate and use amino acids as a nitrogen source. This process has been identified in plants growing in boreal, alpine tundra, arctic, and temperate ecosystems in addition to controlled environments where plants are grown in containers. This principle has seldom been tested in a field production setting, although it has been shown that agricultural plants can utilize amino acids. This 2-year study (2009–2010) evaluates the effects of amino acid fertilization on the foliar chemistry of two conifer seedlings Fraser fir (*Abies fraseri*) and Red pine (*Pinus resinosa*) and one hardwood (hybrid poplar) and the nutrient dynamics in a these short rotation tree production system. The amino acid fertilizer used, arGrow complete®, contains arginine and other plant essential macro- and micronutrients, and was applied at varying rates (0, 50, 100, 200, and 300 lbs N/acre). Granular ammonium sulfate (21% N) was applied to positive control treatments at a rate of 100 lbs N/acre. Foliar nutrient concentrations (N, P, K, Ca, Mg, and Mn) were monitored at the beginning and end of the growing season in both years of the study. Soil exchangeable cation concentration (K, Ca, and Mg) was determined at the beginning and end of the growing season in 2010 by ammonium acetate extraction. Lysimeters were installed prior to beginning the study, and cation nutrient losses (N, K, Ca, and Mg) through the rootzone were quantified weekly during both growing seasons. In both growing seasons, Ca and Mg content in leachate of *A. fraseri* treatments was significantly greater in ammonium sulfate treatments. This trend was observed for *P. resinosa* treatments only for Ca in 2010. Treatment had no effect on cation leaching in hybrid poplar plots, probably due to charge balances in the soil as a result of nitrate leaching. Soil exchangeable cation concentrations were statistically similar in May and in August among treatments for all species, with the exception of reduced Mg in ammonium sulfate hybrid poplar treatments, which was likely due nutrient limitations. Overall amino acid fertilization had a more significant effect on foliar nutrient concentrations in the first year of the study, and the less prominent effect in the second year was suggested to be due to competition with non-target organisms for nutrients when trees were establishing in field soils.

Specified Source(s) of Funding: MSU AgBio Research, Michigan Christmas Tree Association

5:30–5:45 PM

Using Stable Isotopes to Quantify Nitrogen Fates in Container Plants

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Nitrogen use efficiency (NUE) is increasingly important in the production of container plants as awareness of the environmental consequences of nitrogen (N) leaching increases and as regulations on nitrogen losses from nurseries tighten. Furthermore, N lost to the environment reduces the economic efficiency of container production. While N leaching is relatively easy to measure, losses due to nitrification have been difficult to quantify. We have demonstrated that fertilizer with unique stable isotope signatures of oxygen and N can be used to accurately quantify N fate following application. To quantify N uptake and loss, fertilizer containing ^{15}N- and ^{17}O-labeled ammonium nitrate (NH_4NO_3) and potassium nitrate (KNO_3), respectively, was applied to red maple (*Acer rubrum*) plants growing in 2-L

containers. Mass balance equations were used to quantify N conversions and losses in the system. Approximately 18% to 36% of applied N was leached from the container. Within the leachate, 59% of the nitrate came directly from applied fertilizer and 41% from nitrification. Plant nitrogen in new growth was predominately from fertilizer nitrate (30% to 50%), with fertilizer ammonia (20% to 23%) and unknown N (media, fixation, mineralization) accounting for the remainder. The nitrification rates suggest a large fraction of the assimilated ammonia may have first been nitrified and taken up as nitrate. A significant fraction of the applied N was unaccounted for, presumably lost via denitrification, immobilization and/or volatilization. Better quantification of the sources of N loss from container plants will allow us to assess various cultural practices for their effects on N loss and in turn provide valuable information to plant producers.

Specified Source(s) of Funding: Purdue SURF Program Indiana Nursery and Landscape Association

5:45–6:00 PM

Ground Cover Management and Nutrient Source Increase Soil Carbon Sequestration in an Organically Managed Orchard

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A common characteristic of weathered, acidic southeastern US soils is low organic matter content, a condition which can have detrimental effects on orchard productivity. In March 2006 an experimental apple orchard was established to evaluate the effect of three organic nutrient source amendments (untreated control, composted poultry litter, and certified pelletized fertilizer) and four groundcover management treatments (shredded paper, wood chips, municipal green compost, and mow-blow) on tree growth and productivity and soil quality indicators. As a study of the potential environmental impacts of organic orchard management, changes in soil carbon and nitrogen were monitored as affected by the nutrient and ground cover treatments. Soil cores (0–10 cm) were collected in 2006 from a Captina silt loam and analyzed for total soil organic matter by loss on ignition. Soil carbon (SC) and soil nitrogen (SN) levels were calculated using known local values of carbon and nitrogen for this soil series. In Nov. 2011 soil cores (0–7.5 cm) were collected and directly analyzed for SC and SN by loss on ignition. SC and SN increased during the period 2006 to 2011 with ground cover and nutrient source treatments with greatest differences observed in the municipal green compost treatments. Increases in SC were positively correlated to increases in SN ($P < 0.0001$) across treatments. Our results indicate that soil C concentrations can be significantly augmented using organic cultural methods over a relatively short time.

Wednesday, August 1, 2012 Balmoral

Pomology 2

Moderator: Bryan Emmett
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4:15–4:30 PM

Reduction of Sunburn in 'Golden Delicious' Apple (*Malus domestica* L.) Fruit using a Hydrophilic Biofilm

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A unique elastic, hydrophilic organic Biofilm was developed in the College of Pharmacy at Oregon State University in 2008 and refined in 2009–10. A U.S. Patent was awarded in 2011 for the use of the Biofilm for the prevention of fruit sunburn. From 2009 to 2011 several different UV protectants, including cinnamaldehyde, zinc sulfate, and kaolin (Surround$^{(R)}$) were used in conjunction with the elastic Biofilm to determine whether sunburn of apple fruit could be significantly reduced. In vitro tests were undertaken between 2009 and 2011. In 2009 and 2010, 'Golden Delicious' apple fruit were sampled monthly, from May until August, from a commercial orchard trained to a central leader in Milton-Freewater, OR. In 2011, fruit were sampled weekly from early June till early August. All fruit were subjected to intense ultraviolet radiation for up to 8 hours totaling 12,500 KJoules·m^{-2}. Fruit color changes including chroma, hue, and Hunter L, a and b readings were recorded both before and after treatments. A time, UV, temperature interaction was needed to induce discoloration of fruit skins and fruit were only susceptible to sunburn after the red base color associated with fruit set had faded to green. Furthermore, temperature, UV and visible light radiation were recorded in the field in 2011 and modeling of these in relation to in vivo sunburn will be reported on. Two full cover applications of 1 gal per acre of the Biofilm in conjunction with 25 lb of Surround$^{(R)}$ per 100 gal of water per acre applied in late spring and early summer provided better protection to the fruit than five applications of Surround$^{(R)}$. Both treatments were superior to the untreated control in preventing sunburn. The effects on yield, packouts, and postharvest quality will also be reported.

Specified Source(s) of Funding: Oregon Department of Environmental Quality; Pacific BioControl; Agricultural Research Foundation

4:30–4:45 PM

Organic Weed Management Strategies for Apple Trees

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Four weed management strategies were established in 2009 and continued into 2011: 1) periodic mowing and herbicide applied once in 2010 and 2011; 2) Herbicide 2, herbicide twice; 3) Herbicide 3, applied three times; 4) bark mulch applied once in 2009 with herbicide applied once in 2011; and 5) herbicide followed by bark mulch applied once in 2009. Treatment 1 was intended to be an untreated control, but herbicide was accidentally applied once in 2010 and 2011. The herbicide GreenMatch™ , which contains the active ingredient d-limonene, was applied at the labeled rate in a 1-m band under the trees. Bark mulch was also applied in a 1-m band. The orchard was planted in 2007 with 'Honeycrisp' and 'Snowsweet' on M.26 rootstock. In 2010 and 2011, mulch resulted in the greatest duration of weed biomass reduction followed by herbicide applied 3 times. Soil moisture tension was highly variable in this unirrigated orchard and fluctuated from 9 to 72 kPa in 2010 and was as high as 87 kPa in 2011. Soil moisture tension was occasionally lower in mulched plots and with herbicide applied three times compared to other treatments. Midday stem water potential did not differ between treatments, but was measured only 3–4 times each season. Mulch increased foliar levels of potassium in 2010 and 2011, manganese in 2010, and zinc in 2011 compared to herbicide applications. Foliar levels of nutrients were similar among the different herbicide treatments in both years. Shoot growth was greater with mulch compared to herbicide in 2010, but not in 2011. Weed management method did not affect the amount of bloom or yield. Trunk cross-sectional area was greater with mulch compared to herbicide, but no difference occurred between the different herbicide treatments or between the mulch treatments.

Specified Source(s) of Funding: USDA–OREI

4:45–5:00 PM

Replant Disease Development on the Fine-root System of Apple (*Malus domestica* Borkh.)

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Apple replant disease (ARD) is the stunting and poor growth of apple (*Malus domestica* Borkh.) when planted on sites where apple has previously grown. Described as a disease of the fine-root system, ARD has a complex etiology with multiple causal organisms. As a result, disease development on the root system is poorly understood. The goal of this study is to clarify disease dynamics by determining the susceptibility of fine-roots of different developmental stages to commonly implicated ARD pathogens. Hierarchical branching order, as a correlate of root development, is used to investigate shifts in plant defenses and pathogen abundance in response to root development. We hypothesize that root development and branching order may limit pathogen distribution through shifts in the availability or quantity of habitat or through the distribution of plant defenses. In separate greenhouse assays, seedlings and clonal rootstocks were grown in soil from a known ARD site and the same soil steam pasteurized for control. Tissue culture derived plantlets of a rootstock previously shown to be susceptible (M.26) and one that has performed well in replant trials (CG.6210) were grown in the second assay. Following harvests at 3, 6, and 9 weeks post planting, root systems were analyzed for growth parameters, root system development and appearance of visual symptoms. Following dissection by hierarchical branching order, targeted root anatomical and chemical defenses were quantified. Pathogen abundance was measured through quantitative polymerase chain reaction. Restriction of pathogen populations to lower order roots suggest that secondary development of the root and loss of cortical tissues fundamentally restricts the quantity and quality of habitat available to replant pathogens. Distribution of defenses within the hierarchical system reflects greater defenses at higher orders, which may further serve to protect downstream branching modules. Finally, the root system growth and development of M.26 and CG.6210 will be discussed in relationship to relative resistance or tolerance to common replant pathogens.

5:00–5:15 PM

The *OrganicA Project*: A Six-year Summary of Research in Two Organic Apple Orchards

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In 2006, the *OrganicA Project*, a multidisciplinary, multi-state research and outreach organic apple production project, was initiated at the University of Vermont. The overall goal of this project is to holistically examine opportunities and challenges of organic production. To accomplish this goal, two orchards were established utilizing two production systems growers use to change to new cultivars. Orchard 1: a new orchard was planted with young trees purchased from a nursery and Orchard 2: an older orchard (established in 1986) was "top-grafted." The cultivars selected for this project were 'Ginger Gold', 'Honeycrisp', 'Liberty', 'Macoun', and Zestar!'. Their selection was based on grower input of consumer preferences and ease of management. The rootstocks are B.9 for Orchard 1 and M.26 for Orchard 2. Orchard 2 has 'Liberty' and 'McIntosh' as interstocks (original scions). Five year summary results indicate that the trees in Orchard 1 are not performing as well as in Orchard 2. Tree size is smaller and yield is lower. In Orchard 1, the cultivars 'Ginger Gold' and 'Honeycrisp' are performing better than 'Liberty', 'Macoun', and 'Zestar!'. The number of bushels per acre in 2011 for 'Ginger Gold' and 'Zestar!' was 186 and 91, respectively. For the same year, in Orchard 2, 'Ginger Gold' had the highest number of bushels per acre (505) and 'Macoun' had the lowest number (172). For most horticultural parameters measured, there was no significant interstock effect. In both orchards, 'Liberty' had significantly higher number of fruit drop than the other cultivars and 'Liberty' and 'Macoun' are not performing as well as the other cultivars. Results indicate that "top-grafting" appears to be an economical and sustainable technique to change existing apple cultivars. However, the success of this technique is cultivar dependent and several years may be necessary to determine the success or limitations of "top-grafting."

5:15–5:30 PM

Ground Cover Management and Nutrient Source Affect Soil and Foliar Nutrient Contents in an Organically Managed Apple Orchard in the Southern U.S.

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Management of competitive vegetation and appropriate nutrient supply are issues facing organic fruit growers. An experiment was established to evaluate the effects of four ground cover management systems [wood chips (WC), municipal green compost (GC), shredded white paper (SP), and mow-and-blow (MB)] and three nutrient source [untreated control (NF), composted poultry litter (PL), and commercial formulated fertilizer (CF)] on soil chemistry and nutrient content, soil quality, and tree performance in an organically managed orchard. The PL and CF were applied at equal (N) rates annually at prior to bloom. Soil was sampled annually at two depths (0–10 cm and 11–30 cm) underneath the tree at multiple times for chemical properties and total extractable nutrients or available nutrient content (as determined by cation/anion membrane probes). Foliage was sampled at multiple times within each season. The changes observed during the first 6 seasons of orchard establishment, transition, and maturity are presented. From the initial planting year, soil pH increased from 6.5 and 6.4, to 7.2 and 7.2 for 0–10, and 11–30 cm, respectively. The SP resulted in the significantly higher soil pH than other ground cover treatments. Nutrient source did not consistently affected soil pH, although at several sampling dates, NF had higher soil pH at 0–10 cm depth than soils receiving supplemental nutrition from an organic source. Soil NO_3 did not vary significantly with ground cover management treatment. Using PL as a nutrient source resulted in generally higher extractable NO_3 than NF or CF. Soils treated with GC had higher P at 0–10 cm depths than other treatments beginning in year 3. Soils amended with PL had significantly higher P content. Soil available N and NO_3 as detected by ionic membrane probes was significantly higher with GC than other treatments while there were few differences for NH_4. Soil available N and NO_3 was consistently higher with soils amended with CF and those not receiving any additional amendments were the lowest. Soil available P was consistently higher with MB and CF treatments. Foliar concentrations of all nutrients were in a sufficiency range. Although ground cover and nutrient treatments resulted in foliar nutrient contents early in young trees, there were few differences in the sixth growing season. There were few interactions among ground cover management and nutrient source and typically ground cover treatments resulted in greater experimental variation than nutrient source for most nutrients in most years. Other nutrient responses and interactions will be discussed.

5:30–5:45 PM

Influence of Mechanical Thinning Severity Treatments on Vegetative and Reproductive Tissues, Fruit Set, Yield, and Fruit Quality of 'Buckeye Gala'

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The number of chemical thinning compounds available to apple growers is expected to be reduced in the future, and there is a need to develop alternative thinning treatments. The goals of this experiment were to test the efficacy of a mechanical string thinner (Darwin PT-250, Fruit-Tec, Deggenhauserertal, Germany) on apple, and identify an optimal range of thinning severity, as influenced by spindle rotation speed. Trials were conducted in 2010 and 2011 at Penn State's Fruit Research and Extension Center in Biglerville, PA, on 5-year-old 'Buckeye Gala'/M.9 apple trees that were trained to Tall Spindle. The following treatments were applied to the same trees for two consecutive years, at a constant ground speed of 4.8 km/h during full bloom: 1) 0 rpm (control); 2) 180 rpm; 3) 210 rpm; 4) 240 rpm; 5) 270 rpm; and 6) 300 rpm. As spindle speed increased, the removal of the number of blossom clusters per limb cross-sectional area increased. A linear reduction in the number of blossoms per spur was observed as spindle speed increased. In 2010, leaf area per spur was reduced by 9 – 45%. In 2011, the fastest spindle speed reduced leaf area per spur by 20%. Low spindle speeds improved spur quality in 2011, as 180 rpm had a greater spur leaf area than that of the control (22% increase). While increased spindle speed reduced cropload, injury to spur leaves limited any benefit of increased fruit size. The largest gain in fruit weight was 28 g (300 rpm) when compared to the control. In both years, the most severe thinning treatments reduced yield by more than 50%. Fruit quality was generally enhanced with increased spindle speed. There was no relationship between spindle speed and return bloom. The mechanical string thinner consistently removed blossoms in both years, but severe thinning treatments (240–300 rpm) resulted in high rates of spur removal and a drastic reduction in spur leaf area. Damage to spur leaves negatively influenced fruit size, fruit retention, and fruit calcium. Spindle speeds of 180–210 rpm provided the best overall thinning response and minimized injury to spur leaves.

Specified Source(s) of Funding: Penn State Horticulture Department, USDA Specialty Crop Research Initiative, State Horticultural Association of Pennsylvania

5:45–6:00 PM

AVG Combined with NAA Control Preharvest Drop of 'Mcintosh' Apples Better than Either Chemical Alone

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In some years aminoethoxyvinylglycine (AVG, trade name ReTain) imperfectly controls pre-harvest drop of 'McIntosh' apple. These years are warm with daytime temperatures over 35 °C (95 °F) in August. In 2008–2011, we evaluated whether the combination of AVG and napthaleneacetic acid (NAA) would give better preharvest drop control of 'McIntosh' apple than AVG or NAA alone. AVG (832g ReTain/ha or 416g ReTain/ha) was applied 3, 2 or 1 week before normal harvest. At either the 2 or 1 week before normal harvest, a combination of AVG and 20 mg·L^{-1} NAA was also applied. Pre-harvest fruit drop from untreated control trees exceeded 20% by 21 Sept. and by the end of September had reached 60% drop. The traditional drop control treatment of 20 mg·L^{-1} NAA applied alone on 7 Sept. did not reduce drop at any date. AVG applied alone reduced fruit drop if applied 3 or 2 weeks before normal harvest but not when applied 1 week before harvest. The addition of 20 mg·L^{-1} NAA to the AVG sprays, either 2 or 1 week before harvest, improved pre–harvest drop control compared to AVG alone. The combination spray applied 2 weeks before harvest resulted in the lowest pre-harvest drop of any treatment. However, if AVG+NAA was applied 1 week before harvest then its efficacy was reduced but was still similar to AVG alone applied 3 or 2 weeks before harvest. When a reduced rate of AVG (416 g/ha) was combined with NAA, the efficacy in preventing drop was very similar to the full rate of AVG. A hypothesis to explain the improved drop control of 'McIntosh' apples from combining NAA and ReTain is: when NAA is used alone to control pre-harvest drop, it controls the genes associated with abscission zone formation but as a negative side effect it stimulates ethylene production which advances ripening including color formation and softening. With 'McIntosh', the high production of ethylene often overwhelms the stop drop effect of NAA. In contrast, ReTain acts by controlling ethylene biosynthesis but in hot years, pre-harvest drop of 'McIntosh' is not adequately controlled indicating that abscission zone genes are not totally under the control of ethylene and that ReTain does not control these genes adequately under stress conditions. When NAA and ReTain are sprayed together, NAA controls the genes associated with abscission better than ReTain while ReTain blocks the production of ethylene caused by NAA.

Specified Source(s) of Funding: NY Apple Research and Development Program and Valent BioSciences

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Wednesday, August 1, 2012 Tuttle

Postharvest 1

Moderator: Jiwan P. Palta
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4:15–4:30 PM

Postharvest Application of Various Gas Treatments to Improve Passion Fruit Quality

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The local Israeli purple passion fruit (*Passiflora edulis* Sims) line 'Passion Dream' (PD) is a hybrid of purple and yellow passion fruits which produces two cycles of fruit a year, in summer and winter. Fresh fruit quality is reduced after ≈3 weeks of storage, mainly from shriveling and decay development. Passion fruit is typically collected from the ground after natural abscission; however, these fruit will suffer from damage and are not suitable for export. Here we examined the effect of various postharvest gas treatments aimed at maintaining fruit quality of picked fruit after storage. On the day of harvest, fruit at breaker stage were sealed in 250-L chambers for 24 h at 25 °C and provided with 100 ppm ethylene, 500 ppb 1-methylcyclopropene (1-MCP), 2% ethanol vapors (EtV) or 1% low oxygen atmosphere (LO2). After treatment, fruit was placed in 1-L plastic boxes covered with stretchable shrink film and transferred to storage at 12 or 20 °C. In another experiment, we compared the effect of 500 ppb 1-MCP on pink and breaker PD fruits, in order to extend storability. Ethylene levels as well as fruit acidity were initially much higher in winter fruit compared to summer fruit. LO2 enhanced peel color due to anthocyanin accumulation in winter fruit after 12 °C storage, but not in summer fruit. Ethylene treatment increased color development and production of aroma volatiles in breaker fruit, similar to levels in pink fruit, after natural abscission. Aroma volatiles were determined in juice by SPME/GC-MS techniques. In both seasons, 1-MCP, EtV and LO2 delayed ripening by reducing ethylene production, color development and production of aroma volatiles. LO2 and even more so EtV, caused 'off' flavors likely due to more ethanol and ethyl esters production. In both summer and winter seasons, fruit treated with 1-MCP at breaker or pink stage and subjected to 12 °C storage and 20 °C shelf life displayed the best appearance, as measured by minimal weight lost, peel shriveling, and decay, enabling 5–6 weeks of postharvest storage life.

Specified Source(s) of Funding: Chief Scientist, Israel

4:30–4:45 PM

Application of 1-MCP at Different Ripeness Stages Affects Physiology and Final Tomato Fruit Quality

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It is well known that tomato fruit ripening can be regulated by the application of 1-MCP (1-methylcyclopropene or SmartFresh™), but the effects depend on fruit ripening stage at treatment and 1-MCP concentrations. The objectives of this study were to 1) assess retardation of tomato ripening in relation to 1-MCP concentrations and fruit color stage and 2) determine if color stage is a sufficiently accurate indicator of the physiological state of the fruit to achieve consistent 1-MCP effects. Field grown tomatoes (cv. 901 from Syngenta) were harvested as vine-ripe fruit and held at 12.5 °C until used. Fruit at 20 °C were selected for color stage (2, 3, or 4 on USDA color chart), fruit respiration and ethylene production rates were measured on individual fruit before treatment, fruit were treated for 8–12 h with 1-MCP (0, 300, 400, or 500 nL/L), and then placed in individual containers to follow respiration and ethylene production rates at 20 °C until the fruit reached the table ripe stage (color stage 6). The treated fruit had suppressed respiration rates, with greater suppression observed in fruit treated with higher 1-MCP concentrations or with application of 1-MCP at earlier color stages. After the 1-MCP treatment, there was a peak in ethylene production rates followed by decreasing rates to below those of untreated fruit. Red color development (to table-ripe or color stage 6) of fruit treated with a single application of 300, 400, or 500 nL/L 1-MCP was delayed by 2 to 3, 4 to 7, and 8 to 13 days, respectively. Firmness, hue, and lycopene concentrations of fruit treated with 300 nL/L 1-MCP were the same or slightly higher than values for untreated fruit after 10 days. However, after treating fruit with 500 nL/L 1-MCP, the same parameters were significantly different from those of untreated fruit, indicating that 1-MCP clearly retarded the ripening process too much. Treatment with 400 nL/L 1-MCP resulted in an intermediate delay of ripening. Treating with 1-MCP at too early a ripeness stage (color stage 2), too high 1-MCP concentration (500 nL/L), or too long exposure (12 h), affected the recovery of the ripening process, the uniformity of ripening and final fruit quality. The color stage of the fruit did indicate similar physiological behavior (respiration and ethylene production rates) and was sufficiently accurate to ensure a uniform 1-MCP response.

4:45–5:00 PM

Storage Quality of Enzymatically Peeled Baby Persimmons in High CO_2 Controlled Atmospheres

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Freshly peeled "baby" persimmons, 3–4 cm in diameter, were processed by enzymatic peeling of 'Totsutanenashi' cherry persimmon fruit (miniature of full size mature fruit), which is a bud mutation of 'Hiratanenashi' persimmon. The disinfectant treatment followed by an enzymatic peeling process of intact baby persimmon fruit involved a porous treatment of the peel, hot water dipping, protopectinase infusion, and rinsing under running tap water. The microbiological and physicochemical quality of enzymatically peeled baby persimmons was investigated during storage in air or high CO_2 atmospheres (10%, 15%, and 20%) at 10 °C. With intact baby persimmon fruit, the peel had 3.2 log cfu/g of bacteria and 3.7 log cfu/g of fungi and a diverse microflora, while microbial counts of the flesh were below the lower limit of detection (2.4 log cfu/g for bacteria and 3.0 log cfu/g for fungi). Treatment with electrolyzed water reduced the microbial counts of the peel to levels below the limit of detection. Microbial counts of baby persimmons remained undetectable throughout the enzymatic peeling process. When microbial contamination of enzyme-peeled and knife-peeled baby persimmons was compared, the diversity of bacterial and fungal flora was less in enzyme-peeled fruit than in knife-peeled fruit. High CO_2 atmospheres reduced the growth of mesophilic aerobic bacteria, coliform groups, lactic acid bacteria, and fungi of baby persimmons, with the reduction being greater in 15% or 20% CO_2. Bacterial and fungus counts were 4 to 5 logs lower in samples held in 20% CO_2 atmosphere than those in air after 6 days of storage. Diversity of the microflora was also much less in 20% CO_2 atmosphere than in air on day 6. High CO_2 atmospheres inhibited the development of brown discoloration in baby persimmons by day 4, but all samples developed browning to an unmarketable level on day 6. The color index (L* and C* values) and texture of all samples decreased during storage and were not affected by high CO_2 atmospheres. These results indicate that a 20% CO_2 atmosphere is desirable for enzymatically peeled baby persimmons to achieve effective microbial safety when held at 10 °C.

Specified Source(s) of Funding: Research and development projects for application in promoting new policy of Agriculture Forestry and Fisheries.

5:00–5:15 PM

Harvested Asparagus Spears May Be Conditioned to Withstand Chilling by Heat-shock

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Holding harvested asparagus spears at chilling temperatures (non-freezing temperatures below 10 °C) reduces their rate of respiration (i.e., carbon dioxide production), but increases their level of chilling injury (i.e., ion leakage into an isotonic bathing solution). Various heat-shock treatments (i.e., combinations of temperature and duration) increased the chilling tolerance of 1-cm stem segments excised from the apex, center, and base of 18-cm harvested asparagus spears. While the chilling tolerance of all spear segments was increased by specific heat-shock treatments, the optimal temperature and duration of exposure varied among the spear segments to such an extent that no one treatment could increase the chilling tolerance of the whole spear without either being ineffective or damaging some portion of the spear.

5:15–5:30 PM

Postharvest Dip Treatment with a Natural Phospholipid Along with Lecithin May Extend the Shelf Life of Banana Fruit

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Lysophosphatidylethanolamine (LPE), a natural lipid, has been investigated for retarding senescence and promoting the shelf life of fruit and other plant tissues. LPE is water insoluble phospholipid. For most experimental purposes, LPE is dispersed in water prior to treatment of fruits using sonication. In present study, we tried to disperse LPE in water using a formulation of enzymatic hydrolyzed soy lecithin. A combination of LPE and lecithin was used for a dip treatment of banana fruits. For this purpose, banana fruits at stage 2 (3/4 green) were dipped in this solution for 30 minutes, and then stored at room temperature for 10 days. Significant decrease in fruit marketability was observed in non-treated as well as water dipped fruits between 6–8 days after treatment. As observed in our previous studies, LPE alone treated fruits demonstrated improvement in shelf life as compared to untreated and water treated fruits. Interestingly, lecithin alone treatment also seems to improve shelf life but this improvement was less than LPE alone treatment. A combination of 100 ppm LPE and 500 ppm lecithin gave the best improvement in shelf life. In this treatment over 60% of the fruits were marketable at 7 days after treatment. Whereas, only about 20% of the fruits were marketable in the untreated as well as water treated fruits. These preliminary results suggest that there is a potential to improve shelf life of banana fruits using a combination of LPE and enzymatic hydrolyzed soy lecithin.

Specified Source(s) of Funding: partly supported by University of Wisconsin–Madison

5:30–5:45 PM

Effect of Rigid Containers on the Shelf Life of Shell-on Fresh Chestnuts at Retail Temperatures

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Shell-on, fresh chestnuts are currently sold in macro perforated polybags. This package does not protect chestnuts from damage, contamination or weight loss. Protection from damage and reduction in weight loss are expected using closed rigid containers. However, the environment created may promote microbial growth at retail temperatures. The retail shelf life of two shell-on products, one a European/Japanese hybrid cultivar ('Colossal') and the other a harvested group of non-cultivar Chinese chestnuts, was assessed in rigid, snap-fit containers and macro-perforated polybags by analyzing weight loss, soluble solid contents, bacterial and fungal growth, color, and headspace. The impact of two packaging materials—petroleum-based polyethylene terephthalate (PET) and bio-based polylactic acid (PLA) (weaker moisture barrier)—on chestnut shelf-life was also assessed under retail conditions. In order to simulate retail storage conditions, the packages were held for 10 h at 60 °F (display shelving) followed by 14 h at 35 °F (back storage room) for 6 weeks. 'Colossal' chestnuts had a higher weight loss, higher soluble solids content, and higher respiration rate and were more sensitive to bacterial growth than Chinese chestnuts ($P < 0.05$). Rigid containers reduced weight loss up to 13% compared to the commercial polybags. Chestnuts in rigid containers also had more stable soluble solids content ($P < 0.05$). Less bacterial growth but greater fungal growth was observed in Chinese chestnuts in rigid containers compared to polybags ($P < 0.05$). However, no significant differences ($P > 0.05$) in fungal growth were seen across all packages for 'Colossal' chestnuts. Across the packaging materials, differences in weight loss (only for Chinese chestnuts, $P < 0.05$), gas composition ($P < 0.05$) and condensation removal were observed. In conclusion, rigid containers can help to ensure that the package content fulfills the weight specification given on labels and better preserve chestnut quality.

Specified Source(s) of Funding: Midwest Nut Producers Council/ Rogers Reserve Chestnuts Funds

Thursday, August 2, 2012 **Concourse 1**

Postharvest 2

Moderator: Jinhe Bai
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8:00–8:15 AM

Optimal Incubation Time and Use of Random Methylated β-Cyclodextrin (RMCD) to Improve the Solubility of Lipophilic Antioxidants for the FRAP Antioxidant Capacity Assay

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FRAP is one of the most widely used methods to measure the antioxidant capacity of foods. However, there are some major problems: first, there is no standard time for reading the FRAP value; second, the end point of the FRAP reaction differs among antioxidant compounds and among samples; third, the reaction occurs in aqueous solution, making it difficult to measure the antioxidant capacity of lipophilic compounds. Therefore, we evaluated the linearity of the FRAP values at 593 nm as the reaction progressed through the most commonly reported reading times. Also, we tested random methylated β-cyclodextrin (RMCD), which has been used to improve the solubility and resolution of the lipophilic fraction in other antioxidant assays. The FRAP values of pure antioxidant compounds commonly found in tomatoes (ascorbic acid, gallic acid, lycopene, β-carotene, and lutein) and Trolox (the accepted standard), were determined at seven different concentrations; and also in red, orange, and yellow tomato cultivars with or without lycopene added. The hydrophilic and lipophilic fractions of pure antioxidants and fruit samples were measured under standard conditions and using RMCD. The reaction was monitored every 1 minute for 60 minutes. The linearity of the FRAP value versus antioxidant concentration was evaluated at 1, 4, 8, 15, 30, and 60 minutes by comparing the linear regression parameters R^2 and slope. Also, we compared the FRAPsubTE values of the tomato samples at selected reading times. We found that the FRAP reaction increased for every antioxidant compound except for Trolox, which tended to decrease. Time significantly increased the FRAP sensitivity for ascorbic acid ($P = 0.0002$), gallic acid ($P < 0.0001$), lutein ($P = 0.0101$), β-carotene ($P = 0.0549$), and lycopene ($P = 0.0073$), whereas the sensitivity for Trolox decreased ($P = 0.0002$). Only in the case of β-carotene did time positively affect precision ($P = 0.0173$). Furthermore, the sensitivity for lipophilic antioxidants was greatly increased by RMCD only in the case of lutein ($P < 0.0001$), while RMCD had strong limitations in keeping highly lipophilic compounds like β-carotene and lycopene in solution. Even though standard conditions produced higher sensitivity for β-carotene ($P < 0.0001$) and lycopene ($P < 0.0001$), RMCD increased the precision in the case of lutein and β-carotene. Similarly absorbance constantly increased over time for every tomato sample and RMCD produced a positive effect on the absorbance of the lipophilic fraction. In conclusion, the FRAP reaction should be conducted for at least 30 minutes to accurately measure the antioxidant capacity and to avoid losing the Trolox standard resolution.

An asterisk (*) following a name indicates the presenting author.

Specified Source(s) of Funding: "This project was supported by Specialty Crops Research Initiative Grant 2009-51181-05783 from the USDA National Institute of Food and Agriculture."

8:15–8:30 AM

Multi-year Flavor Analyses of University of Florida Tomato (*Solanum lycopersicum*) Lines

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University of Florida (UF) tomato breeding lines were evaluated for sensory (sweet, sour and overall flavor) as well as chemical characteristics including total soluble solids (Brix), titratable acidity (TA), solids/acids ratio (Brix/TA), sugars (glucose and fructose), acids (citric and malic), color, lycopene and aroma volatiles. Fruit were harvested over a 7-year period (multiple harvests in December and June for central Florida and sometimes also March in Homestead) and were brought from the field to the laboratory, washed and prepared for consumer sensory panels. From each of the four replicated servings/harvest, a subsample was taken for chemical analyses. Brix was determined using a refractometer, TA using a titrator, individual sugars, acids, and lycopene by HPLC, color by chromameter (L*, a*, b*) and aroma volatiles by gas chromatography. Anova analysis revealed highly significant differences for sensory characteristics by line and year, but not season. Principal components analysis (PCA), however, showed separation by line, year and season with sweetness strongly correlated to overall flavor and both positively correlated to Brix/TA ratio, and sugar content. Sourness changed independently from sweetness and overall flavor, however, was positively correlated to acid content. The breeding lines low in sweetness and overall flavor ratings also had more earthy and musty volatiles, such as methional, 2+3-methylbutanal and 1-octen-3-one or were not generally correlated with volatiles. On the other hand, breading lines high in sweetness and overall flavor ratings also had higher lycopene content, more red color and were more correlated with volatiles in general, especially green (C-6 aldehydes) and fruity/floral ketones, aldehydes and a terpene alcohol (1-penten-3-one, geranylacetone, acetone, citral, benzaldehyde, β-ionone, furanone and linalool). Special attention was given to the new UF release, 'Tasti-Lee' (line 8153) in comparison to the industry standard FL47 since they were included in every trial. 'Tasti-Lee' correlated with flavor, sweetness, Brix and volatiles in general, while FL47 showed generally negative correlations to these attributes.

8:30–8:45 AM

Extraction of DNA from Orange Juice and Detection of 16S DNA of *Candidatus* Liberibacter Asiaticus by Quantitative PCR

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Orange juice processed from Huanglongbing (HLB) infected fruit often associated with bitter taste and/or off-flavor. However, so far there is no single indicator that can be used to predict juice quality loss caused by HLB. *Candidatus* Liberibacter asiaticus (CLas), a phloem-restricted bacteria, is thought to be the cause of HLB in Florida. The objective of this research is to establish a methodology to quantify the CLas in orange juice as an indicator of orange juice quality. Current standard methods for citrus HLB diagnosis use real-time qPCR to quantify 16S DNA of CLas, isolated from midribs of leaves, where CLas is highly concentrated. However, no existing protocol effectively detects CLas in orange juice because of its special characteristics. These include a low population of CLas, low pH value, high concentrations of sugar and pectin, and existence of potential inhibitors to qPCR reactions. Here, we report a method developed to improve the sensitivity and accuracy of detection of CLas in orange juice. In brief, orange juice samples were mixed with lysis buffer and homogenized using a sonicator, and then incubated with pectinase to hydrolyze pectins. The pH value was adjusted to neutral before proteins were denatured and precipitated by ammonium acetate. After removal of proteins, DNA was precipitated by isopropanol/ethanol, and further applied to a spin column-based purification. The role of sonication was to release CLas from phloem and resulted in an increase of DNA yield by 86%. The role of pectinase was to eliminate pectin, without which pectin gel traps the DNA. Use of the spin column purification removed potential PCR enzyme inhibitors from the DNA solution. Currently, qPCR results of CLas are often expressed as cycle threshold (Ct) values, which are potentially influenced by DNA extraction practices. Our study used CLas index (ratio of CLas 16S DNA Ct to citrus cytochrome oxidase or COX Ct), to express the quantification of CLas. The CLas index can express the relative quantity of CLas without the complications caused by different sampling, extraction and amplification techniques. A multiplex qPCR of

COX and CLas 16S DNA showed that the amplification of CLas 16S DNA was inhibited by COX in an ABI PRISM 7500 FAST sequence detection system.

8:45–9:00 AM

Application of OFFGEL and Dimethylation Labeling as Quantitative Proteomic Analysis Procedure to Investigate Protein Changes in Fruit during Ripening and in Response to Postharvest Treatment

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Proteomics is a systematic approach to study changes in proteins. It provides an essential linkage between the transcriptome and metabolome. Despite recent developments, fruit proteomics is still facing major challenges that limit in-depth study. In addition to limited protein sequences available for most fruits, high throughput, reliable and quantitative protein analysis procedure for fruit is also lacking. As a sample preparation step, OFFGEL isoelectric focussing (IEF) offers the ability to fractionate peptides or proteins prior to LC/MS analysis, which has become one of the more popular sample preparation procedures in proteomic research. In order to develop and improve the quantitative fruit proteomic research platform, we conducted a detailed investigation to exam the advantages of OFFGEL in fruit proteomic research using apple, banana and strawberry fruit. We provided technical details concerning sample preparation, trypsin digestion, OFFGEL-IEF, reversed phase nano-LC separation. We demonstrated that proteomic protocol employing OFFGEL–IEF as a crucial sample preparation step can significantly improve the proteome coverage and quantitative proteomic workflows. Our results demonstrated that the use of OFFGEL is an effective method for peptide fractionation and increased significantly the number of proteins identified by at least 10 times as compared with unfractionated samples, with more than 900, 800, and 928 proteins in apple, banana and strawberries respectively. With improved and developed protocol, we further combined the OFFGEL-IEF with quantitative proteomic procedure such as isotope dimethylation labeling to investigate the protein changes in banana fruit after ethylene and high temperature treatment. We identified and quantified more than 220 proteins that changed significantly (at least two fold for up- and down-regulation) in these treatments. The link between the changes of these proteins with their biological functions is also discussed.

9:00–9:15 AM

Evaluation of Raspberry (*Rubus* sp.) Genotypes for Postharvest Quality and Resistance to *Botrytis cinerea*

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Raspberries are a delicate, high value specialty crop with an extremely short shelf life. This is exacerbated by their susceptibility to postharvest decay caused by *Botrytis cinerea* Pers.:F. Of the three commercially available species, European red raspberry (*Rubus idaeus* L.) is the most widely grown. Yellow (*R. idaeus L.*), black (*R. occidentalis* L.) and purple raspberries (*R. neglectus* Peck. or *R. occidentalis* ×*idaeus* hybrids) are mainly available at local markets and U-pick farms. To the best of our knowledge, this is the first study to systematically examine postharvest quality differences between multiple raspberry types and the role of host genotype in decay resistance. The postharvest quality of 17 cultivars of red, yellow, purple, and black raspberries was examined twice weekly from June to September over a 2-year period. Storage life of unsprayed, ripe berries was assessed weekly, while firmness, color, respiration, and ethylene evolution rates were measured in select harvests. Our results show that black and purple raspberries took the longest to reach 25% rot in storage. Yellow raspberries took the shortest number of days to reach 25% rot. The incidence of bleed appeared to be unrelated to disease tolerance. Black raspberries had the lowest ethylene evolution rates, highest total anthocyanins and phenolics, and the lowest incidence of *B. cinerea* decay. Current studies are focused on confirming the relationship between *B. cinerea* resistance and postharvest physiology. This information could then be used to guide raspberry breeding programs to screen for improved quality and shelf life.

9:15–9:30 AM

The Effect of Preharvest Coatings and Foliar Nutritional Sprays on Postharvest Peel Breakdown of Citrus Fruit

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The fresh citrus industry in Florida generates more than one billion dollars in economic activity for the state. Marketability of fresh citrus and customer satisfaction are greatly affected by fruit peel condition. Peel breakdown is a physiologic disorder that usually develops during postharvest handling and may result in economic losses of a million dollars or more in some years. Previous studies found that peel breakdown can be reduced by applying a foliar preharvest application of mono-potassium phosphate (MKP), magnesium (Mg), or an antitranspirant (Vapor Gard). Further studies were conducted during the 2011–12 Florida citrus season to evaluate additional preharvest materials and their possible mechanism(s) in reducing peel breakdown. All fruits used in this project were from commercial citrus groves in Vero Beach and Ft. Pierce, FL. The treatments consisted of MKP at 23.5 lb MKP per acre (0–52–34; 8 lb K2O per acre) with 4 lb per acre low-biuret urea (46–0–0); 1%, 1.5%, or 2% Vapor Gard (antitranspirant); 2% calcium chloride ($CaCl_2$); 1% WashGard (a carnauba coating formulated for field applications); or 1% Polymer Delivery System (PDS). The materials were applied at 5 gallons per tree using a hand-gun sprayer. Fruit samples were harvested 3, 7, or 14 days after application, washed and waxed using a commercial carnauba coating, stored under ambient conditions, and evaluated weekly for the development of decay and peel disorders. Preharvest foliar treatments with $CaCl_2$ never significantly reduced peel breakdown compared to the water-sprayed control, whereas differences with MKP, Vapor Gard, PDS, or WashGard were almost always significant. Of the latter group, 2% Vapor Gard, PDS, and WashGard were most effective, usually resulting in 20% to 50% less peel breakdown. Leaf stomatal conductance was significantly reduced compared to the control 6 and 21 days after application with WashGard, and tended to be lower after treatment with Vapor Gard or MKP. There were no consistent treatment effects on fruit peel integrity, measured as peel puncture resistance. There was also no relationship in peel thickness between fruit that remained healthy and those that ultimately developed peel breakdown. As expected, fruit that developed peel breakdown lost more water during storage than healthy fruit.

Thursday, August 2, 2012 Sandringham

Vegetable Crops Management 3

Moderator: Ajay Nair

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8:00–8:15 AM

Growth and Productivity of Hybrid Tomato Varieties in Single-layer or Double-layer Polyplastic High Tunnels

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High tunnels have become an important way to extend the season for vegetable crops in the last 10 years. While a high tunnel is similar to a greenhouse in structure, it provides a different growing environment compared to a typical greenhouse, since high tunnels usually do not have additional heating and cooling devices. This unique feature has made selection of vegetable varieties, for example tomatoes, a difficulty. In most cases, greenhouse or field type varieties have been grown in high tunnels because most seed companies were behind in terms of breeding for high tunnel varieties. Fortunately, seed companies have started to release high tunnel varieties/species. The objective of this study was to test newly released tomato varieties for high tunnel production with either a single-layer or double-layer polyplastic. In Spring 2011, 10 determinate and 10 indeterminate tomato hybrid varieties were selected. Transplants were raised in a greenhouse in March and planted in two 30 ft × 96 ft Zimmerman brand high tunnels (with ridge-vents) covered with either a single-layer or double-layer 6 mm polyplastic film. For the determinate type, 'Defiant PHR', 'Polbig', 'Scarlet Red', and 'Charger' yielded higher than others; 'BHN-961' yielded the least. For the indeterminate type, 'New Girl', 'Goliath', and 'Mountain Magic' yielded the most. The layers of plastic had little effect on yields, probably due to the extremely hot weather last summer. In conclusion, 'Charger', 'Defiant PHR', 'Polbig', and 'Scarlet Red' were recommended determinate type varieties; 'Mountain Magic', 'Massada', 'New Girl', and 'Goliath' showed great promise in the indeterminate group.

Specified Source(s) of Funding: 1890 Extension.

8:15–8:30 AM

Season Extension Strategies for Lettuce Production in Midwest: Implication of Row Covers and Foliar Calcium Applications

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One of the biggest challenges that Midwest vegetable growers face is the unpredictable weather and narrow seasonal window for crop production. The risk of frost damage and low soil and air temperatures during the growing season are major constraints for vegetable production. Strategies that help extend growing seasons are imperative for successful production of fresh and quality produce. This study investigated the effect of row cover and calcium application on fall lettuce (*Lactuca sativa* L. 'Ermosa') production at the Horticulture Research Station, Iowa State University, Ames, IA. The study comprised of a randomized complete-block design with following treatments: 1) 50 mM calcium; 2) 100 mM calcium; 3) row cover; 4) no cover; 5) 50mM calcium+row cover; and 6) 100 mM calcium+row cover. Calcium was applied in weekly intervals, twice during transplant production phase and three times in the field to add up to 50 mM and 100 mM concentrations. Three-week-old lettuce transplants were transplanted on 3 Oct. 2011 on raised beds covered with black plastic mulch. A medium weight row

cover was installed over the row cover treatment one week after transplanting. Row cover increased the air temperature by 4 to 5 °C than the ambient air temperature. Row cover and row cover-calcium treatments significantly increased marketable weight. Marketable weight ranged from 0–2.3 kg. Row cover, 50 mM calcium+row cover, and 100 mM calcium+row cover treatments produced higher yields than all other treatments; however there were no statistically significant differences between them. Plants in the 5 mM calcium+row cover and 100 mM calcium+row cover treatment produced the highest dry weight. Row cover treatments significantly increased plant leaf area when compared to treatments that did not have row covers. Our idea to include treatments with calcium applications but without row covers was to test the hypothesis that calcium would provide some degree of cold tolerance since it is an integral component of cell wall. This hypothesis did not stand true as no marketable heads were produced in 50 mM or 100 mM calcium treatments. Plants under row covers performed the best, and the effect of row cover was enhanced when used in combination with foliar calcium application. This study shows that by utilizing tools such as row covers and a combination of row cover and calcium foliar applications, growers can extend their growing season and grow an additional lettuce crop that could be harvested well into November.

8:30–8:45 AM

Factors Affecting Fruit Set in Triploid Watermelons from Delaware On-farm Surveys

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On-farm surveys were conducted in Delaware watermelon fields in 2010 and 2011 to assess factors affecting fruit set. Twenty watermelon fields representing 14 cooperating growers were surveyed from the third week in June through the second week in August in 2011; Fourteen watermelon fields with 21 plantings representing 12 cooperating growers were surveyed from the third week in May through the last week in June 2011. Data were collected weekly on male flower counts, fruit set, stem number and length, vigor, and health for triploids and pollenizers. In 2011, plant crown and leaf temperatures were also recorded. In 2010, crown set did not differ significantly by pollenizer or triploid; however, there was a significant trend toward reduced early set with reduced pollenizer or triploid vigor. Fruit numbers varied significantly with pollenizer but not triploid. Mean fruit numbers ranged between 2.0 and 2.7 per plant. There as a linear reduction in fruit numbers ($R^2 = 0.25$) with reduced triploid vigor. Reductions in pollenizer vigor, male flower counts, or pollenizer vine length also reduced fruit numbers; however, adding these factors only explained an additional 2% of the variability. There were no differences in mean fruit numbers between bumble bee and honey bee pollinators. In 2011, crown set occurred earlier when leaf temperatures were below 23.8 °C. Mean fruit number varied significantly with pollenizer and triploid. Several special pollenizer varieties produced male flowers earlier than standard diploid pollenizers and the pollenizer 'Accomplice' had high male flower counts throughout the survey. There was a significant linear reduction in the number of fruit carried with an increase in plant temperature measured over the crown of triploids from 2.9 at 18.3 °C to 2.0 in temperatures above 32.2 °C. Fruit numbers varied between triploid cultivars in relation to crown temperature.

8:45–9:00 AM

Effects of Biodegradable Mulch on Yield of Tomato Grown in High Tunnels and Open Field Conditions in Northwestern Washington

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Biodegradable mulches which can be tilled into the soil at season's end could provide economic and environmental benefits compared to polyethylene plastic mulch film (PEM) if they do not negatively affect yield. A study at Mount Vernon, WA in 2010 and 2011 compared three commercially-available mulches marketed as bio-degradable [BioBag® (BB), BioTelo® (BT), and WeedGuardPlus™ (WG)] and one experimental spun bonded poly(lactic acid) mulch fabric (PLA) to PEM and bare ground (NM) controls on yield of tomato 'Celebrity' grown in high tunnels and open field. In 2010, BB (12.5 kg/plot), BT (12.0 kg/plot), and paper WG (10.0 kg/plot) produced yields statistically equivalent ($P = 0.0036$) to PEM (10.1 kg/plot); BB, BT, and PEM yields were greater than bare ground (8.3 kg/plot); and, BB and BT yields were greater than PLA (9.0 kg/plot). In 2011, BB (15.2 kg/plot), BT (16.5 kg/plot), and NM (15.1 kg/plot) produced similar yields to PEM (15.8 kg/plot; $P = 0.0259$); and, BB, BT, and PEM yields were greater than PLA (13.9 kg) and WG (12.7 kg/plot). In 2010, using the USDA standard for Grade 1 tomatoes, NM (19.6%) had a greater percentage of marketable fruits (by weight) than BB (7.8%), BT (8.9%), PLA (12.7%), and PEM (7.1%); and, WG (14.1%) had a greater percentage of marketable fruit than BB and PEM ($P = 0.0018$). In 2011, using a slightly different direct market standard, NM (71.7%) and WG (68.5%) produced a greater percentage of marketable fruits than BB (50.0%), BT (50.4%), PLA (54.2%), and PEM (38.6%); PEM was significantly lower than all other treatments ($P \leq 0.0001$). Though NM consistently produced a greater proportion of marketable fruits, BB, BT, and PEM tended to produce higher overall yields. NM tended to have less fruit cracking compared to BB, BT, and PEM ($P = 0.0003$ in 2010, $P = 0.4541$ in 2011), and this cracking was likely the reason for increased marketable fruit with NM. Fruit cracking was the primary unmarketability factor both years.

Specified Source(s) of Funding: SCRI Grant Award No. 2009-51181-05897

An asterisk (*) following a name indicates the presenting author.

9:00–9:15 AM

Cabbage Yield as Function of Plant Population Cultivated on Plasticulture

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Florida cabbage production in northeast Florida covers about 5,500 acres which represents 56% of the planted area for cabbage in the state and produces 30,100 lb/acre on average. In this region water is supplied to the crop using seepage irrigation which relies on a shallow hardpan, high water table, and an abundance of fresh water pumped from the aquifer. Seepage irrigation is an inefficient method for irrigating crops and water distribution throughout the field is typically irregular. Drip irrigation and plastic mulch offer increased water use efficiency through precise application (timing, quantity, and location), reduced soil water evaporation, and reduced weed competition. Cabbage produces have reported that up to 30% of the cabbage planted does not produce a marketable head. Variability in plant growth, uniformity, and head size all contribute to reduced marketable yields. This study focuses on determining if higher plant populations and the use of plastic mulch and drip irrigation can help produce a more uniform crop and increase yield per cultivated area. Cabbage (variety Bravo) was grown on 48-inch-wide raised beds spaced 80 inches on center, with black plastic mulch and two drip tapes per bed. Field experiments were conducted during the winter of 2011 and 2012 in Hastings, FL. A split plot design with randomized complete blocks and four replications was used. Main plots consisted of three or four rows of plants per bed and the subplot factors were in-row plant spacing (6, 8, 10, 12, and 14 inches). Final plant population ranged from 14,816 to 46,093 plants/acre. Total fresh yield ranged from 49,500 to 62,800 lb/acre. Marketable cabbage yield (2–4 lb/head) showed a quadratic response to the increase of plant population ($Y = -3669.4 + 5.544x - 0.0001344x^2 - R^2 = 0.85$). Plant populations between 17,000 and 22,000 plants/acres (3 rows per bed at 8 and 10 inch in-row spacings and 4 rows per bed at 10 and 12 inch in-row spacings) showed the highest marketable yields. Marketable yield was significantly reduced with 6 inch in-row spacing at both 3 and 4 rows of plants per bed.

9:15–9:30 AM

Onion Bulb Size Response to Plant Population for Four Varieties under Three Irrigation Systems

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Changing market opportunities for smaller size onion bulbs and the availability of new onion varieties, necessitate evaluations of yield and bulb size response to plant population for onion production in the Treasure Valley of eastern Oregon and southwestern Idaho. These evaluations can aid growers in making planting rate decisions. The objective of this trial was to evaluate the response of four onion varieties to four plant populations under "conventional" drip irrigation, "intense bed" drip irrigation, and furrow irrigation. Conventional drip irrigation had 4 onion double rows and two drip tapes on a 2.2 m bed. Intense bed drip had 6 onion double rows and three drip tapes on a 2.2 m bed. Furrow irrigation had 4 onion double rows and two furrows on a 2.2 m bed. Four onion variety split plots were planted in each irrigation plot. Each variety split plot was thinned to four plant population split-split plots (296,000, 395,000, 494,000, and 593,000 plants per hectare). Irrigation system was not a statistically significant factor in the response of bulb size to plant population. Averaged over irrigation systems and varieties, marketable yield increased with increasing plant population over the full range of populations tested. Averaged over irrigation systems and varieties, yield of bulbs larger than 10 cm in diameter decreased and yield of bulbs smaller than 7.6 cm in diameter increased with increasing plant population. Yield of bulbs 7.6 to 10 cm in diameter increased or decreased with plant population according to the variety. Optimal population varied with growers' marketing opportunities, with lower populations best for onion rings and populations with 400,000 plants or more per hectare when a mix of medium and jumbo onions are to be marketed.

Specified Source(s) of Funding: Idaho–Eastern Oregon Onion Committee

9:30–9:45 AM

Planting Configuration and Mulch Affect Growth and Yield of Globe Artichoke

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Globe artichoke [*Cynara cardunculus* L. var. *scolymus* (L.) Fiori] has been recently introduced as a specialty crop in southwest Texas. Field experiments were conducted over three seasons (2008–09, 2010–11 and 2011–12) in the Wintergarden of Texas to investigate plant growth, yield, and yield components of artichoke grown as an annual system. Three strategies were evaluated, planting configuration (single and double lines per bed), plasticulture (baresoil and black plastic mulch) and cultivars differing in maturity ('Imperial Star', early; 'Green Globe Improved', late). Each fall, transplants were established in the field at 1.80 m between rows and 0.90 m between plants (single line) or 3.60 m between rows and 0.90 m between plants (double line). Irrigation was applied with subsurface drip. In both cultivars, double line increased plant height while reduced plant width and leaf number. The combination of single line with plastic mulch enhanced plant height, plant width, leaf number and leaf photosynthetic rate. Chlorophyll index was not affected by either planting configuration or plastic mulch. Similarly, single line with plastic mulch had higher total and marketable yield, as compared to double line. This response was due to both increased in head weight and higher head number per plant. Comparing cultivars, Green Globe Improved had similar growth components but higher marketable yield than Imperial Star in one season. Our results indicate that one line per bed with plastic mulch is recommended to increase yield, head size and water savings (approximately 20%) as compared to the baresoil system.

Specified Source(s) of Funding: TDA–SCBP; NIFA–USDA "Food for Health"

Thursday, August 2, 2012 Windsor

Extension

Moderator: Cheryl R. Boyer
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8:00–8:15 AM

The University of Tennessee Farmers Market: Providing an Engagement Opportunity for the University Community, Students, and Growers

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In 2010, a campus farmers market was started at the University of Tennessee (UT). The purpose of the market was to: 1) provide a source of fresh, local produce for the UT community; 2) train students interested in becoming growers in all aspects of farming; 3) provide public education though outreach activities; 4) integrate and showcase other departments on campus; and 5) provide a weekly fun and family-friendly gathering place for the University and Knoxville communities. A one-booth, student-run pilot market was tested in 2010 at the UT Gardens. The pilot market proved that the university community wanted and would support a campus market. As a result of a campus survey, lessons learned the first year and through suggestions from the advisory board, the 2011 market was greatly expanded to include 20 vendors, prepared food, educational booths, children's events and musical entertainment each week. A student internship program was developed in conjunction with the market for students interested in becoming growers. Three to five student interns each year receive course credits and gain valuable hands-on learning as they plan crops and produce vegetables and fruits at the UT Organic Farm, which is then sold through a student-run booth at the market. Students meet other grower vendors at the market, observe their pricing and marketing techniques and establish informal mentors. Additionally, the market is managed by two student interns who coordinate vendors, educational booths and entertainment. The integrated participation across university departments makes this market distinct from other markets. For instance, public programs on kitchen gardening, food safety, food preservation, and cooking demonstrations showcase UT Institute of Agriculture (UTIA) faculty and student expertise. Beyond the UTIA, the market provides an opportunity to showcase other departments and their students on the main campus, such as the School of Art, the Department of Nutrition, the Medical Center, the Department of Music and the Culinary Institute. For example, students training at the UT Culinary Institute (UTCI) prepare a dinner for purchase each week utilizing the fresh produce that is abundant at the market that week. This provides great experiential learning for the UTCI students as well as marketing and exposure for their unique program. Farmers Markets have proven to be informal gathering place for communities. The UT Market provides a gathering place for the UT community, serves as a recruitment tool and invites the greater Knoxville community into the university.

Specified Source(s) of Funding: ARRA Funds, TN Agricultural Enhancement Program, Alliance of Women Philanthropists

8:15–8:30 AM

Sustaining Farmers Markets in Low-income, Urban Areas: Farmer Attitudes Regarding Electronic Benefits Transfer (EBT) Programs

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Sustaining farmers markets in low-income areas is challenging nationwide. Since long-term farmer participation is often influenced by profitability, market managers in low-income areas strive to expand their customer base, and thus sales, by accepting Supplemental Nutrition Assistance Program (SNAP) benefits (formerly food stamps) in the form of Electronic Benefits Transfer (EBT). Enhancing sales with EBT has the potential to increase farm profitability and thus farmer commitment to markets; yet little is known about why farmers choose to participate in EBT programs or what the range of farmer experience has been with EBT redemption systems. The goal of this research was to discover farmers' perspectives regarding on-site EBT redemption programs. A detailed, qualitative approach was used to understand the knowledge, experience and perceptions of farmers who did and did not use EBT at their farmers market. Twenty-three in-depth interviews were conducted with farmers selling at six Michigan farmers markets located in low-income, urban areas. Farmers identified the challenges encountered in selling at farmers markets in low-income areas as well as their reasons for participating or not participating in the EBT program. Results indicate that farmers are not only willing to participate in EBT programs organized and managed by the farmers market, but participation also increases their awareness and knowledge of food assistance programs.

Specified Source(s) of Funding: NCR–SARE

8:30–8:45 AM

Using Business Plans to Empower Women Who Manage Horticultural Businesses in New Jersey and Turkey

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The mission of two Rutgers led projects is to empower women who own horticultural businesses by giving them several sessions of business management training with a focus on developing a business plan throughout the training. *Annie's Project New Jersey* is based on a nationally-acclaimed educational program dedicated to strengthening women's roles in the ever-evolving agricultural sector. While *Annie's Project* originated in the mid-west where agronomic crops are the primary agricultural crops, New Jersey is the most densely populated state in the U.S. with higher land and labor costs and more regulations than other states. On the flip side, the state's comparative advantage over other states is that it has a higher percentage of high-income consumers. Thus, successful farmers in New Jersey are often horticultural producers and many are direct marketers; they need to produce high value crops and products to succeed in agriculture in New Jersey. With New Jersey farmers working in such a competitive environment, the project team decided that it would require every *Annie's Project New Jersey* program participant to complete a business plan. Inspired by the early success of *Annie's Project New Jersey*, Rutgers University partnered with Akdeniz University in Antalya, Turkey to develop *Suzanne's Project* in the Antalya province of Turkey. This project provides specialized training in business management, computer skills, and best management production practices to help Turkish women who operate small vegetable greenhouses and citrus orchards pursue opportunities to improve their farm businesses by creating a business plan throughout the course. Lessons learned from each program have been used to improve the other while adapting to local conditions. Now, all of the women in both locations have completed parts of a business plan, and most of them have plans to finish their plans.

Specified Source(s) of Funding: Funding for Annie's Project in New Jersey was provided by the Northeast Center for Risk Management Education, the USDA National Institute of Food and Agriculture's Risk Management Agency, Farm Credit East, New Jersey Farm Bureau and Rutgers Cooperative Ext.

8:45–9:00 AM

Providing Locally Grown Food by Training Non-traditional Students in Agriculture

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Buying locally grown food is a trend that is increasing nationwide through direct markets such as farmers markets. Farmers across the country sell directly to customers but in Yuma, the countries largest producer of winter vegetables, no direct sales are available. The majority of Yuma's agriculture producers are large acreage corporate entities; their produce is under contract to large distributors so they are unable to make direct sales to consumers. This means very little locally grown produce is available in Yuma. The University of Arizona, Yuma

County Cooperative Extension, offered a new class to train interested community members in business and agricultural practices so they could start their own agriculture business. This was achieved through a combination of hands-on and classroom learning. Lectures included business topics, such as business planning, obtaining land and capital, marketing, and taxes. Production-based topics such as growing vegetables, soil and water management, food safety and pest management were also offered. Land at the Yuma Agriculture Center was set aside for the participants to grow produce. During the first 11 weeks of the class, participants also planned and marketing Yuma's first locally grown farmers market. Once the classroom portion ended the produce grown was harvested and sold at the farmers market. The market supplied the need for locally grown produce in Yuma while providing a place for start up agricultural businesses to access interested buyers.

Specified Source(s) of Funding: USDA

9:00–9:15 AM

Low-income Seniors Benefit When They Receive Horticulture and Nutrition Information in a Combined Program

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Many elderly citizens are low-income, at risk of malnutrition, and in need of nutrition-related assistance, yet only a small segment receive it. The Commodity Supplemental Food Program is simple and accessible, and more seniors enroll in it than in the Supplemental Nutrition Assistance Program ("Food Stamps"). Eat Smart Live Strong was developed to improve seniors' nutrition and self-efficacy. Participants learn to grow herbs indoors to enhance the palatability of commodity foods, particularly fruits and vegetables. Lessons focus on growing herbs, product dating, food safety, increasing fruit and vegetable consumption, and use of commodity foods in a healthful diet. Plants, seeds, and cuttings are distributed over the course, with recipe demonstrations using herbs and commodity foods accompanying each lesson. Program evaluations assessed comfort with growing plants, as well as improvement in food selection, meal planning and preparation, nutritional health, and personal control. Results showed participants were less likely to discard foods from food packages, less likely to run out before the end of the month, and less likely to avoid items in the commodities package because of health concerns. They also reported eating at least two meals per day with more fruits, vegetables, and milk products. Students reported feeling more in control of their lives and less helpless in dealing with problems after the course.

Specified Source(s) of Funding: SNAP-Ed

9:15–9:30 AM

Creating a Horticultural Curriculum Addressing Environmental Concerns

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Research indicates that the average age of the American farmer is 57. This fact warrants future research detailing why more individuals are not involved in agriculture in a traditional sense. To encourage today's youth to become more aware of agriculture, an education program was developed to increase youth interest in agriculture and environmental concerns. A horticultural curriculum was developed and implemented at a summer camp targeting participants ages 9–12. A treatment group consisted of campers that signed up for the program and a control group consisted of randomly selected campers from a different camp track. A pre-test and post-test were given to both student groups. The test consisted of 16 general horticultural knowledge multiple choice questions and four questions pertaining to the campers' environmental stewardship. During the second year of the study, pre-tests and post-tests had minor corrections but also included a short answer question targeting in-depth knowledge of flower pollination. Lesson topics included propagation, Victory Gardens, soil, recycling, plant parts, pollination, photosynthesis, and insects. Lessons were developed with several teaching methods using of the three basic learning styles of visual, auditory, and kinesthetic. Statistical analysis of variance using PROC GLIMIX at the 0.05 level found that participants in the treatment group had a significant improvement of general horticulture knowledge from pre-test to post-test responses. In addition, post-test scores of treatment participants were significantly higher than control participants in both years of the study. Confidence analysis found that treatment students were significantly more likely to be confident that they could explain to others how to grow a plant, and that they could grow more than one type of plant. Analysis of the second year of data found that treatment students were significantly more likely to feel confident that they could plant a seed that would grow into a plant. Although demographic data was taken for each participant including gender, age, and ethnicity, no significant differences were found for any of these groups. Analysis of the short answer portion of the exam found that students from the treatment group were more likely to respond with multiple correct answers.

9:30–9:45 AM

The Relationship of Tree Canopy Cover and Vegetation with Incidence of Stress-related Illness in Metropolitan Statistical Areas of Texas

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Urban living is often characterized by a hectic pace. This causes a great deal of pressure resulting in stress. One-third of Americans are reportedly living with extreme stress, with 75% to 90% of visits to primary care physicians being for stress-related problems. It is known that green areas have positive physiological impacts on human health. Past research found that visiting green areas lowers blood pressure, reduces headache and fatigue, improves mood and hastens recovery from stress. The main objective for this study was to determine if stress-related illness rates in regions of Texas were related to vegetation and tree cover. Stress-related illness data was collected from the Center for Health Statistics and the Texas Department of State Health Services. The stress-related illnesses for each Metropolitan Statistical Areas (MSA) were mapped and inserted into a corresponding vegetation map for each MSA using a geographical mapping software. Researchers looked for visual relationships among data. Quantitative data was also analyzed using PASW. The study compared vegetation rates and stress-related illness rates in metropolitan areas to observe whether vegetation and tree cover were related to higher or lower incidences of stress-related illnesses rates. Results will be used to evaluate the value of green spaces and the urban forest in city areas.

9:45–10:00 AM

Incorporating Social Media into the Conference Experience

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Encouraging conference participants and even an industry as a whole to communicate can be challenging. NurseryWorks, a conference for commercial nursery growers and retail garden centers (15–16 June 2011), made use of new social media tools to foster conversation before, during, and after the event. Participants from 13 states convened both online (7) and in person (87) to learn cutting-edge techniques for nursery crop production. Technology tools employed for this conference included Twitter (@Nursery_Works), Facebook (www.facebook.com/NurseryWorks), Google Moderator, Adobe Connect, YouTube and a conference website (www.ksu.edu/NurseryWorks). While participants on-site had opportunities to interact face to face, participants from around the country were able to interact both among themselves and with on-site participants. This was achieved primarily through Twitter (a search for the conference hashtag, #NurseryWorks, revealed the entire conversation, even if participants did not have a Twitter account). In addition to projection screens for speaker content, two screens at the sides of the room displayed the discussions happening on Twitter and Google Moderator (both discussed content from speaker presentations). Google Moderator was less effective than Twitter, most likely due to a lack of user familiarity and the ability for online participants to use the chat window in Adobe Connect to ask questions. YouTube was used to share videos created for the conference which profiled local growers, shared content from speakers as well as an audio slide story created after the event. The Facebook and Twitter sites continue to share information pertinent to nursery crop production and retail garden center operation with "fans" (about 60 for Facebook and 110 on Twitter). Use of these tools continues to be an effective way to connect with stakeholders, while also building an audience for future conferences.

Thursday, August 2, 2012 Tuttle

Ornamentals/Landscape and Turf 1

Moderator: Yan Chen
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8:00–8:15 AM

Loropetalum Growth Management in the Landscape

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Many flowering shrubs used in the landscape require routine pruning or shearing to keep their shape neat and compact. Pruning is a significant expenditure of time and a major labor cost for the landscape service industry. In addition, over half of the states in the U.S. have passed laws against disposing of yard wastes in landfills, which has increased the interest in using PGRs to reduce pruning or the amount of clippings. Application rates and frequency of Cutless .33G (flurprimidol) were studied in two studies for managing growth of two loropetalum cultivars, 'Merlot Lace' and 'ZhuZhou', in the landscape. Results indicated that Cutless at 14 lb/1000 ft^2 applied once in the spring is effective on controlling shoot growth from spring to summer for both cultivars. Additional application in August provide no or limited growth control compared to single application in April. However, a fall application improved plant visual quality during early spring of the next growing season. Darker color leaves were confirmed by a chlorophyll content meter. Higher fertilization rates improved plant visual quality but resulted in taller plants even at high rate of flurprimidol.

8:15–8:30 AM

Root Dynamics of Congeneric Native and Invasive *Lonicera* and *Rhamnus*

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Invasive woody plants, often escaped ornamentals, are recognized as a major threat in forest ecosystems, altering biodiversity and ecosystem processes, however, little is known about how belowground processes influence these changes. A common trait associated with woody plant invasion is higher carbon gain from earlier bud break. Through adaptation of the vernal dam hypothesis, we attempt to understand how the relationship between leafing phenology and belowground patterns of root growth influence seasonal patterns of nitrogen uptake in congeneric native and invasive woody plants. Toward this goal, we established a comparative study examining root dynamics of congeneric native and non-native species of two common genera in Northeastern North American forests, *Lonicera* and *Rhamnus*, which show marked contrasts in leafing phenology. A field plot of 28 potted plants, seven of each species (*L. japonica*, *L. sempervirens*, *R. frangula*, and *R. caroliniana*) were established at Cornell University in Ithaca, NY. Using minirhizotron technology and mylar windows, root systems were nondestructively monitored for fine root growth, turnover and lifespan from July 2010 to March 2012. Additionally, ^{15}N tracers were used to determine the seasonal physiological uptake and efficiency of fine roots, through a depletion method in intact roots coupled to root respiration. We hypothesize that invasive individuals will have higher root relative growth rate and faster root turnover, corresponding to higher uptake in nitrogen. The data from belowground processes will be correlated with data from aboveground leaf demography collected from Syracuse University to obtain a whole-plant perspective on invasive potential. We expect root processes to be positively correlated with aboveground leaf dynamics, especially during spring leaf-out when plant nutrient demand is greatest. Characterization of belowground root systems with joint information on aboveground patterns can significantly enhance our understanding of how woody plants are able to acquire resources necessary to outcompete similar native species.

Specified Source(s) of Funding: New York State Flowers Initiative, Kieckhefer Adirondack Fellowship

8:30–8:45 AM

Waterlogging and Inundation Tolerance of C_4 Turfgrasses

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Relative waterlogging and inundation tolerance of five C_4 turfgrasses [*Axonopus compressus* (Sw.) P. Beauv.; *Cynodon dactylon L.* × *C. transvaalensis* L.; *Paspalum vaginatum* L.; *Stenotaphrum secundatum* (Walt.) Kuntze; and *Zoysia matrella* Willd.] were determined by growing them in pots held under different waterlogging levels. Established grasses were exposed to 4 water level treatments: 1) WLC: Control, well drained; 2) WL-5: water level maintained at 5 cm below soil surface; 3) WL0: water level maintained at soil surface; and 4) WL+5: inundation water level maintained at 5 cm above soil surface. Following 10 weeks of waterlogging stress, there was a reduction in live shoot turf density (TD), chlorophyll fluorescence (CF), leaf dry weight (LDW), shoot length (SL), root length (RL), root area (RA), root dry weight (RDW), and root/shoot ratio (R/S). All parameters were analyzed, and thus effective in predicting waterlogging and inundation tolerance. Aerenchyma formation was observed in the roots of all species under waterlogging stress. Waterlogging and inundation tolerance varied among the 5 turfgrass species. Under waterlogging treatments WL-5 and WL0, *A. compressus* and *S. secundatum* were tolerant, while *P. vaginatum*, *C. dactylon*, and *Z. matrella* were moderately tolerant. Only *P. vaginatum* was tolerant to inundation (WL+5). *C. dactylon* and *Z. matrella* were moderately sensitive, and *A. compressus* and *S. secundatum* were highly sensitive to inundation. Understanding waterlogging tolerance potential of C_4 turfgrasses could be utilized to improve turfgrass management in tropical conditions, where rootzone waterlogging occurs frequently.

Specified Source(s) of Funding: CUGE, National Parks Board, Singapore

8:45–9:00 AM

Louisiana Super Plants—Three Years of Successful Plant Promotions

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The LSU AgCenter, in cooperation with the Louisiana Department of Agriculture and Forestry (LDAF), initiated an ornamental plant marketing and promotion program in 2010. This program is called "Louisiana Super Plants", Funded has been provided via an intial 3-year award via the Louisiana Department of Agriculture and Forestry's Specialty Crop Competitiveness Block Grant Program. Two subsequent years have now been funded. Plants have been selected for fall and spring promo-

tions since the Fall 2010. Plants selected for Fall 2010 were 'Shishi Gashira' camellia, 'Camelot' foxglove, and 'Amazon' dianthus. Promoted plants in Spring 2011 were 'Frostproof' gardenia, 'Shoal Creek' vitex, 'Serena' angelonia, and 'Butterfly' pentas. Plants to be promoted in the future include: Fall 2011—'Swan' columbine, 'Redbor' kale, 'Belinda's Dream' rose, Southern sugar maple; Spring 2012—'Senorita Rosalita' cleome, 'BabyWing' begonia, 'Penny Mac' hydrangea; and Fall 2012—'Sorbet' viola, 'Conversation Piece' azalea, and evergreen sweetbay magnolia. Spring and Fall 2013 plants have also been selected with 2014 plants being scheduled for selection shortly. Over 175 green industry businesses in Louisiana and one in Mississippi are actively participating. Plants are promoted as "university tested and industry approved." The authors meet with a group of nursery, landscape and garden center professionals twice annually to evaluate the program and select new plants. Point of purchase signs are provided complimentary to retail garden center participants. Hang tags and flat tags are provided to growers. Plants are promoted by the LSU AgCenter's Get It Growing mass media program. The Get It Growing program has weekday radio, weekly television and weekly news article segments. Billboards have been used since spring 2011 in major metropolitan areas around the state Baton Rouge, Lafayette, Lake Charles, Monroe, Shreveport, and Alexandria. Growers have reported tripling production for the selected herbaceous plants. Growers have obtained 50% sale increases for woody plants selected. Retailers are very pleased with the program and have reported tremendous sales increases. The program also has print ads in newspapers across the state and in Louisiana Gardener magazine. A website, www.lsuagcenter.com/superplants, also supports the program.

9:00–9:15 AM

Safety Training for Hispanic Landscape Workers: Challenges and Solutions

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Landscape work is dangerous. Workers not only handle dangerous machinery and chemicals, but are also exposed to heat and sun. Tragically, landscape work can be deadly; there were 157 fatalities nationwide in 2010. In Georgia, many Hispanics work in the landscape industry. Their access to safety information can be limited because language and cultural barriers. Since 2004, safety training programs targeting Hispanic landscape workers have been conducted by a bilingual team from the University of Georgia. Over 2,500 workers have been trained to date. Marketing the program to business owners and workers presented challenges. These challenges were overcome primarily by venue selection and timing of training. Low literacy levels and related issues were identified as impediments to learning. Visual materials and hands-on demonstrations were incorporated into the trainings to account for the literacy level of participants. Pictorial and scenario-based questions were developed to assess the impact of the trainings on participant safety knowledge, before and after, the trainings. Results suggest that using pictures to evaluate participant learning is a moderately effective evaluation technique. Challenges included pictures of unsafe practices that were potentially misinterpreted by participants. However, scenario-based questions were more effective at measuring safety knowledge and showed that participants gained valuable information from the trainings in the areas of pedestrian hazards and identification of hazardous landscape features. In addition, the scenario-based items allowed participants to engage in a conversation with the educator while thinking critically about safety on the jobsite. This presentation will highlight what worked and what did not from both a data collection and safety training standpoint.

9:15–9:30 AM

Maintenance of Substrate Water Content to Control Growth of *Gardenia jasminoides*

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Soil moisture sensor controlled, automated irrigation has been used to successfully maintain substrate volumetric water content (θ) of container plants. By maintaining different θ thresholds and monitoring water applications, it is possible to relate plant growth to irrigation volume. This would provide nursery growers with the ability to control plant growth via irrigation control. To most successfully utilize this method for controlling plant growth, growth patterns of different species and different cultivars of the same species in response to θ need to be understood. Using a soil moisture sensor controlled, automated irrigation system, we irrigated two *Gardenia jasminoides* cultivars, 'Radicans' and 'August Beauty', at θ thresholds of 20, 30, 40, and 50% (v/v) to assess their growth and flowering at two locations, Studies were conducted at Watkinsville (USDA Hardiness zone 8a) and Tifton, GA (USDA Hardiness zone 8b) to look at environmental impacts. Growth of both cultivars was related to θ threshold, and patterns of growth were similar at the two locations. High mortality was observed at the lowest threshold (20%) with poor root establishment due to the low irrigation volume. In Watkinsville at the 20% threshold 'August Beauty' received 1.9 L/plant and 'Radicans' received 1.4 L/plant over the course of the experiment. Growth of plants at the 30% threshold was reduced compared to plants grown at the 40 and 50% thresholds. Flowering was delayed at the 30% threshold, with blooming not occurring until after rainfall late in the experiment. Irrigation volume for the 30% threshold in Watkinsville was 15.0 L/plant for 'August Beauty' and 14.1 L/plant for 'Radicans'. Plants grew similarly at the 40 and 50% thresholds, but with significant differences in irrigation volume. In Watkinsville 'August Beauty'

received 48 L/plant at the 40% threshold and 88 L/plant at the 50% threshold. 'Radicans' received 33.5 L/plant at the 40% threshold and 136 L/plant at the 50% threshold. The irrigation volume at the 50% threshold was likely in excess of what was needed for growth, resulting in leaching. The growth reductions at lower θ show that θ adjustment is a possible means of controlling plant growth and crop timing.

Specified Source(s) of Funding: USDA–NIFA-SCRI Grant

9:30–9:45 AM

Reaction of Selected Herbaceous Perennials to Low-input Cultural Practices and Severe Heat and Drought Conditions

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The focus of this multi-year Earth-Kind® research study was to investigate the reactions of 69 different species or cultivars of herbaceous perennials to low cultural inputs, disease and insect pest pressure, and severe heat and drought conditions. A goal of the research was to determine what percentage of carefully selected, highly recommended herbaceous perennials would perform at a high level when grown using the Earth-Kind Environmental Soil Management approach of compost and mulch only. The location of the research was Myers Park and Event Center, McKinney, TX. During May of 2010 the plants were installed in alkaline, Houston Black Clay soils amended with 3 inches of fully finished, plant derived compost. A 3-inch-thick layer of locally available wood mulch was applied to the soil surface and maintained at this thickness throughout the study. These plants received no fertilizer, no pesticides of any kind, no removal of spent blooms, and no pruning other than the routine removal of winter-damaged tissue. The perennials were evaluated throughout the growing season for landscape performance, nutrient deficiencies, disease susceptibility, insect injury, drought tolerance, plant size, and vigor. Landscape performance, including heat and drought tolerance, was exceptional for 34 cultivars. Many of the cultivars exceeded the mature height and width dimensions listed in reference sources. During the second year of testing, the plants were subjected to the worst drought in this area in the past 75 years. The plants received supplemental irrigation only one time, in mid August, during this very stressful 12-month period. This represents a 97.5% reduction in supplemental irrigation. Some cultivars, such as *Anisacanthus quadrifidus, Eupatorium greggi, Malvaviscus arboreus, Wedelia hispida*, and numerous species of *Salvia* showed extraordinary drought tolerance. Incidence of diseases and insects throughout the two years of the study were minimal. Only four species of plants exhibited any nutrient deficiencies, with nitrogen deficiency being the most common. Results of this study identified multiple species and cultivars of herbaceous perennials suitable for growing in low-input landscapes consistent with the Earth-Kind management strategy

Thursday, August 2, 2012 Sevilla

Pomology 3

Moderator: Jennifer Reeve
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8:00–8:15 AM

Everything about Peaches: A One-stop Shop for Peach Information

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In July, 2010 a new site "Everything About Peaches" was launched (http://www.clemson.edu/peach) to provide comprehensive, research-based information for the commercial and backyard grower and general consumer. To date, this site has been utilized extensively around the world and in 2011 it was recognized by both S.Reg. ASHS and ASHS with website awards. The purpose of this presentation is to familiarize the audience with website features and content, strategies used to keep information current and relevant and approaches to reach new audiences. In 2011, a Twitter (http://twitter.com/peachdoctor) and FaceBook (http://www.facebook.com/peachdoctor) page were added that link to and compliment the website. The site includes 33 educational YouTube videos, 36 grower-oriented educational columns, 35 frequently asked questions (FAQs) most with complementary images, current news, and links to production guides and homeowner guides. The use of Google Alerts has enabled us to stay current with relevant peach news worldwide and use of this service enables interesting tweets (often 2 or more per day) that appear both on the FaceBook and Twitter pages and in a Twitter pane on the website home page. This website also incoporates a searchable database for peach germplasm evaluation of more than 300 cultivars and advanced selections tested over as many as 10 years at multiple locations in South Carolina. The germplasm database is fully searchable with performance data, digital images, cultivar descriptions, etc. Interested persons can make side-by-side comparisons of cultivars of interest.

Specified Source(s) of Funding: South Carolina Peach Council and USDA–SCRI

8:15–8:30 AM

Influence of Foliar Nitrogen Content on Freezing Injury of Flower Bud in Peach Tree

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The objective of this study was to find out freezing injury of flower bud according to nitrogen nutrition status in peach tree. The average temperature and the mean minimum temperature in Jan. 2011 were lower than those of the last 30 years by 3.7 °C and 4.0 °C in Korea, respectively. Peach trees in northern Chungcheong province (Korea) were severely damaged by cold temperature during the recent two years when their cultivation area was considered. As a countermeasure of unusual cold temperature, we need to increase starch content in peach tree. Four nitrogen application levels were applied to evaluate the accumulation of starch in a 1-year-old tree. To verify the freezing injury of flower bud according to nutritive conditions of adult trees, the foliar nitrogen and shoot starch content of adult trees that were over 7 years old were investigated in July and in December, and freezing injury of flower bud was also examined in April next year. Foliar starch content was the highest on 20 July, but root starch content was the highest on 22 Aug. among the four parts (leaf, branch, trunk, and root) of 1-year-old tree. The starch contents of all parts in 1-year-old trees were a reduced tendency with increase of nitrogen fertilization. It was concerned with increase of foliar Hunter "a" value caused by accelerating aging. In case of adult trees, shoot starch contents of freezing injured trees were lower than those of non-freezing injured trees by 11.4% to 22.4% in May. The average freezing injury level of flower bud was 9.0% in trees with normal range of foliar nitrogen content, but that was 49.0% in trees with excessive range of foliar nitrogen content. The foliar nitrogen content had the negative correlation coefficients with starch content of shoot and starch content of shoot had the negative correlation coefficients with bud injury ratio. Accordingly, the foliar nitrogen content had the right correlation coefficients with bud injury ratio. In conclusion, the preceding results showed that the freezing injury of peach tree can be efficiently reduced by management of optimal nitrogen for starch accumulation.

Specified Source(s) of Funding: Cooperative research program for agriculture science and technology development(Project No. PJ907104032012) of Rural Development Administration, Republic of Korea

8:30–8:45 AM

Approaches for Establishing Organic Stonefruit Orchards in Utah and the Intermountain West

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Adequate nutrient supply and weed control is critical for the successful establishment of fruit trees. A lack of available N and inadequate weed control is of particular concern in organic tree fruit establishment, especially when a short growing season and shallow alkaline soils limit natural fertility and use of nitrogen fixing winter cover crops, as is the case in the Intermountain West. In order to determine the best approach for establishing peach trees (*Prunus persica* L.) organically in the Intermountain West, six organic and four integrated and conventional treatment combinations were established in two first leaf orchards at the Kaysville Research Farm, UT, in 2008. Treatments in the certified organic orchard were: 1) straw mulch with compost and a grass alley way; 2) straw mulch, compost and a legume alleyway; 3) living mulch (low-growing shallow rooted sweet alyssum, *Lobularia maritime* L.), compost and grass alley way; 4) living mulch, compost and a legume alley way; 5) woven plastic mulch, compost and a grass alley way; and 6) tillage, compost and a grass alley way. Paunch manure compost was applied at a baseline rate of 90 g total N per tree and adjusted up or down based on tree growth. Treatments in the integrated orchard were: 1) conventional fertilizer (N–P–K 90 g N per tree) plus herbicide; 2) compost (90 g total N per tree) plus herbicide; 3) N–P–K with paper mulch and reduced herbicide;and 4) compost with paper mulch and organic herbicide. All treatments in the integrated orchard were planted with grass alley ways. In the organic orchard, tree growth was initially slowed in combination with both living and non-living mulches. By the end of 2011 trees were largest in legume alley way treatments, despite considerable tree row weed pressure, suggesting N limitation. However, in the integrated orchard trees were largest in the compost herbicide treatment indicating that weed control, not lack of nitrogen was likely limiting growth. Paper mulch depressed tree growth in combination with both N sources, but more so in combination with compost and organic herbicide were weed control was moderate, than with N–P–K and conventional herbicide. Tree growth in organic treatments matched tree growth in the conventional control when good weed control was achieved. A legume alley way may help alleviate the need for intensive weed control when establishing organic peach orchards.

Specified Source(s) of Funding: OREI, Utah Specialty Crop Block Grant and the Utah Horticulture Association

8:45–9:00 AM

Cropload Affects the Size but Not the Number of Cells in Sweet Cherry Fruit

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High crop loads in sweet cherry typically result in a large proportion of undersized fruit. However, the anatomical basis for fruit size has not been established raising the question "Is the potential for fruit size determined by cell number or cell size?" Because horticultural practices can affect both cell division and cell enlargement, we investigated the timing of cell division and enlargement to identify critical timing when horticultural practices could be employed. Early season 'Chelan', mid-season 'Bing' and late-season 'Sweetheart' were evaluated for fruit growth and anatomy beginning at full-bloom and ending one week after commercial harvest. At about 40% full-bloom, balloon-stage flowers were identified and all other opened or unopened flowers were removed leaving only two to four flowers per spur. This 'bloom-setting' procedure reduced the variability in the timing of fruit-set to about 4 days compared to about 9 days for the whole orchard. This was shown with detailed growth analysis from samples taken daily of the "set" and "un-set" fruits. Additionally in 'Sweetheart', crop load was reduced by bud-thinning in the dormant stage. For the high crop load treatment in 'Sweetheart', flowers of unthinned spurs were marked with tape at a similar balloon-stage and no flowers were removed. Light-microscopy of whole and dissected fruit was used for growth analysis and scanning electron microscopy (SEM) was used for cell number and size measurements. High crop loads reduced the growth of fruits and pits beginning as early as 18 days after full bloom. We documented spatial and temporal changes in cell number, shape and size of cells of the mesocarp tissue (flesh). Roughly half the number of cells comprising an individual fruit at harvest was already present at full bloom. The cell division period was completed during mid-stage I growth, at about the same time as the crop load effects on fruit size were first detected. Cells of the outer region of the mesocarp were elongated during most of the growing season, but during the final fruit swelling became rounded as they expanded tangentially. Cells of the inner region of the mesocarp remained elongated at harvest. Final fruit size was more strongly correlated with cell size than cell number and cell size differences were most apparent in the outer mesocarp during final fruit swelling.

9:00–9:15 AM

Tree Architecture Affects Labor Efficiency during Sweet Cherry Harvest

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Despite its singular importance in sweet cherry (*Prunus avium* L.) production budgets, harvest efficiency is not well studied. Intuitively, there are biological, technological, and sociological factors that will affect harvest efficiency, yet there are limited empirical reports on these for tree fruit. Herein we report on the use of a novel real-time labor monitoring system (LMS) to investigate the role of training system on harvest efficiency in sweet cherry. The LMS consists of: a) a digital scale; b) a RFID reader/writer; c) a computational unit (CU) and d) wearable dataloggers. In 2011 the LMS was used to study picker efficiency in 11 commercial sweet cherry orchards throughout the Pacific Northwest. Four different architectures were evaluated: 1) Upright Fruiting Offshoots (UFO), a planar architecture comprised of unbranched vertical wood; 2) Y-trellised, an angled planar architecture; 3) Kym Green Bush (KGB), a multi-leader bush system; and 4) traditional open center (TOC), large trees comprised of 3–5 main leaders. A consistent picking crew was utilized to facilitate comparisons among systems. In each orchard the LMS calculated the harvest rate, weight of harvested fruit, number of harvested buckets, range in fruit weight per bucket, and mean fruit weight per bucket, for each individual picker. Our testing revealed a dramatic effect of canopy architecture on labor efficiency with a ≈2-fold range among orchards from 0.46 kg/min to 0.93 kg/min. The highest mean harvest rates (0.93 ± 0.19 kg/min and 0.77 ± 0.12 kg/min) were in UFO orchards of 'Cowiche'/'Gisela®5' and 'Tieton'/'Gisela®5', respectively. High harvest efficiency in these two orchards was due to most fruit being readily accessible from the ground and the simplified architecture. The third highest efficiency was recorded for the KGB system with mean harvest rate of 0.71 kg/min in a fully pedestrian orchard. Interestingly, inexperienced pickers improved to a greater extent (+130%) than experienced pickers (+80%) when comparing efficiency in TOC with pedestrian and planar systems (e.g., UFO and KGB). Furthermore, picking rate for individual pickers varied within a day by more than 100%. This range is likely due to variability in fruit density within trees, tree size, as well as fruit accessibility. The LMS also recorded significant variability in final bin weight of more than 35 kg, across all orchards, and a range in bucket weight between 7.00–13.00 kg was documented. These results suggest that current systems of picker reimbursement, by bucket or bin, are beset with inaccuracy.

9:15–9:30 AM

Mechanical Pruning Shows Promise for Sweet Cherry Trained to the UFO Architecture

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The planar, upright fruiting offshoots (UFO) architecture for sweet cherry (*Prunus avium*L.) was developed at WSU, in part, to facilitate the incorporation of mechanization and automation technologies. In the current study we investigate the potential to mechanically prune sweet cherry trees trained to the UFO system. This trial was established in a 6-year-old block of 'Selah' on 'Gisela®6' rootstock at the WSU Roza experimental farm. Each of three rows was divided into 3 equal blocks of 16 trees and assigned one of three treatments: hand pruning, full mechanical pruning, and mechanical pruning + hand pruning follow-up. Mechanical pruning was accomplished in Feb. 2012 using a hydraulic, tractor-mounted pruner containing three adjustable rotary disc blades for cutting. This machine pruned only one side of the trees in each pass. The pruner was set to cut all wood extending in the row beyond about 4 inches on both the east and west sides. First, the blades were oriented vertically to remove lateral wood. Then, the blades were oriented horizontally, topping the trees at 11 ft. Hand pruning was carried out to remove all lateral wood and top the uprights to a height of 11 ft. In each replicate block, the pruning time and the weight of prunings were measured. The average time for hand pruning was about 42 min/section (≈158 s/tree) and the average weight of cutting wood was 59.87 kg/section (3.74 kg/tree). In contrast, the average pruning time for full mechanical pruning, for both sides of the trees, was 2 min 40 s (≈9 s/tree) and for the tops was 1 min 7 s (≈4 s/tree); a total 3 min 47 s per section (≈13 s/tree). Full mechanical pruning therefore took about 8% of the time of manual pruning. The average weight of prunings was ≈24 kg/section (≈1.5 kg/tree, -60% less than hand pruning). In the combined mechanical + hand treatment, the average time for pruning was almost 34 min/section (≈127 s/tree, -20% lower than hand pruning alone) and the average weight of prunings was almost 58 kg/section (≈3.6 kg/tree). We will also report on the effects of these pruning strategies on fruit yield and quality, canopy light interception and distribution, and tree growth. This preliminary evaluation shows great potential to reduce pruning time/costs mechanical systems.

Thursday, August 2, 2012 **Sevilla**

Floriculture 1

Moderator: Karen L. Panter
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10:15–10:30 AM

Daily Water Use of *Antirrhinum majus* in Hydroponic Greenhouse Production

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We are interested in quantifying daily water use for cut-flower *Antirrhinum majus* (snapdragon) production, since floral development is highly sensitive to available water in soilless substrates and plant densities are typically very high in greenhouse cut-flower production. Daily water use of snapdragon cultivars was measured using a load-cell based system coupled with a dense environmental sensor network, including capacitance sensors, temperature and relative humidity, and light (PPF) sensors. Two snapdragon cultivars, 'Opus Fresh White' (Group III–IV) and 'Overture White' (Group II) were used to estimate daily water use for summer and winter cultivars, respectively. All research was performed in a commercial snapdragon production greenhouse (Bauers Greenhouse, Jarrettsville, MD). Six replicate bags, each with independent load-cell and sensor systems, were planted with 48 plants per bag. All plants were grown in a perlite (Grade A-20; Pennsylvania Perlite Co., Bethlehem, PA) substrate and fertigated 3–6 times daily with a customized fertilizer solution in a closed hydroponic system. Substrate water content was maintained at 0.33 ± 0.03 (SD) $m^3 \cdot m^{-3}$. Plants were grown for 47 and 120 days after transplanting, for the summer and winter cultivars, respectively. All plants were destructively harvested at the end of each study and a number of plant growth variables measured. Leaf area index was measured repeatedly during the studies. Average daily light integrals were very different between seasons (18.3 and 8.0 $mol \cdot m^{-2} \cdot d^{-1}$ for summer and winter), but differences in cumulative intercepted light intensity during each production period was relatively small (611 and 709 $mol \cdot m^{-2}$ for summer and winter cultivars). Daily water use of 'Opus Fresh White' ranged from 15.1 to 66.9 $mL \cdot d^{-1}$, compared to that of 'Overture White' which ranged from 2.6 to 26.2 $mL \cdot d^{-1}$ per plant. The total water use of each cultivar over each production period was similar at 2.0 and 1.9 L per plant for summer and winter, respectively. A daily water use regression model was developed based on plant development and environmental factors. Intercepted daily light integral and vapor pressure deficit accounted for the largest amount of variability in daily water use ($P < 0.001$). With environmental variables and plant age, a simple daily water use model could provide growers with quick estimate of daily water use, for efficient irrigation scheduling of snapdragon in greenhouse production.

Specified Source(s) of Funding: USDA-NIFA-SCRI Award no. 2009-51181-05768

An asterisk (*) following a name indicates the presenting author.

10:30–10:45 AM

Assessment of Vase Life for Two Ornamental Grasses

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Cut flowers are very perishable and deterioration begins as soon as stems are detached from the mother plant. Many researchers have investigated vase life of cut flowers by adding different preservatives. However, there is limited published information about the vase life of ornamental grasses. The objective of this study was to find the most effective vase solutions to maintain longer post harvest life of ornamental grasses. Two different grasses, Switchgrass (*Panicum virgatum)* and Johnsongrass (*Sorghum halepense*), were used, and vase life was based on stem, inflorescence, and leaf color change as well as level of wilting. Treatments included 5 and 20 $\mu L \cdot L^{-1}$ ClO_2, 10 and 20 $\mu L \cdot L^{-1}$ bleach, 10 and 20 $g \cdot L^{-1}$ floral preservatives, and deionized water as a control. Sucrose (10 $g \cdot L^{-1}$) was added to each vase solution and all treatments were replicated three times. For Johnsongrass stems, control and floral preservatives at 20 $g \cdot L^{-1}$ gave the highest vase life of 18 days and was found to be significantly different to floral preservative at 10 $g \cdot L^{-1}$. However, in Switchgrass stems, bleach at 20 $\mu L \cdot L^{-1}$ gave the highest vase life of 24 days and was significantly different to 20 $\mu L \cdot L^{-1}$ ClO_2 and floral preservative at 20 and 10 $g \cdot L^{-1}$. Similarly, in Johnsongrass inflorescence, ClO_2 at 5 $\mu L \cdot L^{-1}$ gave the greatest vase life of 17 days and was found to be significantly different to all other treatments except ClO_2 at 20 $\mu L \cdot L^{-1}$ which gave 16 days of postharvest life. However, in Switchgrass inflorescences, ClO_2 at 20 $\mu L \cdot L^{-1}$ gave maximum vase life of 17 days in comparison to control at 13 days and was found to be significantly different to bleach at 10 and 20 $\mu L \cdot L^{-1}$, floral preservative at 10 and 20 $\mu L \cdot L^{-1}$, and the control. In the same way, ClO_2 at 20 $\mu L \cdot L^{-1}$ gave the highest vase life to Johnsongrass leaf ratings of 16 days followed by the control at 15 days, and was found to be significantly different than floral preservative at 10 and 20 $\mu L \cdot L^{-1}$ and bleach at 10 $\mu L \cdot L^{-1}$. In contrary , ClO_2 at 5 $\mu L \cdot L^{-1}$ gave the greatest vase life for Switchgrass leaf ratings at 15 days in comparision to control at 13 days, but no treatments were found to be significantly different to each other.

10:45–11:00 AM

Homemade Floral Preservatives Effects on Postharvest Performance of Selected Specialty Cut Species

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Effects of homemade floral recipes applied as a 48-hour grower treatment or a continuous consumer (vase) application were studied on cut 'ABC Blue' lisianthus, 'Double Eagle' African marigold, 'Red Bentley' rose and 'Deep Red' zinnia. Cut stems were subjected to solutions containing 300 $mg \cdot L^{-1}$ citric acid, 20 $g \cdot L^{-1}$ sugar and either 200 $mg \cdot L^{-1}$ Al_2SO_4 (citric-Al), 10 $mL \cdot L^{-1}$ household bleach (citric-bleach), 0.05 $mL \cdot L^{-1}$ Greenshield (citric-Greenshield), or 7 $mg \cdot L^{-1}$ Kathon CG (citric-Kathon); 500 $mL \cdot L^{-1}$ lemon/ lime soda and 500 $mL \cdot L^{-1}$ water (soda); 10 $mL \cdot L^{-1}$ household bleach, 20 $g \cdot L^{-1}$ sugar and either 37 $mL \cdot L^{-1}$ household lemon juice (lemon juice) or 6 $mL \cdot L^{-1}$ household vinegar (vinegar); 10 $mL \cdot L^{-1}$ Floralife Clear Professional (Floralife); or 10 $mL \cdot L^{-1}$ Chrysal Clear Professional 2 (Chrysal), dissolved in tap water, which was also used as control without any added compound. Cut stems of all tested species had longest vase lives, when placed in citric-Al for 48 hours followed by shifting to tap water until termination. Lisianthus stems had greater number of buds opened when placed in soda. In marigold, preservative recipes had no effect on postharvest performance except vase life. In roses, stems placed in citric-Al or soda lost less fresh weights and all recipes effectively controlled bent neck in roses. In zinnia, use of soda, citric acid with either Greenshield or Kathon or Floralife maintained fresh weights of the stems. Moreover, citric-Al also controlled petal necrosis in zinnia. When the same recipes formulations were used as a continuous vase solution until termination, cut lisianthus and marigold stems had longest vase life with citric-Greenshield or soda, which were statistically similar with citric-Kathon, commercial Floralife or Chrysal for lisianthus. In roses, Chrysal, Floralife, and citric-Al had longest vase life, while citric-Al proved detrimental for zinnia, where it had only 3.3 days vase life compared to 16.6 and 15.9 days with commercial preservatives. In summary, citric-Al proved best recipe for short term treatment, while for continuous application, soda or citric acid with either Greenshield or Kathon were effective for extending longevity of selected species. Among treatment durations, continuous vase application had longer vase life than short-term application. Moreover, treatments containing household bleach and vinegar were generally detrimental and had higher solution pH and EC, which not only reduced vase life, but also enhanced microbial contamination.

11:00–11:15 AM

Harvest Time Affects Postharvest Longevity, Water Relations, and Carbohydrates Status of Selected Specialty Cut Species

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The effects of harvest time on cut 'ABC Purple' lisianthus, 'Double Eagle' African marigold, and 'Deep Red' zinnia were studied to determine the best time of the day for harvest. Cut stems were either harvested in the morning (0700–0800 HR), at noon (1200–1300 HR), or in the afternoon (1700–1800 HR) and their postharvest performance was evaluated either fresh or after 2 week storage in tap water at 2 ± 1 °C. Cut lisianthus stems harvested in the afternoon had longer vase life, higher

water uptake, bud opening, leaf relative water contents (LRWC), and better postharvest quality than morning or noon harvests, when compared after storage. However, unstored stems had similar vase life. Marigold stems also had longer vase life when harvested in the afternoon, while storage had no effect on vase life. However, harvest time had no effect on LRWC of marigold. Harvest time did not affect vase life and LRWC of zinnia, although afternoon harvested stems had higher water uptake and less stem bending. In marigold, the morning harvest had lower carbohydrate contents than noon or afternoon harvests, while in zinnia, no apparent differences were recorded. In both species, petals had higher carbohydrate contents than stem and leaves and carbohydrate contents decreased both with storage and time in vases. In summary, afternoon harvest was either better or equally good as the generally practiced morning harvest for extending vase life and maintaining high relative water content of cut lisianthus, marigold, and zinnia.

11:15–11:30 AM

Year-round Production of Fresh Cut Sunflowers in Wyoming

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Begun as a short-term project to grow brown and gold flowers for the University of Wyoming Agricultural Experiment Station banquet in Feb. 2011, the idea progressed into a year-long feasibility study. The main objective of the project was to determine if three cultivars of cut sunflowers could be successfully grown on a year-round basis in a Wyoming greenhouse. The three cultivars chosen were 'Dafna', 'Sunbright Supreme', and 'Premier Lemon'. An additional cultivar, 'Pro Cut Bicolor', was added in June 2011. Every 2 weeks, starting 11 Nov. 2010, enough seeds were sown of each of the cultivars for four replications of four plants each. Seedlings were transplanted into 10 cm, 577 mL containers 15 days later and were placed on a rolling mesh bench in the University of Wyoming Laramie Research and Extension Center Greenhouses. Containers were placed on 15-cm centers and were supported by bamboo stakes against which stems were held using hook and loop closures. Data recorded were days to harvest and stem lengths for each cultivar. Results showed 1,201 stems were harvested from 23 sowings, or about 130 stems per square meter per year. Days to harvest for the other three cultivars averaged 87.4 days ('Pro Cut Bicolor'), 75.2 days ('Sunbright Supreme'), and 73.4 days ('Dafna'). Stem lengths varied among cultivars with 'Pro Cut Bicolor' averaging 93.5 cm, 'Sunbright Supreme' averaging 74.4 cm, and 'Dafna' averaging 63.8 cm. Data from 'Premier Lemon' are not presented due to inferior stem lengths, unusable in the floral trade. There were significant differences among harvest dates in all three cultivars with respect to both days to harvest and stem lengths. Details on these differences will be highlighted as well as progress on a follow-up study currently underway at the University of Wyoming.

11:30–11:45 AM

Investigating the Nitrogen Sink–Source Relationship in *Phalaenopsis* by Using Stable Isotope ^{15}N as a Tracer

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Phalaenopsis is an important floriculture crop characterized by slow growth, slow response to fertilization, and resilience to drought and nutrient starvation. Little has been published about the partitioning of nitrogen among the various organs of *Phalaenopsis*. In this study, ^{15}N-labeled Johnson's solution containing $K^{15}NO_3$ was applied to *Phalaenopsis* Sogo Yukidian 'V3' plants in different experiments, to study the partitioning of fertilizer nitrogen shortly after application and after it is stored within the plant. Shortly after fertilizer application, fertilizer nitrogen was not sufficient to supply the requirement of expanding leaves, and nitrogen was sourced elsewhere from within the plant. Over a 2-month period, fertilizer nitrogen was preferentially accumulated in the two youngest leaves rather than older leaves. Following application of ^{15}N-labeled fertilizer to roots or leaves, young leaves and newly-grown roots contained the highest ^{15}N concentrations among the distant organs to which the label has been translocated. Following reduction of endogenous nitrogen pool in *Phalaenopsis* through root excision, the amount of stored nitrogen allocated to the inflorescence and young leaf did not decrease, while the extent of utilization of stored nitrogen in mature leaves increased as the size of nitrogen pool decreased. Export of fertilizer nitrogen previously accumulated in mature leaves and roots was evident as *Phalaenopsis* plants shifted from vegetative to reproductive growth stage, even though absorption of fertilizer nitrogen through the roots still continued. These experimental results indicate that new leaves, new roots, and new inflorescences are strong sinks of nitrogen in *Phalaenopsis*, while mature leaves and roots have the capacity to serve as sources of nitrogen.

Specified Source(s) of Funding: National Science Council, Taiwan

Thursday, August 2, 2012 **Tuttle**

Vegetable Breeding

Moderator: Kevin Crosby
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10:30–10:45 AM

Reactions of Some Tomato Cultivars against *Pseudomonas syringae* pv. *tomato*

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Pseudomonas syringae pv. *tomato* is the causative agent of the bacterial speck disease of tomato (*Solanum lycopersicum*), a disease that occurs worldwide and causes severe reduction in fruit yield and quality. Disease resistance conferred by the *pto* gene, encodes a serine–threonine protein kinase, is one of the first R-genes to be cloned and sequenced. In this research, the resistance reactions of 44 popular tomato cultivars which are grown commonly in Turkey against *P. s*. pv. *tomato* causal agent of bacterial speck disease were determined. Six-week-old plants were inoculated by spraying of *P. s*. pv. *tomato* YA-1 and YA-2 strains (10^8 cfu/mL) with an airbrush until leaf surfaces were uniformly wet. After inoculation, the plants were incubated at 25 ± 1 °C in 60% to 70% relative humidity with a 12-h photoperiod and the disease progress occurred on the seedling leaves by *P. s*. pv. *tomato* was followed by counting the dark brown-black leaf necroses in 2 days after inoculation of the seedlings. Each experiment was performed at least three times and control plants were sprayed with sterile distilled water. The results of resistance reactions on plants were evaluated according to Chambers and Merriman scale. The total peroxidase activity (U/mL) was measured by a spectrophotometric method at λ=460 nm using H_2O_2 as a substrate in 24, 36, and 72 hours after bacterial inoculations. The resistance levels of the cultivars were statistically determined by using ANOVA variance analyze and Duncan multiple range tests. Presence of *pto* gene (963 bp) in the tomato cultivars was verified by using the primers SSP17 and JCP32 by PCR and the gene was determined in 15 different tomato cultivars.

Specified Source(s) of Funding: This study was supported by Selcuk University Scientific Researches Coordinator's

10:45–11:00 AM

Patterns of Accumulation and Genetic Mapping of Fructose, Glucose, and Sucrose in Snap Beans

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Sugars, including fructose, glucose, and sucrose contribute significantly to the flavor and consumer acceptance of snap beans (*Phaseolus vulgaris*). Little is known regarding differences between and within dry bean and snap bean cultivars, the patterns of sugar development with increasing pod size, or the presence of quantitative trait loci associated with sugar concentration. This study consists of two experiments. In experiment one, alcohol-soluble sugar content of five snap bean cultivars and one dry bean cultivar planted in field trials were assayed throughout pod development over two years using high-performance liquid chromatography. Significant differences in sugar accumulation patterns were observed among cultivars. In general, fructose and glucose levels decreased while sucrose levels increased with increasing pod size in the snap bean cultivars. In contrast, fructose and glucose levels increased in the dry bean cultivar while sucrose levels remained unchanged with increasing pod size. No year by genotype interactions were observed for sugar accumulation patterns. Results indicate that differences among cultivars can be sampled at commercial sieve size 3 (7.34–8.33 mm) or 4 (8.33–9.52 mm). In the second experiment, a recombinant inbred line population consisting of 75 F2:10 recombinant inbred lines (RIL) developed from a cross between 'Eagle' and 'Puebla 152' by single seed descent was utilized to identify putative QTL. A previously published random amplification of polymorphic DNA (RAPD) linkage map of the 'Eagle' × 'Puebla 152' RIL (EP-RIL) population was used to scan for putative QTL associated with sugar concentration levels. Significant differences were observed among the EP-RIL genotypes, with no significant genotype by environment interactions. Heritability estimates for fructose, glucose, and sucrose were 0.85, 0.81, and 0.85, respectively. A single QTL was mapped to linkage group B1 and was closely linked to marker W9.1050 for fructose and sucrose concentration levels. Marker W9.1050 explained 28.8% of the variation in fructose and 26.6% in sucrose. A two-QTL model with associated markers W9.1050 on linkage group B1 and F8.500 on linkage group B6 was mapped for glucose and explained 36.4% of the variation in glucose concentration levels.

Specified Source(s) of Funding: USDA Hatch

11:00–11:15 AM

Biplot Analysis of G×E Interactions for Fruit Yield and Component Traits in Melons (*Cucumis melo* L.)

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Genotypic evaluation in multi-environments is essential to better understand the nature and magnitude of genotype by environment (G×E) interactions for any desirable trait. Melon (*Cucumis melo* L.) trials were conducted to determine stability of fruit yield and component traits. Nine genotypes including four commercial hybrids were planted at three locations (College Station, Uvalde, and Weslaco, TX) in 2 years (2010 and 2011). Total fruit yield (TFY; $t \cdot ha^{-1}$), marketable yield (MFY; $t \cdot ha^{-1}$), percent marketable yield (PCMY), number of fruits per vine (FN) and average fruit weight (FW) were recorded. Data was analyzed by the combined analysis of variance and trait stability by bi-plot analysis. Location had significant ef-

fect on all the traits except PCMY. Location × year interaction was significant for TFY, PCMY, and FN. Location × genotype interaction significantly affected TFY and FN, while Location × year × genotype interaction was significant only for MFY and PCMY. Biplot analysis indicated that 'Orange Casaba' was the highest mean performing genotype for TFY, MFY, 'Oro Duro' for FN, and 'Mission' for PCMY. Further, the ideal genotypes for specific traits were as follows: TAMU F39 (TFY), Mission (MFY, FN), and Sol Real (PCMY). Mission was the most stable and average performing genotype for marketable yield across all environments, while the Uvalde location was the most ideal environment for selecting varieties adapted to south-central Texas.

Specified Source(s) of Funding: TDA–SCBP

11:15–11:30 AM

Characterization and Deployment of Recessive Resistance to *Phytophthora capsici* in *Capsicum annuum*

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Resistance to two highly virulent isolates of *Phytophthora capsici* was confirmed in *Capsicum annuum* lines Fidel and CM334. In order to assess inheritance of the resistance in Fidel, segregating populations were created by controlled pollinations in a greenhouse. F_1, reciprocal F_1, F_2 and backcross seed were generated with five susceptible lines or cultivars: Hidalgo Serrano, TM6, YB50, MJ201, and Mesilla. Seeds were planted in pasteurized commercial growing media consisting of ground peat moss and perlite. Inoculum was prepared by culturing two isolates of *P. capsici* (New Mexico and Zacatecas) on V8 agar for 10 days to allow mycelial coverage of the plates. The plates were flooded with sterile water and allowed to sit for 3–4 days, followed by shocking at 10 °C to induce zoospore release. Zoospore counts were conducted with a hemacytometer under a microscope at 10×, followed by dilution to 5,000 spores/mL. Seedlings were inoculated after 35 days at the 4–6 true leaf stage with 2 mL of the spore suspension, providing approximately 10000 spores per plant. Resistance expression in the F_1 was consistently close to zero, regardless of the susceptible parent. Segregation ratios for resistance in the F_2 families varied based on the susceptible parent. The ratios of susceptible:resistant progeny for families with TM6, Hidalgo and MJ201 parents suggested the possibility of duplicate, dominant gene action for susceptibility. This would mean that two recessive genes would be required for resistance. The families with the susceptible parents- YB50 and Mesilla, had much fewer resistant progeny. The Chi-square values for their susceptible:resistant ratios suggested that 3 recessive resistance genes would be a better fit. One possibility could be that TM6, Hidalgo, and MJ201 share a common recessive resistance allele with Fidel. Another explanation could be that the resistance threshold effect of inoculum was lower for YB50 and Mesilla, leading to more susceptible plants at 10,000 spores. The threshold for these isolates was established at 20,000 spores/mL for Fidel, above which resistance expression began to break down. At 50,000 spores, resistance was completely overcome for all resistant genotypes Fidel, CM334, and PI 201234. Nevertheless, this recessive resistance has been successfully backcrossed into New Mexico chile and Ancho breeding lines, which will soon be trialed in infested grower fields.

Specified Source(s) of Funding: New Mexico Chile Commission

11:30–11:45 AM

Identification of Molecular Markers Linked to Bacterial Spot Race T4 Resistance from the *Solanum lycopersicum* var. *cerasiforme* Accession PI 114490 QTL: Toward Developing Broad-spectrum Resistance

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The development of resistance to bacterial spot (*Xanthomonas* spp.) in tomato (*Solanum lycopersicum*) has been particularly challenging, particularly because of the emergence of new races of the pathogen that overcome specific resistance mechanisms. In response, breeding efforts at the University of Florida have shifted to focus more on quantitative, race non-specific resistance. The *S. lycopersicum* var. *cerasiforme* accession PI 114490 has a high level of resistance against all known races of bacterial spot and may be a source of novel resistance loci. PI 114490 was crossed to two susceptible breeding lines, Fla. 7324 and Fla. 7613, and F_2 populations were developed. In Spring 2010, approximately 2600 F_2 seedlings were screened with a molecular marker at the *Sp* locus, and 500 determinate plants were planted to the field and subsequently evaluated for bacterial spot disease severity. Phenotypic evaluations and selections were carried out on 500 F_2 progeny in Spring 2010, on 260 F_3 progeny lines in Spring 2011, and on 200 F_4 progeny lines in Fall 2012, always selecting for highest or lowest levels of resistance. Ninety highly resistant or highly susceptible $F_{2:4}$ plants were selectively genotyped in Fall 2012 using the "SolCAP" SNP array, consisting of 7,720 SNPs. 2449 of these SNPs were polymorphic between PI 114490 and both susceptible parents. Marker-trait analysis identified seven regions associated with resistance, including two previously identified QTL.

Thursday, August 2, 2012 Balmoral

Viticulture and Small Fruits 2

Moderator: Tripti Vashisth
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10:15–10:30 AM

Can Increasing Strawberry Flavor Decrease Strawberry Pathogens?

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Cultivated strawberries (*Fragaria ×ananassa*) are known around the world for both their beauty and delicious flavor. Selection for flavor and disease resistance are both current breeding objectives, and may actually overlap in some cases. Previous reports have demonstrated that plant volatiles suppress growth of an array of fungal pathogens including *Colletotrichum* spp. and *Botrytis cinerea*. In the present study, we examined the in vitro effects of select strawberry volatiles on *C. acutatum*, *C. gloeosporioides*, and *B. cinerea* growth. We have focused specifically on methyl anthranilate and structurally similar compounds including the fungicide Dichloran. Methyl anthranilate produces a favorable "sticky sweet" flavor and is the key volatile of concord grapes. Methyl anthranilate is absent in most octoploid strawberry genotypes and yet has positive organoleptic properties. Our results show that methyl anthranilate is able to slow fungal growth *in vitro*. Its activity is approximately 10 times less effective than Dichloran, a structurally similar compound, at controlling fungal growth. Another similar compound is anthranilic acid which differs from methyl anthranilate by a single methyl group. Methyl anthranilate is >5 times more effective than anthranilic acid at controlling fungal growth. The results indicate that methyl anthranilate and other volatiles may have anti-pathogenic roles in vivo. By extension, they suggest possible benefits of using plant volatiles to control pathogenic fungi with less environmental impact, while at the same time enhancing consumer-desired flavor of the product. Most importantly, they define an opportunity to breed for flavor and at the same time possibly breed for resistance to disease.

Specified Source(s) of Funding: Univ. of Florida Plant Molecular Breeding Initiative Florida Strawberry Growers Assn.

10:30–10:45 AM

Evaluation of Fresh Dug Strawberry Plants as an Alternative Method of Establishing Hoop House (High Tunnel) Strawberry Crops in Oklahoma

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The use of fresh dug plants to establish hoop house strawberry crops has not been considered a viable option because plants are not available from the nursery until mid-October, a time generally considered to be too late to insure adequate plant size prior to the onset of winter. However, based on visual observation of a small planting of hoop house strawberry plants established from fresh dug plants in 2007, there appears to be potential for using fresh dug plants to establish hoop house strawberry crops in Oklahoma. Because they are less expensive, fresh dug plants have the potential for replacing plug plants as the establishment method of choice among Oklahoma hoop house strawberry growers. A 2-year study was contained to determine the feasibility of establishing hoop house strawberry crops using fresh dug plants compared to plug plants. Replicated trials included six strawberry varieties to determine total production as well as marketable production.

10:45–11:00 AM

Retrospective of Analysis of Cultivar Development in the Northeastern United States during the 20th Century

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The early American strawberry varieties were selections of the small fruited species *F. virginiana*, known as the Scarlet strawberry, and at least 30 varieties were available by 1820. The introduction of the much larger fruited *F. ×ananassa* varieties (Pineapple strawberry) from Europe quickly became the dominant strawberry grown. During the early stages of cultivar development, the improvement of size was a priority, but increasingly important were characters such as disease resistance and fruit characteristics (i.e., flavor, firmness, color) all of which remain a priority today. By the early 1900s, breeders were focused on developing cultivars for a particular region due to the specific conditions of the area; this regionality of cultivar development continues today. In the northeastern United States, strawberries are produced in a perennial system, and therefore, disease resistance has been a primary focus of breeders who have successfully developed several cultivars with resistance to many of the common diseases in the region. As a result, breeding for high yield has been more challenging compared to breeders developing cultivars for an annual system which is primarily focused on fruit size, firmness and yield. The objectives of this study were to evaluate some of the top cultivars that have been released in the northeastern United States. during the past century for yield, fruit quality, and photosynthetic performance.

11:00–11:15 AM

Thornless Blackberry Production in High Tunnels

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Thornless blackberries do not perform consistently in the Northeast. This has been attributed to both cold mid-winter temperatures and fluctuating spring temperatures. We have grown four cultivars of blackberry in a four-season high tunnel for six consecutive years, and with the exception of one year when we experienced rabbit damage, production has been several-fold higher than adjacent blackberries grown outdoors. Mid-winter temperatures and temperature fluctuations are not much greater inside compared to outside the tunnel, yet yields are much higher inside. Yields of 'Chester', 'Doyle', 'Triple Crown', and 'Ouachita' increased for each of the first 4 fruiting years, then decreased slightly. Fruit size, ther percentage of marketable fruit, and length of harvest were almost always higher in the tunnel than outside. High tunnel yields approached 40,000 kg/ha with 'Chester' in the fourth fruiting year. Disease and insect problems were few. The biggest challenge is cane management and trellising as primocanes can grow several meters in length inside the tunnels. Experiments are underway to better determine how to manage such excessive primocane growth. An economic analysis of blackberry production was conducted, and showed that establishment costs were covered by the fifth year, and subsequent years could net a grower several thousand dollars per 9 × 30 m tunnel.

11:15–11:30 AM

Methods for Producing Long-cane Blackberry Plants

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U.S. blackberry (*Rubus*) growers need to find ways to expand market share by entering specific niches. Production of blackberries in off-season is one desired approach. However, with the high investment for protected cultivation systems, yield in the first year of production is desirable to obtain a quick return on the investment. A variety of techniques and vegetative materials have been used to asexually propagate blackberries. We used a unique trellis and cane training system to propagate 2-m-long cane plants with roots at the distal end and 4-m-long looped cane plants with roots at both ends. The new propagation system increased plant output five- to seven-fold over the current commercial propagation technique. By inducing root formation at both ends of 4-m-long primocanes, percent budbreak, number of flowering shoots per m cane length, and number of fruit per cluster were increased. The long-cane plants can be established in a warm area, such as southern Florida, in late winter to obtain a crop in March and April. For late season fruit production, plants are held in cold storage until summer and then grown in a warm environment so that the fruit matures from August to October. This new propagation method is efficient for producing a large number of blackberry plants that can be manipulated to produce fruit in the off-season and is therefore useful to both growers and nurserymen wishing to produce container plants for off-season fruit production.

Specified Source(s) of Funding: USDA–ARS

11:30–11:45 AM

Bed Fumigation for Preplant Management of Soilborne Pathogens and Nematodes in Raspberry Fields

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Raspberry growers in Washington frequently fumigate soil before planting to reduce soilborne pathogens and nematode populations during plant establishment. The EPA's new soil fumigant reregistration eligibility decisions will affect use of most common soil fumigants, and include the establishment of buffer zones, areas excluding all but workers and handlers involved in the application. Structures within buffer zones may not be inhabited, but many berry fields are near or adjacent to homes. Buffer zones size can be substantially reduced by fumigating planting beds only and covering fumigated beds with an impermeable tarp. However, the long-term efficacy of bed fumigation in preventing re-colonization of treated areas by soilborne pathogens and nematodes is unknown. Five trials were established in commercial raspberry fields to compare bed and broadcast fumigation. Trials were established in randomized complete blocks, with 3 or 4 replicate blocks; one was non-replicated. In four trials, bioassays for the root rot pathogen *Phytophthora rubi* in the first year of growth indicated that soil from bed fumigated plots had no more *P. rubi* than that of broadcast fumigated plots. In the remaining trial, the bed fumigated plots had significantly ($P < 0.05$) less root rot than the broadcast fumigated plots. Root lesion nematode (*Pratylenchus penetrans*) population densities in bed-fumigated plots were lower than those in broadcast-fumigated plots in one trial ($P < 0.05$), and were statistically similar in all other trials. Plants in bed fumigated plots were more vigorous than those in the broadcast fumigated plots in one trial, and had the same vigor as the broadcast fumigated plots in the other trials. These first year results suggest that bed fumigation supports raspberry establishment as well as broadcast fumigation, with greatly reduced buffer zone size.

Specified Source(s) of Funding: USDA–RAMP and the Northwest Center for Small Fruit Research

11:45–12:00 PM

Assessing the Damage Potential of Root Lesion Nematodes on Red Raspberry Varieties

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Washington State is the nation's largest producer of red rasp-

berries for processing. The root lesion nematode, *Pratylenchus penetrans,* which feeds on fine roots, is a major constraint to the industry, shortening the productive lifetime of many plantings. Current management of *P. penetrans* relies upon preplant soil fumigation, but federal regulation of soil fumigants has made this practice increasingly more difficult and expensive for growers. In addition, few post-plant nematode management options exist. To guide the management this nematode in the future a better understanding of the damage potential of this nematode to raspberry needs to be determined. The objective of this project was to determine whether several popular raspberry varieties, 'Meeker', 'Cascade Bounty', 'Saanich', and 'Cheminus' differ in their susceptibility to *P. penetrans*. Field trials in established plantings of these varieties were established in northern Washington. Treated plots were sprayed with a combination of two nematicides oxamyl and fosthiazate, while non-treated plots received no nematicide. *P. penetrans* population densities in soil and root samples were assessed Spring and Fall 2011. *P. penetrans* populations in nematicides treated plots were consistently lower than those in non-treated plots at the fall sampling. In Summer 2011, yield of nematicide treated plots was not significantly higher than yield from non-treated plots in all trials. In Dec. 2011, destructive plant samples were collected from one of the trials. Plants from nematicide treated plots had a greater amount of fine roots biomass (root diameter< 8 mm) than plants from non-treated treated plots ($P < 0.05$), while woody root biomass (> 8 mm) was not significantly different between nematicides treated and non-treated plots.

Thursday, August 2, 2012 Windsor

Crop Physiology

Moderator: Leo Gene Albrigo
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10:15–10:30 AM

Physiological Responses of Flooded Avocado (*Persea americana* Mill.) Trees to Leaf Removal

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Periodic flooding occurs in many areas where avocado (*Persea americana* Mill.) trees are commercially grown. This depletes oxygen from the root zone which can result in severe tree stress or death. Removing a portion of the canopy has been recommended for rehabilitating flood-damaged avocado trees. Preliminary studies with plants in containers have shown that removing a portion of the canopy immediately after flooding reduces stress and increases tree survival, whereas removing a portion of the canopy shortly before flooding increases flooding stress. Our hypothesis is that, leaf removal prior to flooding decreases carbohydrate production and transport to the roots due to a reduction in photosynthesizing area, resulting in reduced root respiration and increased stress of flooded plants. To test the effects of decreasing photosynthesis on stress and recovery of flooded avocado trees, we compared net CO_2 assimilation (A), stomatal conductance (g_s) and growth among avocado trees with: 1) two-thirds of their leaves removed one day before flooding; 2) no leaves removed but sprayed with Freeway®, a chemical adjuvant that inhibits photosynthesis, one day before and during flooding; and 3) non-treated control trees. Leaf removal or Freeway® application resulted in significantly lower A, g_s and plant dry weights for flooded trees compared to the control treatment (no leaves removed and not sprayed). In another experiment, we compared A, g_s, and root carbohydrate concentrations between flooded trees with either two-thirds of their leaves removed one day before flooding, or no leaves removed. In addition to reducing A and g_s, leaf removal prior to flooding resulted in lower total carbohydrate concentrations in roots of flooded trees compared to those with no leaves removed. These observations support the suggestion that increased flooding stress as a result of leaf removal immediately before flooding may be related to a reduction in net CO_2 assimilation and carbohydrate transport to the roots.

10:30–10:45 AM

Flowering Gene Regulation in *Citrus sinensis* during Floral Bud Induction and Initiation: Water Deficit Effects

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Citrus trees were induced to flower by either exposure to low temperatures or water deficit. In the last decade, several genes considered to be involved in the regulation of flowering have been isolated and their expression characterized in response to low temperature in Citrus. However, reports on the effect of floral-inductive water deficit on the expression of flowering-related genes are lacking. In this work, the patterns of transcript accumulation of 4 flowering-related genes (CsFT, CsSL1, CsAP1, and CsLFY) from *Citrus sinensis* were characterized during floral induction by water deficit. Exposure to water deficit increased the accumulation of CsFT in leaves whereas transcript levels of CsSL1, CsAP1, and CsLFY were slightly reduced for the duration of the treatment. However, when the water deficit was relieved, the accumulation of CsFT decreased sharply; and conversely, accumulation of CsSL1, CsAP1, and CsLFY transcripts increased. When floral-inductive water deficit and floral-inductive temperatures occurred at the same time, the increase in accumulation of CsFT, CsAP1, and CsLFY was larger than when water deficit occurred at non-floral inductive temperatures or at floral-inductive temperatures in well-watered

trees. These results indicate that floral-inductive water deficit and low temperatures cause a similar response in the accumulation of transcripts of flowering-related genes suggesting that these genes could be ultimate targets of flowering signals initiated by both environmental stimuli that promote flowering in *C. sinensis*. Furthermore, in other species, these genes are key regulators of flowering in response to changes in photoperiod, vernalization and developmental age, suggesting that these genes could have evolved in plants to respond to a wide variety of flower-promoting signals from the environment. Responses of these genes in orange trees to gibberellins and day/night alternation will also be described.

Specified Source(s) of Funding: University of Florida

10:45–11:00 AM

Factors Affecting Early Cone Development in Fraser Fir

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Plantation-grown Fraser fir Christmas trees produce cones at a much younger age than those in natural stands. Cone-removal is expensive for growers, but cones left to grow consume tree resources and leave behind unsightly stalks and resin. We adopted a comprehensive approach toward understanding and reducing precocious coning in Fraser fir trees. We randomly selected 25 trees from same-age plots at 10 farms representative of the diversity of environmental conditions and cultural practices in Michigan. We obtained climate data from a state-wide automated weather network (Enviro-weather) and measured tree height and number of cones at the beginning of the season, and leader growth weekly throughout the season. We analyzed soil samples for pH, texture, and nutrient content, and foliar samples for nutrient content and C13 discrimination. We also compared paired plots of heavy and low coning areas at three individual farms. At one farm, we applied plant growth regulators to 50 trees to determine their effectiveness at chemically controlling coning. To quantify the effects of cone production on vegetative growth, we picked cones from eight large trees and left cones to grow on eight similar trees in one plot, and measured bud density and shoot and needle length at the end of the season. We also established irrigation studies at two sites to examine the effect of irrigation on cone development. Across state-wide locations, maximum temperature, precipitation, radiance, PET, C13 discrimination, foliar nutrition, soil nutrition, and pH showed little correlation with coning. Soil organic matter and clay content were inversely correlated with coning, and minimum air temperature was strongly correlated, suggesting that warmer nights and decreased soil moisture holding capacity might contribute to early cone development. In our paired plots comparing areas of heavy and low coning, minimum air temperature, C13 discrimination, soil organic matter, and clay content were inversely correlated with coning, consistent with moisture stress as a factor in cone development. We also noted correlations between cone development and nutrition. In our carbon partitioning study, shoots on picked trees were 22% longer than on unpicked trees at the end of the season. Bud density was 23% lower on picked trees. Understanding the factors influencing early cone development and the impacts of cone development on tree growth will enhance our knowledge of tree maturation and assist growers in making cultural management decisions.

Specified Source(s) of Funding: MSU Project GREEEN, Michigan Christmas Tree Association, John L. Arend Excellence in Graduate Student Research Endowment

11:00–11:15 AM

Roles of Starch and Sorbitol in Apple Leaves and Stems under Water Stress and Crop Load Combinations

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Apple (*Malus* ×*domestica* Borkh.) grown in a Mediterranean climate depends on regular irrigation throughout the growing season. The objective of the current study was to elucidate the roles of major carbohydrate components in mature, field-grown apple trees in response to water availability and crop load. Fourteen-year-old 'Golden Delicious' apple trees were grown under various combinations of irrigation rate (11, 33, or 77 L/day per tree) and crop level (~100, ~300, or >1000 fruit per tree), beginning 47 days after full bloom (DAFB). In a second experiment, similar 'Golden Delicious' trees with high (>1000 fruit per tree) or low (<200 fruit per tree) crop loads were irrigated at 77 or 11 L/day per tree). Fruit count and weight, photosynthetic assimilation, stomatal conductance, midday stem and leaf water potentials, osmotic potential and concentrations of non-structural carbohydrates in leaves and stems were determined. Leaf and stem starch contents were positively related to irrigation rate and negatively related to crop level. Mean fruit weight at harvest was positively related to stem starch content and neared maximum at a content of 4% dry weight. Starch content recovered after harvest, especially in water-stressed trees. Sorbitol concentration was inversely related to both irrigation

rate and crop level. Sorbitol in leaves averaged at 366 and 618 mmol·Kg^{-1} in high and low irrigation regimes, respectively, implying the existence of an osmotic modification mechanism in apple. In average, soluble carbohydrates accounted for 96% of leaf osmotic potential with sorbitol alone accounting for 70% to 80% of this term. Stem starch content appears to represent the overall balance between carbon sources and sinks and may therefore be used as a reliable indicator of photo-assimilate availability for vegetative and reproductive growth in apple trees. Sorbitol, on the other hand, serves a dual role in apple trees, both as a primary agent of carbon translocation and as an efficient osmotic regulator. The competition between those two processes is exacerbated in heavily cropping, deficiently irrigated trees. *Specified Source(s) of Funding:* Supported by funds of the Israeli Ministry of Agriculture

11:15–11:30 AM

Different Wavelengths of LED Light Affect Plant Photosynthesis

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Light emitting diodes (LEDs) are an emerging versatile artificial light source offering many advantages over conventional artificial light sources, including high energy efficiency, long life, and especially the possibility to test out the effects of many different spectral combinations of wavelengths on plant growth and development. This could eventually allow determination of the ideal light emission spectrum for optimal plant growth, allowing for lighting system designs tailored to optimize plant growth while minimizing associated energy costs. The impact of the photosynthetic rate of two plant species under different wavelengths of LEDs is determined in this study. The photosynthesis rate verse LEDs at different wavelengths was analyzed. The 14 specific wavelengths of LED (405, 417, 430, 450, 470, 501, 520, 575, 595, 624, 633, 662, 680, and 700 nm) and 3 plants (tomato, lettuce, and petunia) were used in this study. The 14 specific wavelengths of LED were determined based on the unit design, LED availability and pigment absorption spectra. The LED array was controlled (current controlled) using a single channel controller to produce uniform intensity of specific wavelengths of light over the PAR spectrum. Specifications of the controller is a 24VDC, 2.0A maximum, 48 watt unit with current selected and displayed (0°1.92ADC), automatic voltage control. The intensity of the LED lighting system was calibrated and measured before and after the test at canopy level using a spectroradiometer to determine wavelength width, intensity, and any changes that may occur during the test. The LED lighting system irradiated the plant with the carbon dioxide usage rate monitored until stabilization occurred (within 10 minutes). Carbon dioxide utilization rate was measured with the LI-COR LI-6400XT portable photosynthesis system, with photosynthesis rate normalized with leaf area. The plants were tested at irradiance levels consisting of 30 μmol·m^{-2}·s^{-1}. The measurements of tomato, lettuce, and petunia to redefine the photosynthetically active radiation (*PAR*) curve are included. From our research we found photosynthesis, absorbance, quantum yield and action spectrum peaks in the range of 417 to 450 nm and in the range from 630 to 680 nm. This research will facilitate the improved selection of LEDs in the *PAR* spectrum.

11:30–11:45 AM

Pre-harvest Application of Ethephon Enhances Skin Lignification and Increases the Force Required to Peel Sweetpotato Storage Roots

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Skinning in storage roots of sweetpotato [*Ipomoea batatas* (L.) Lam.] occurs during harvest and causes substantial losses in marketable products. Since there are reports that ethephon improves skinning resistance in sweetpotato, a field study was conducted to determine the association of pre-harvest application of ethephon with skinning resistance and the effect on skin lignifications. Beauregard (B-14) plants grown in the field were treated with foliar applications of ethephon or devined before harvest. Storage roots from treated plants were compared with roots from non-treated/non-devined plants (control). Root samples were taken periodically for analysis. At day 6 after treatment, all roots were harvested and cured in a chamber (29 °C and 85% RH). Roots samples were also taken after harvest and curing for analysis. Results showed that devining and ethephon treatment increased the force required to peel the root (skinning force). The skinning force in roots from ethephon treatment plants was slightly higher than devined plants. Skin lignin content had a similar pattern among treatments and was well correlated ($r = 0.89$) to skinning force. Skin phenolic contents were lowest in the ethephon-treated plants while untreated plants had higher phenolic contents. Our results suggest that although ethephon is applied to the foliage, it activates the production of skin lignin in the roots. Also skin lignification appears to be involved in skin toughening and skinning resistance.

11:45–12:00 PM

Reactive Oxygen Species in Interactions between Plants and Pathogens

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The production of reactive oxygen species (ROS) is one of the earliest cellular responses which mediating defense gene activation following successful pathogen recognition. The amount of extracellular H_2O_2 is produced depends on several factors including the nature of the elicitor, the plant species, and age or developmental stages of the plant cells. Several enzymes have been implicated in apoplastic ROS generation following pathogen recognition, i.e., reduced form of nicotinamide adenine dinucleotide phosphate (NADPH) oxidase, super oxide dismutase, oxalate oxidases, peroxidases, lipoxygenases and amine oxidases. ROS usually correlates with successful disease resistance responses however some pathogens may induce production of ROS to their own advantage. There are profound differences between monocots and dicots as well as in the biology of biotrophic, hemibiotrophic and necrotrophic pathogens. ROS acts synergistically in a signal amplification to drive the hypersensitive reaction (HR) and the establishment of systemic defenses. The role of ROS in successful pathogenesis, it is important to try to inhibit the cell death machinery selectively and simultaneously to monitor other defense and pathogenesis-related events. Avirulent pathogens successfully recognized via the action of disease resistance (R) gene products in plant immune system. However, virulent pathogens that avoid host recognition induce only the transient, low-amplitude first phase of this response, suggesting a role for ROS in the establishment of the defenses. Elicitors of defense responses, referred to as microbe or pathogen-associated molecular patterns (PAMPs), also trigger an oxidative burst. With the understanding of the molecular mechanisms underlying the localized activation of the oxidative burst following perception of pathogen avirulence signals and key downstream responses including gene activation, cell death, and long-distance signaling, novel strategies will be developed for engineering enhanced protection against pathogens by manipulation of the oxidative burst and oxidant-mediated signal pathways.

12:00–12:15 PM

Reactive Oxygen Species Levels of Some Apple Cultivars after Fire Blight Infection

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Erwinia amylovora, the causal agent of fire blight of Maloideae, induces in its susceptible host plants an oxidative burst as does an incompatible pathogen. The oxidative burst, a rapid production of reactive oxygen species (ROS) released into the apoplast, is described as one of the earliest responses to pathogen infection and is generally associated with hypersensitive reaction (HR). In this work, we examined the possible involvement of ROS in the initiation of infection of different apple cultivars by *E. amylovora*. The experiments were performed on apple seedlings (six to eight leaves) from apple cultivars (*Malus domestica* cv. Gala, cv. Golden, cv. Scarlet and cv. Braeburn) with M9 rootstock. Plants were grown in individual pots in the greenhouse at 25 ± 2 °C in 60% to 65% relative humidity under natural photoperiod. Completely folded the youngest leaves of plants were inoculated with highly virulent wild-type strain Ea 43b suspensions adjusted to a concentration of 10^8 cfu·mL^{-1} and sampled at various times for 24th and 72nd hours. Control plants were sprayed with sterile distilled water. Leaf tissues (0.5 g fresh weight) were homogenized in 1 ml of ice-cold 50 mm sodium phosphate buffer (pH 7.5) containing 1 mm polyethyleneglycol, 1 mm phenylmethylsulfonyl fluoride, 8% (w/v) polyvinylpolypyrolydone, and 0.01% (v/v) Triton X-100. Homogenates were centrifugated at 16,000*g* for 20 min at 4 °C and supernatants were immediately measured by a spectrophotometric method and determined hydrogene peroxidase (H_2O_2), ascorbate peroxidase (AsPOX), superoxide-dismutase (SOD), catalase (CAT), peroxidase (POX), proline accumulation and chlorophyll concentration levels. All experiments were performed with a minimum of three tissue sample replicates per time point. The data were statistically evaluated by ANOVA variance analyze and Duncan multiple range tests. Our results showed that a sustained production of ROS and its immediate consequences in plant tissues and the level of enzyme activities showed variability in different apple cultivars in comparison with control plants.

Thursday, August 2, 2012 **Tuttle**

Environmental Stress Physiology

Moderator: Jiwan P. Palta
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1:45–2:00 PM

Seedling Vulnerability to Abiotic Stressors: Recovery and Phenylpropanoids

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From germination, young seedlings can experience many abiotic stimuli in the environment. We have characterized how seedlings responding to abiotic signals may be influenced by products of the shikimic acid and phenylpropanoid pathway in young (0 to 6-day-old or to 8-day-old), completely dark-grown (etiolated) soybean, rice and other crop seedlings. One commonality for all seedlings is that the timing of stress and the concentrations of particular metbolites is critical to responses to abiotic stimuli, which were studied first in the model organism Arabidopsis in order to better study the genetics of the responses. Thresholds and responses to salt, chilling, heat, and different qualities of UV were studied, and the quantity of phenylalanine in the young seedling is of critical importance. In particular, we examined how the mtr1 mutant of rice responded to particular abiotic conditions and biochemical treatments. Particular developmental indicators in the young seedling of soybean were observed for electron microscopy, biochemical and whole plant phenotypes. Chemical constituents of the young leaves were different, as evaluated by absorbance spectra. For young soybean, stress and/or biochemically manipulated plants were used to evaluate the palatability of leaves to soybean pests in comparison to untreated/non-stressed young soybean.

Specified Source(s) of Funding: Illinois Soybean Association; National Science Foundation

2:00–2:15 PM

Xylem Sap Cytokinin Levels Change with Severe Water Stress in Containerized Citrus Nursery Trees

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This experiment was conducted to quantify the effect of water stress on xylem sap cytokinin content in container-grown citrus nursery trees. Trees of Hamlin sweet orange budded on Swingle citrumelo rootstock, were obtained from a commercial citrus nursery. The trees were re-potted in washed quartz sand in 2.65-L citra-pots and were acclimated for 8 weeks. Two sets of 90 trees each were subjected to three water stress treatments (30 trees per treatment): 100% evapotranspiration (ET) (control); 50% ET (mild stress) and 20% ET (severe stress) for 15 days. Stem water potential was measured every other day while photosynthesis measurements were taken on three different days spread across the experimental period. From the first set, five trees were destructively harvested every other day from each of the treatments for xylem sap extraction. To the second set, foliar application of benzyladenine (BA) was given for three consecutive days, starting at day 16 of stress treatments, and the trees were destructively harvested for sap extraction. The xylem sap (800 μl per tree) was extracted using a Scholander-type pressure chamber. Modified Beiliskey's Solution was added to the sap and the tubes were immediately frozen in liquid nitrogen. The sap samples were analyzed for dihydro-zeatin riboside (DHZR) levels by enzyme linked immunosorbent assay. The stem water potential decreased with the decreasing level of irrigation and with the increasing duration of water stress. The DHZR concentration showed no significant increase with mild water stress, but increased significantly under severe water stress. No correlation was found between foliar application of 100 ppm BA and the DHZR levels over the three day period. However, the trees under water stress showed relatively higher cytokinin levels as compared to the other trees which included the trees under 100% ET as well as those changed from 50% to 100% ET. The increase in DHZR concentrations may be attributed to a possible stimulation of cytokinin biosynthesis in the root-tips in response to the water stress. DHZR has earlier been reported to increase with water stress in other plant species. However, to determine the implication of altered cytokinin levels on the bud push and scion growth in citrus, the effect of water stress on cytokinin export and delivery rates must be explored.

2:15–2:30 PM

Exogenous Methyl Jasmonate Mitigates the Oxidative Damage in Cucumber Seedlings Subjected to Water Stress

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Drought tolerance is considered to be an essential element for cucumber (*Cucumis sativus*) production in arid climates, and it has been suggested that higher antioxidant activity could mitigate the oxidative damage caused by water stress. The study was aimed to investigate whether the exogenous application of methyl jasmonate (MJ) accelerates antioxidant activity and the resulting drought tolerance potential of cucumber seedlings. Cucumber seedlings (cv. Sambar), which are reported to have moderate drought tolerance were grown in greenhouse environment to evaluate the effects of MJ on the concentration of organic osmolytes (proline, glycinebetaine, amino acids) and antioxidant activity superoxide dismutase (SOD), peroxidase (POD), catalase (CAT), guaiacol peroxidase, and ascorbate peroxidase (APX). MJ was applied as a foliar spray (spray with

water as control and 4 mM MJ) and plants received irrigation to 50% (drought stress) and 75% (control) relative water contents RWC. The seedlings submitted to water stress showed a significant elevation in the leaf proline, glycinebetaine, amino acids, SOD, POD, CAT, GPX, and APX activities. However, exogenous MJ reduced the lipid peroxidation (LPO) and improved the membrane stability index (MSI) of water stressed seedlings. It was concluded that exogenous application of MJ as a foliar spray strengthened the antioxidant system and enhanced the osmotic adjustment potential of water stressed cucumber seedlings therefore potentially alleviating the oxidative damage caused by water stress.

Specified Source(s) of Funding: Higher Education Commission of Pakistan

2:30–2:45 PM

Genotypic Differences in Mobilizing Insoluble Phosphates by Potato Grown in Sandy Soil

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Crop production has been challenged by economic constraints, environment concerns and mineral resource depletion. Phosphorus (P), as a macronutrient, has involved in all of the above aspects. Potato is one of the widely grown crops over the world. It is imperative to improve P-use efficiency, reduce P fertilizer requirement, and minimize negative impacts on the environment. The morphological characteristics of potato are different between genotypes and play a key role in phosphate acquisition while grown under low P condition. An insoluble phosphate source, tri-calcium phosphate [$Ca_3(PO_4)_2$] was used to indentify P-efficient genotypes out of potato germplasm banks in hydroponics. In this research, different Ca concentrations were used to adjust the bioavailability of P in growing solution. Potato plants would need to either decrease the pH of the solution or uptake more Ca^{2+} in order to release the phosphorous from tri-calcium phosphate. We have found that increasing Ca^{2+} concentration results in decreasing plant size and increasing root/shoot ratio. In soil, most of the phosphates are presented as non bio-available forms, mostly bind with iron, aluminum or calcium. The effective mobilization of insoluble phosphates by elite potato genotypes will contribute to improving P use efficiency. To screen potato germplasm for P-efficient genotypes, 0% and 100% of recommended P rates were applied in a pot experiment at Hastings, FL. Chlorophyll content, photosynthesis rate and harvest index were evaluated upon seven potato genotypes.

2:45–3:00 PM

Foliar and Ground Application of Abscisic Acid to Increase Cold Tolerance in Citrus

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Freezes have led to tremendous economic losses to the fruit production industry in the United States either by direct death of trees and rotting of fruits or indirect losses caused by decreased fruit quality. In leaves, freezes form ice crystals that draw out the water inside the cells and make water unavailable to plant tissues as well as cause damage by disrupting cell membranes. Abscisic acid (ABA) is a hormone that is involved in the cold tolerance response of many plants. The application of exogenous ABA may alter ABA metabolism and induce cold tolerance. Two experiments were designed to test the efficiency of exogenous ABA applications in citrus: foliar and ground applications of the hormone. For the foliar experiment, our hypothesis was that the interaction between drought stress and foliar application of ABA to trees will result in an increase in cold tolerance since drought stress causes an accumulation of ABA inside the plant. For the ground application of ABA, our hypothesis was that it would optimize the efficiency of the hormone avoiding the use of high ABA concentrations. In the foliar experiment, four treatments were applied to 3-year-old grapefruit trees grown under greenhouse conditions. The treatments consisted in the combination of two irrigation regimes (drought stress, where trees were exposed to three weeks of continuous drought, and normal irrigation), and two concentrations of foliar ABA application (0 and 1 mM ABA). Significant differences in stem water potential were recorded between well-watered and drought-stressed trees, confirming differences in tree water status before the ABA application. Leaf samples were taken 3 days after the application and lethal freezing temperature was determined by exposing leaf samples to temperatures between 0°C and –12°C. Results showed that foliar application of ABA increased cold tolerance in grapefruit trees. Nevertheless, there was an interaction with tree water status since ABA application on drought-stressed trees increased cold tolerance more than on well-watered trees (2.3 °C vs. 0.5 °C). The ground experiment consisted of four concentrations of ABA: 0 ppm (control), 60 ppm, 125 ppm, and 250 ppm) applied to well-watered trees. In this experiment, lower concentrations of ABA (60 ppm) resulted in an increase in cold tolerance (1.0 °C vs. 0.34 °C) when compared to higher concentrations. The ground application proves to be of greater efficiency due to there was no need to have the trees at drought stress status to observe significant differences unlike with the use of foliar applications.

Specified Source(s) of Funding: This research was funded in part by the Rio Grande Basin Initiative USDA/NIFA award # 2010-34461-20677 and the Texas Citrus Producers Board.

3:00–3:15 PM

Electrical Signals in Walnut Trees in Relation to Soil Water Content and Vapor Pressure Deficit

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Several studies have shown that electrical signals in plants are a mechanism for communicating the detection of environmental stimuli, such as soil water content, air temperature or relative humidity, from the site of detection to more distant plant organs. Most of those studies were conducted with herbaceous plants and relatively little is known about electrical signaling in woody plants. Moreover, little is known about the relationship between the electrical signal strength and the intensity of the environmental variable. We measured electrical signals in young walnut (*Juglans regia*) trees in relation to soil water content and vapor pressure deficit (VPD) in a glasshouse. Trees were subjected to two irrigation treatments over a 3-day period: T1) one irrigation event per day, or T2) two irrigation events per day. The same quantity of water was applied during each irrigation event so that trees in T2 received twice as much water as trees in T1. The VPD in the glasshouse fluctuated naturally throughout the day. Soil content was continuously monitored with frequency domain reflectometry probes and VPD was recorded using a Hobo sensor/datalogger. The electrical potential (EP) was measured with three electrodes inserted into the trunk at 8.5, 32.5, and 37.5 cm above the soil surface. Electrical potential differences (ΔEP) between each set of electrodes were also recorded. Data were analyzed by Principal Component Analysis (PCA) and Partial Least Squares Regression (PLS), with the objective of quantifying the relationship between irrigation regime and VPD with respect to EP and ΔEP. PLS analysis to find correlations among EP and ΔEP, soil water content and VPD, showed that 79.3% of the variation in EP and ΔEP could be explained by changes in soil water content and VPD. Thus, multivariate analyses were useful for quantifying electrical signals in walnut trees produced in response to changing environmental conditions. The results also suggest that measurement of electrical signals has potential as a sensor system for quantifying physiological responses of walnut trees to environmental changes.

Specified Source(s) of Funding: Programa Fondecyt, Chile

3:15–3:30 PM

Comparative Studies on the Physio-biochemical and Ionic Responses of Three Avocado (*Persea*) Species under Salt Stress

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The physio-biochemical responses of *Persea gratissima*, *Persea americana*, and *Persea nubigena* were investigated in response to NaCl stress (0, 3, 6, 9, and 12 $dS \cdot m^{-1}$) in hydroponics. Growth (shoot/root fresh and dry biomass, leaf area, number of leaves), cell membrane stability index (CMSI), photosynthetic activity (*A*), stomatal conductance (gs), number of stomata (NS), chlorophyll contents (chl), ion accumulation (Na^+, Cl^-, K^+, Ca^{2+}), electrolyte leakage (EL), lipid peroxidation (LPO) and antioxidant enzyme activities (SOD, POD, CAT) were measured 15 days after salinity treatment. Salt stress significantly reduced the all above mentioned attributes in tested *Persea* species except Na^+, Cl^-, LPO and antioxidant activities, which were elevated under saline regimes. Of the three species *P. americana* exhibited the least reduction in plant biomass, leaf area, CMSI, *A*, gs, NS, chl, K^+, Ca^{2+}. Similarly, *P. americana* had the least LPO and EL values and maximum antioxidant activities as compared to the other two species. The high CMSI and low LPO and EL in *P. americana* indicates that this species had the lowest salinity-induced membrane injury under NaCl stress, thus representing its high salt tolerance ability. The reduction in the gas exchange attributes (*A*, gs, NS) was highly correlated with LA, and leaf Na^+ and Cl^- content in tested *Persea* species. Although Na^+ and Cl^- content increased in both roots and leaves with increasing salt stress, the accumulation of these two ions in *P. americana* shoots was lower than in the other two species. Likewise *P. americana* exhibited the greatest leaf K^+, Ca^{2+} contents under increasing salinity. *P. americana* had the greatest Na^+ and Cl^- content in roots as compared to the other two species, which may be an adaptation to stop the movement of toxic ions to upper plant parts. *P. americana* showed the highest SOD, POD, CAT activities at all salinity levels as compared to the *gratissima* and *nubigena* species. The findings of the current investigation represent that among the investigated *Persea* species, *P. americana* was more salt tolerant than *P. gratissima* and *P. nubigena* to NaCl salinity. The relative salt tolerance of *P. americana* was associated with the higher Na^+ and Cl^- exclusion capacity via roots and

An asterisk (*) following a name indicates the presenting author.

the increased antioxidant activities, which ultimately enhanced the osmotic adjustment potential of plants under stressed conditions.

Specified Source(s) of Funding: Higher Education Commission of Pakistan

3:30–3:45 PM

Response of Two Tomato Cultivars to NaCl Stress in the Presence and Absence of Mycorrhiza

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To investigate the beneficial effect of mycorrhizal symbiosis on plant under saline conditions, two tomato cultivars; i.e. Castle Rock; relatively salt-sensitive, and Super Strain B; relatively salt-tolerant, were sown in mycorrhiza-inoculated autoclaved soil mixture (2 composted field soil: 1 sand: 1 perlite v/v/v). Seedlings were grown for 21 days before transplanting to 5 L pots containing the same autoclaved soil mixture. Non-mycorrhizal treatments had an autoclaved inoculums. Salinity treatments were started after 2 weeks of establishment stage. Salinity levels were adjusted by adding 7.4 and 14.28 mg NaCl to the soil mixture in each pot to achieve 6.0 and 10 $dS \cdot m^{-1}$ in soil saturated paste extract, respectively. Control soil had 1.7 $dS \cdot m^{-1}$ salinity level. Each plant was given 25 mg of soluble fertilizer (NPK; 20:20:20) every week and irrigated with water to maintain adequate moisture. Leachate from each pot was collected and added back to soil in the same pot. The growth temperatures were 25/18 °C day/night with 16 hours photoperiod at PAR ranging from 550–650 μmol photon $min^{-2} \cdot s^{-1}$. The plants were grown in four replicates for a month before sampling and harvesting the shoots. Growth parameters including fresh weight, dry weight and plant height were recorded. Samples taken from the third fully expanded terminal leaf from the top of the plant were tested for ion leakage. All growth parameters were reduced by the higher salinity levels in both cultivars. However, the sensitive cultivar was more dramatically affected than the tolerant cultivar. Preliminary results suggest that the influence of mycorrhiza is complex; only in tolerant cultivar, mycorrhiza seems to have overall positive effect on growth. At high salinity level, there seems to be no positive effect of mycorrhiza on either of the cultivars. The negative impact of salinity was reflected in higher ion leakage from leaf tissues in both the cultivars. Furthermore, the mycorrhizal plants had lower ion leakage in both the cultivars.

Specified Source(s) of Funding: Funded by the Egyptian government and partially by the University of Wisconsin–Madison.

Thursday, August 2, 2012 Concourse 1

Ornamental Plant Breeding

Moderator: Neil O. Anderson
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2:00–2:15 PM

Utilizing CT Technology to Answer Unsolved Questions in Ornamental Tree Root Research

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Direct observations of finest root morphology are inherently difficult because of the opaque and heterogeneous nature of soil matrices. Moreover, direct measurements of root morphology traditionally involve destructive harvesting of root material, or root visualization along a two-dimensional surface. Advances in recent x-ray computed tomography (CT) scanning technologies have yielded improvements in image resolution, but there are still many opportunities to authenticate, improve, and apply CT for use in root research and potted plants in particular. My lab's research demonstrates the use of CT for answering multiple questions at different scales. I will discuss two projects utilizing CT technology to answer relevant belowground inquiries including micro-CT for quantifying fine root growth as a function of neighbor identification and the adoption of large scale CT scanning systems capable of accommodating larger ornamental trees for root system distribution and growth analysis in a nursery mix substrate in pots. Multiple medical imaging software packages were utilized to stack the sequential CT scans, effectively increasing the visible rooting volume and depth to improve image analysis of root growth and belowground competition. Individual root identification was performed manually and semi-automated during image analysis as a means of increasing image processing speed while maintaining accuracy. These two studies represent the first in situ, non-destructive comparison of a) root neighbor interactions between two tree seedlings and b) tree root growth over time on whole root systems of 10 maturing tree species.

Specified Source(s) of Funding: USDA–SCRI President's Council of Cornell Women

2:15–2:30 PM

Breeding in the Private Sector versus Academia: Objectives and Challenges

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Objectives of academic breeders have traditionally focused on identifying genetic relationships, developing new protocols, and publishing results that aid the advancement of science. Scientific rigor, process, and findings take priority over the end product. In contrast, private sector breeding is primarily product driven

and is focused on developing superior commercial varieties. Differences are also seen in the career and work environment of academic versus private sector breeders. The academic breeder is faced with publication pressure, limited resources, and appointments that are multi-faceted in nature. In the private sector, challenges include the need to meet market expectations faster than your competition and manage numerous projects simultaneously. However, the private sector provides superior financial and labor resources and allows the breeder to focus solely on breeding. Despite the above differences a synergy exists between the two sectors. With the increasing demand for better commercial varieties, the science-based academic breeding programs have an increasing impact on the private sector. Examples include progress in tissue culture and marker assisted breeding. In addition, the public sector plays a crucial role in educating and training scientists for industry.

2:30–2:45 PM

Disease Resistance Gene Candidate Sequences in Gerbera: Cloning, Characterization, and Utilization for Molecular Marker Development

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The most common class of disease resistance genes (R genes) in plant genomes seems to be the nucleotide-binding site leucine-rich repeat (NB-LRR) class genes. High levels of sequence conservation in this class of R genes have enabled the designing of degenerate primers for PCR amplification of resistance gene candidate (RGC) sequences from numerous plants. In this study, eight combinations of reported degenerate primers were used to amplify RGCs from gerbera. Out of 172 fragments sequenced, 84 were RGC sequences containing the typical motifs of the NB domain of the NB-LRR R genes. Twenty-eight representative gerbera RGC sequences were selected for further analysis, and they were clustered into nine groups, designated as RGC1 to RGC9, respectively. RGC1 to RGC4 belong to the TIR (Toll interleukin receptor)-NB-LRR subfamily, while RGC5 to RGC9 to the CC (coiled coil)-NB-LRR subfamily of plant NB-LRR R genes. Specific primers designed from 15 of the RGCs detected polymorphisms, following restriction enzyme digestion, between the gerbera breeding line UFGE 4033 and the gerbera cultivar 'Sunburst Snow White', parents of two mapping populations that were created for locating and mapping genes for powdery mildew resistance in gerbera. When used with four random primers designed for the target region amplification polymorphism marker system, RGC-derived specific primers revealed additional polymorphisms between the two parents. Our results indicate that RGC sequences can be very useful and valuable in multiple ways for molecular marker development.

Specified Source(s) of Funding: University of Florida/IFAS, the Fred C. Gloeckner Foundation, Inc., and the China Scholarship Council.

2:45–3:00 PM

Limiting Invasive *Ruellia* Populations via Breeding Sterile Cultivars and Developing Efficient Control in Natural Areas

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Ruellia simplex (also known as *R. brittoniana*, or Mexican petunia) has profuse flowering and low maintenance requirements, and is a popular landscape plant in southern U.S. However, this introduced plant has escaped cultivation and become invasive in natural areas in Florida and other Southern states. Currently 'Purple Showers' with tall habit and purple flowers is the only sterile cultivar. Our objective was to develop sterile cultivars in other flower colors such as pink, white, white with a purple corolla tube; and potentially different growth habits such as tall, semi-dwarf, and dwarf. Breeding techniques utilized ploidy manipulations, irradiation, and interspecific hybridizations. This approach was coupled with efforts to control invasive populations in natural areas. Tetraploid *R. simplex* plants in four flower colors were obtained by treating diploid plants with oryzalin, and mutant plants were obtained by irradiation treatments. Hybridizations were performed between tetraploid and diploid individuals in both directions, as well as between other interploidy combinations, morphotypes and different species of *Ruellia*. Seeds from selfing tetraploid individuals and mutants were also collected. All seeds were sown in 2010, resulting in 495 seedlings. Initially progenies were grown in a greenhouse at Gainesville, FL. Plants were selected for female sterility and lack of fruit formation, and their ploidy levels were determined by flow cytometry. A total of 15 selected breeding lines and five commercial cultivars as controls were evaluated in replicated field trials located in northwestern, north central and southeastern Florida. Breeding lines were evaluated monthly from May to October 2011 for landscape performance, flowering and fruiting. Three breeding lines have potential as new cultivars for the plant industry and have been evaluated for female and male fertility. Plants will be maintained for over one year to also evaluate winter hardiness and vegetative spread. In addition to controlling Mexican petunia indirectly by developing non-invasive alternatives, direct control methods in natural areas were also evaluated. Using twelve 3 m × 3 m plots, treatments included four levels of aquatic-labeled glyphosate herbicide application frequency (0, 1, 2, or 3 herbicide applications) and two application seasons (spring and fall). Results showed that glyphosate treatments reduced Mexican petunia cover in this floodplain forest wetland,

but that season of spray treatments and application frequency had no effect.

Specified Source(s) of Funding: USDA–TSTAR

3:00–3:15 PM

Inheritance Study and Molecular Marker Development for Powdery Mildew Resistance in Gerbera

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Gerbera (*Gerbera hybrida*) is an important floricultural crop in the United States and worldwide. Powdery mildew (PM) is the most common and destructive disease in gerbera production and landscape use. The primary causal agent of this disease in the southern United States is *Podosphaera fusca*. Previously two sources of PM resistance were identified out of 2,000+ gerbera lines screened in central Florida. The PM resistance has been transferred into a number of advanced gerbera breeding lines and new cultivars. One of the resistant lines (UFGE 4033) was crossed reciprocally with a susceptible cultivar ('Sunburst Snow White') and two segregating populations were created. Progeny of these populations (110 in total) were evaluated in 2011 and again in 2012 for resistance to PM. The distribution of PM resistance based on PM-infected leaf area and the area under disease pressure curve (AUDPC) among the progeny in both years was continuous but with two peaks. Thus the phenotyping data suggest that the PM resistance is quantitative in nature but with major genes contributing to the resistance. Bulked segregant analysis was performed using the target region amplification polymorphism (TRAP) marker system to develop molecular markers for the major genes. Screening 415 primer combinations and more than 14,000 DNA bands resulted in the identification of nine DNA bands that were polymorphic between UFGE 4033 and 'Sunburst Snow White' and between the PM-resistant and the PM-susceptible segregant bulks. The nine DNA markers were mapped to one genetic linkage group, and one region of the linkage group defined by three markers accounted for 51.5% to 70.7% of the variance in PM resistance in the two segregating populations. These results indicate the identification of a major gene responsible for PM resistance in gerbera.

Specified Source(s) of Funding: University of Florida/IFAS; the Fred C. Gloeckner Foundation, Inc.; the China Scholarship Council.

3:15–3:30 PM

Field Evaluation of Heat Tolerance in Rose

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Roses generally experience a decrease in flower productivity and size in response to summer temperatures greater than 30 °C, which is common throughout the southern states of the U.S. In 2011, the August mean and mean maximum temperatures in College Station, TX, were about 40 °C and 32 °C, respectively. Under these extreme heat stress conditions, large rose germplasm collections in two field trials in Texas were evaluated for flowering intensity which takes into account both flower number and flower size. Of the 600 accessions evaluated, 20 (3%) showed excellent flower intensity and 86 (14%) showed good to very good flower intensity during August. Among those that showed excellent flower intensity during the heat stress were 'Baby Jane Clare', 'Lady Ann', 'Ring of Fire', 'Little Emma' and various breeding selections. Cultivars such as 'Homerun', 'Knockout', 'Robi', 'Alburquerque Enchantment', 'Julie Link', 'Orange Parfait', 'Woodstock', 'Saint Mary', and 'Green Ice' showed good to very good flower intensity during the summer heat. This preliminary evaluation indicates that developing rose cultivars that flower well in the summer months is possible.

3:30–3:45 PM

Heritability of the Groundcover ('wave') Plant Habit in Garden Chrysanthemums

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The success of the 'wave'™ petunia phenotype in the bedding plant market created widespread interest among flower breeding programs to create 'me, too' *Petunia* products. Soon thereafter, other crops were bred and promoted with this trait, e.g., *Calibrachoa, Begonia*. Garden chrysanthemums (*Chrysanthemum* ×*grandiflorum, C.* ×*hybridum*) are no exception. For the past 20 years, the University of Minnesota garden chrysanthemum breeding program has focused on an adaptable wave or groundcover phenotype. The objective of this study was to determine the heritability of this phenotype within the elite, selected parents and cultivars in the 80-year-old germplasm bank. Groundcover and non- groundcover parents (cultivars, inbred and noninbred selections) within the major flower color classes (red, purple/pink, bronze, yellow, white) and with the best combining ability (fertility, seed production, yield potential) were used to create hybrid populations for inheritance studies. Groundcover × groundcover and groundcover × non-groundcover crosses were performed, with ten replications (seed heads) per cross. Due to low seed set, crosses within color classes and cross types were pooled for analysis. Fertility (seed production), % germination, % yield potential, % flowering, and plant habit (groundcover

vs. non-groundcover) were assessed. Chi-square ratios, 1:3, 3:1, or 1:1 (groundcover:non-groundcover), were calculated to determine the genetic control. Seed set within the same flower color classes varied from 7 to 218. Percent germination ranged from 28.9% (red groundcover × groundcover) to 80.6% (pink/lavender groundcover × groundcover). Yield potential was lowest with pink/lavender groundcover × non-groundcover crosses (8.3%), while the highest was 79% for the same color class, groundcover × groundcover crosses. Percentage of flowering varied as well (6.5% to 94%). Surprisingly, several yellow groundcover × non-groundcover crosses with a specific parent in common produced 100% groundcover progeny. However, no groundcover × groundcover crosses produced 100% groundcover progeny. The groundcover habit is not due to a single gene and allelic configuration (homozygous recessive, heterozygous or homozygous dominant), but is most likely the result of many genes. This complicates obtaining groundcover progeny for continued breeding and selection.

Thursday, August 2, 2012 **Windsor**

Herbs, Spices, and Medicinal Plants

Moderator: Jules Janick
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2:00–2:15 PM

Comparative Analysis of Essential Oil Contents of Tuberose (*Polianthes tuberosa*) by Supercritical Fluid Extraction (SFE) Method Grown at Different Regions

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A research project was carried out with the objective of comparing the composition and quantity of essential oil of *Polianthes tuberosa* obtained from two different regions, i.e., Pattoki and Faisalabad. To avoid volatilization losses the flowers were collected in the morning time and after preparation, the oil was extracted through supercritical fluid extraction method using CO_2 as the solvent. The quantity of oil obtained, differed in both cases as more oil was obtained from flowers of Pattoki region and less oil was obtained from flowers of Faisalabad region. The difference in the yield of essential oil of both regions was due to the variation in temperature, seasonal rainfall, wind speed and humidity of both regions. The quantity of absolute oil obtained from flower of Pattoki region was 3 g per 20 Kg of tuberose samples while in case of Faisalabad region was only 2 g per 20 Kg of tuberose. Physical and chemical analysis like color, refractive index, optical rotation, congealing point, acid number, ester number, etc., were different in both cases. The comparison of the chemical composition of oils revealed significant differences among the quantities of all components in both oils.

2:15–2:30 PM

Relation of the *Juliana Anicia Codex* and the *Codex Neapolitanus*: Ancient Greek Illustrated Dioscoridean Herbals

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The Greek pharmacopeia of Pedanius Dioscorides (20–70 CE), entitled *Peri Ylis Ialikis* (latinized as *De Materia Medica*, On Medical Matters) was written about the year 65. It was destined to be one of the most famous books on pharmacology and medicine but is also rich in horticulture and plant ecology. An illustrated alphabetical version of Dioscorides' manuscript was completed in Constantinople about 512. This magnificent volume was prepared and presented to the imperial Princess Juliana Anicia (462–527), daughter of the Emperor Anicius Olybrius, Emperor of the Western Roman Empire. The bound manuscript (stored in the Osterreichische Nationalbibliothek in Vienna) is available in facsimile and is now referred to as the *Juliana Anicia Codex* (*JAC*) or the *Codex Vindobonensis Dioscorides*. The *JAC* contains 383 paintings of plants including many horticultural crops, many of which can still be recognized in modern day examples. An analysis of the illustrations indicates that they were made by numerous artists of varying skills and it is probable that some were derived from an earlier lost version. The *Codex Neapolitanus (NAP)* (late 6th or early 7th century), which now contains 406 plant images on 172 folios resides in the Biblioteca Nazionale, Naples, is closely related to *JAC*, and is also available in facsimile editions. A comparison of the 352 common illustrations contained in both *NAP* and *JAC* suggests that many of the illustrations derived from a common source, perhaps an illustrated collection owned by Theodosius II, but the possibility also exists that some of the *NAP* images are direct copies of *JAC* images. There are 31 images in *JAC* which do not appear in *NAP*, 1 is a 13th century addition, 4 are images that can be assigned to 2 torn pages. and 26 can be assigned to 11 missing leaves of the *NAP*. Of the 54 images in *NAP* that do not appear in *JAC*, 2 are likely to have been *Mandragora* included in lost folios in *JAC*, but the other 52 may include other images that existed in the common source. While common images in *NAP* and *JAC* are often very similar, 11.6% show substantially differences including variants of the same plant

in different stages. Additional images in the archetypic source including different stages of the same plant could have provided the copyists working on *JAC* and *NAP* the opportunity to select different images to fulfill their commissions.

Specified Source(s) of Funding: Amy Goldman Fund

2:30–2:45 PM

Antidiabetic Compounds in Plant Species

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Many of the currently available drugs have been directly or indirectly derived from plants. Identification of guanidine and related compounds in French lilac plant (*Galega officinalis* L.) led to the development of biguanides such as metformin for the treatment of type-2 diabetes. Despite of their plant origin, biguanides have not been reported in plants. The objective of this study was to identify and quantify biguanide and related compounds (BRCs) in experimentally or clinically substantiated antidiabetic medicinal plant foods and potatoes. The results of Voges-Proskauer (V-P) assay after corrections suggest that the highest amounts of BRCs are present in green curry leaves (*Murraya koenigii* (L.) Sprengel) followed by fenugreek seeds (*Trigonella foenum-graecum* L.), green bitter gourd (*Momordica charantia* Descourt.), and potato (*Solanum tuberosum* L.). Whereas, garlic (*Allium sativum* L.), and sweet potato (*Ipomea batatas* (L.) Lam.) contain negligible amounts of BRCs. Liquid chromatography-mass spectrometry (LC-MS) analysis confirmed the presence of biguanide, triguanide, galegine, and other guanidine and urea compounds in these plants with few exceptions.

Specified Source(s) of Funding: Partially supported by a grant from the Colorado Department of Agriculture through the USDA's Specialty Crop Block Grant Program (award #10991) and Colorado Potato Administrative Committee Area II.

2:45–3:00 PM

Nutritional Quality of Oyster Mushroom as Affected by Drying and Pretreatments

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Oyster mushrooms (*Pleurotus ostreatus*) are the second most widely grown mushrooms in the world, valued for their monetary worth, medicinal properties, nutritional quality and unique flavor. Oyster mushroom production does not require high technology or large capital investment thus it has potential to help improve livelihoods in resource limited communities. However, a major drawback is that oyster mushrooms are highly perishable. Most research has been focused on preservation methods that are more adoptable to large scale operation than household production. While reports on sensory quality evaluations are available, studies on nutritional changes associated with postharvest treatments are largely lacking. There is need for simple and efficient preservation methods that can maximize quality and be easily adopted at household level, especially in communities where food availability and nutrition are a constant challenge. An experiment was conducted to evaluate the effectiveness of postharvest treatments and drying methods on the nutritional quality of oyster mushrooms. Two drying treatments (oven and solar), three blanching treatments (water, steam, and no blanching) and four chemical pretreatments (lemon juice, vinegar, potassium bisulfite, and no chemical) were evaluated. The experiment was laid out in a randomized complete block design with factorial arrangement. Dried mushrooms were evaluated for minerals, ergothioneine, protein, and antioxidant capacity. Analysis of variance was made (SAS program) with least significant differences used to separate means. Blanching and chemical treatment were shown to reduce the protein content. Higher K, Mg, Mn, P, Na, and Fe were found in the steam blanched and non-blanched mushrooms when compared to the water blanched mushrooms. Higher Ca, Mg, Na, and P were found in mushrooms treated with lemon and vinegar when compared with potassium bisulfite, while higher Zn was found with the potassium bisulfite treatment. No differences in mineral content were observed between the solar and oven dried mushrooms.

Thursday, August 2, 2012 Concourse 1

Genetics and Germplasm 1

Moderator: Dilip Panthee
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4:00–4:15 PM

Assessment of Genetic Diversity in *Psidium guajava* L. using Simple Sequence Repeat Markers

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Accurate identification of cultivars and assessment of diversity

in guava (*Psidium guajava* L.), a nutraceutical and medicinal plant, is vital for germplasm management and genetic improvement. In this study, 20 simple sequence repeat (SSR) markers were used to characterize genetic relationships among 39 guava accessions obtained from the Pacific Basin Tropical Plant Germplasm Resource Center, Hilo, HI. Microsatellite alleles were detected using WellRED fluorescent-labeled primers and capillary electrophoresis. Pairwise genetic distance computed using the distance procedure in GenAlEx 6 showed that all accessions could be unambiguously differentiated based on SSR fingerprints. A total of 163 alleles were detected ranging from a minimum of 2 to a maximum of 15. Summary statistics for expected heterozygosity of individual SSR loci computed using PowerMarker version 3.0 showed an average of 0.73. The mean observed heterozygosity was very low indicating a high rate of inbreeding among cultivars. Multivariate analysis showed clustering of accessions into well-defined groups that reflected their geographical origins. These results demonstrate the effectiveness of SSRs in cultivar identification and genetic diversity assessment. Identification and selection of parents for guava improvement programs is possible using these molecular markers.

4:15–4:30 PM

Identification of Aroma Volatile Compounds in Juice of California-grown Pomegranate Cultivars

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The pomegranate (*Punica granatum*) is one of the oldest cultivated fruits as well as richest in history and folklore. Its juice becomes the base for sauces and flavorings for drinks, savory dishes, and sweets due to pomegranate arils´ fruity and sweet characteristics. Pomegranate-rich diets have been demonstrated to help protect the brain, cardiovascular and central nervous system, reduce type 2 diabetes etc. based upon demonstrated anti-inflammatory, anti-carcinogenic and anti-mutagenic characteristics. This has led to a remarkable surge in production and consumption of pomegranate products. Recently, increased consumer awareness of the health benefits of consuming phytonutrient-rich fruits, and keen marketing, has created demand for juices and functional beverages containing pomegranate. However, there is little information concerning the aroma of juices from around the world. The aim of this work was to define the aroma profiles of pomegranate juice in selected cultivars from the germplasm program at the USDA in Davis, California. Cultivars were specifically chosen to represent high versus low in aril color, acidity, sugars/sweetness and astringency/bitterness. They included: 'Haku-botan', 'Nikitski ranni', 'Wonderful' (commercial), 'Myagkosemyannyi Rozovyi', 'Fleischman's', 'Salavatski', 'Sin Pepe', 'Nusai', 'Ovadan', DPUN0081 'Wonderful', and 'Kara Gul'. Fruit were harvested in 2011, washed, dried, chilled (8 °C), individually wrapped, boxed carefully and transported overnight to the Food Processing & Sensory Quality, Agricultural Research Service, Southern Regional Research Center in New Orleans where they were mechanically pressed in a juice pilot plant. A DVB/Car/PDMS SPME volatile headspace extraction was accomplished with 10-mL juice and isoamyl isovalerate in 20-mL vials for 12.5 minute exposure at 40 °C, prior to injection into a HP6890/5973 GC-MS with a DB-5 column. Compounds were identified in triplicate runs by HP ChemStation software searched against the NIST, Wiley libraries and authentic standards. Preliminary analyses have identified ethanol, hexanal, 3-hexen-1-ol, 2-nonanone and alpha-terpineol to be recovered in the pressed whole-fruit juice in most of the different cultivars. Other compounds (e.g. different C_6 aldehydes and alcohols, pinenes, terpinolenes, isocineole, terpineols, limonene, linalool) which could help to distinguish the germplasm cultivars "uniqueness" and/or utility for juicing will be differentiated. A long-term goal is to determine important compounds in juices that have flavor importance, and conserve them during juice filtration and pasteurization.

4:30–4:45 PM

Evaluation of Tomato Germplasm for Flavor and Flavor-contributing Components

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Flavor is one of the most highly demanded consumer traits of tomato at present. The lack of flavor is one of the most commonly heard complaints associated with modern varieties of tomato. Research in the past has identified reducing sugars, organic acids and approximately 30 plant volatiles as either directly impacting flavor or exerting an effect through interactions with other compounds. In order to combine flavor with other desirable fruit traits in improved cultivars, it is important to determine how much variability exists in the crucial compounds that contribute most to flavor. The objective of the present study was to determine the variability of flavor-contributing components including total soluble sugars (TSS) and total titrable acids (TTA) among other subjective traits related to flavor in a core collection of tomato germplasm. The core collection comprised of 173 tomato genotypes from USDA repository with a wide genetic background. The TTA varied from 0.20% to 0.64% whereas the TSS ranged from 3.4% to 9%, indicating the existence of a good variation for these traits. Rinon118783, Turrialba, Purple

Calabash, and LA2102 were among the high TTA (> 0.45%) containing genotypes, whereas those with high TSS (> 7.0%) were AVRDC#6, Sponzillo and LA2102. A positive correlation of overall flavor measured by untrained panelists with TTA ($r = 0.33$; $P < 0.05$) and TSS ($r = 0.37$; $P < 0.05$) indicated that these two components have an important role in determining the overall flavor in tomato. Subjectively measured other traits including fruity odor and fruity flavor had positive correlations with overall flavor. Overall flavor is discussed in perspective of other traits including fruit firmness, color parameters, lycopene and vitamin C. Information obtained from this study may be useful for tomato breeders aiming to improve tomato flavor.

Specified Source(s) of Funding: ARS–USDA

4:45–5:00 PM

Genetic Mapping and QTL Analysis in Interspecific Chestnut Population

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Genetic linkage map were constructed in interspecific population between Japanese chestnut (*Castanea crenata* Sieb et Zucc.) and Seguin chestnut (*C. seguinii* Dode). These maps were constructed based on Amplified Fragment Length Polymorphism markers (AFLPs) and Simple Sequence Repeat markers (SSRs). A map of Japanese chestnut as female parent consisted of 139 loci including 132 AFLPs and 7 SSRs on 13 linkage groups of 629 cM in a total length. A map of Seguin chestnut as paternal parent consisted of 133 loci including 123 AFLPs and 10 SSRs on 13 linkage groups of 764 cM in a total length. On a map of Japanese chestnut, a major QTL was detected for nut weight. On the other hand, 8 major QTLs were detected for plant height, leaf size, number of leaf vein, nut weight, pollen fertility and the time of bud break on a map of Seguin chestnut. Interestingly, 5 out of 8 QTLs for plant height in 2009, plant height in 2010, leaf size, number of leaf vein and the time of bud break were located at the almost same position on a map of Seguin chestnut. The highest LOD score, 37.69, were observed for the plant height in 2010. The results suggested that the plant height was controlled by a major gene.

Specified Source(s) of Funding: The grant no. 21380020 of Grants-in-Aid for Scientific Research, Ministry of Education, Culture, Sports, Science and Technology, Japan

Thursday, August 2, 2012 Dupont

Nursery Crops

Moderator: Robert H. Stamps
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4:00–4:15 PM

Efficacy and Duration of Control using Indaziflam during Containerized Plant Production Varies with Formulation and Application Rate

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Weed control during containerized plant production continues to be a serious challenge, especially in light of current economic and labor restraints. The purpose of this experiment was to determine the relative length and degree of control of a grass and a broad leaf weed using three indaziflam formulations applied at three application rates compared to untreated control treatments. Nursery containers filled with a mix composed of pine bark:new peat:sand (6:4:1 by vol.) were treated with one of two granular formulations or a liquid formulation (SC) of indaziflam applied at the rates of 0.022, 0.034, or 0.045 lb a.i./acre. Seeds of large crabgrass [*Digitaria sanguinalis* (L.) Scop.] and spotted spurge [*Chamaesyce maculata* (L.) Small] were sown in different sets of containers at 0, 14, 28, 42, 56, 70, or 84 days after treatment. For both weeds, control generally increased linearly with increasing application rates for all three formulations of indaziflam. The rate effect was more apparent at the later weed seed sowing dates. There was little difference in the performance between the two granular formulations; however, the SC formulation provided better control than the granular formulations at several evaluations, predominately in comparisons of the lowest indaziflam application rate. Weed control from the 0 and 14 days after treatment sowings was mostly good to excellent for three months even for the low and middle application rates suggesting that indaziflam sensitive plants could potentially be treated at reduced rates and still provide acceptable weed control.

Specified Source(s) of Funding: Florida Agricultural Experiment Station

4:15–4:30 PM

A Narrowly Endemic Dirca from Mexico Outperforms Its Broadly Distributed Congener in the Upper Midwest

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Shrubs in the genus *Dirca* are rarely used despite their shade tolerance and beauty. A trial of 81 plants, 27 of each of three species, was established in 2007 near the border of USDA hardiness zones 5a and 4b to evaluate survival and growth. After four winters, survival of *Dirca mexicana* (89%) was greater than survival of *Dirca palustris* indigenous to Florida (44% survival) and *Dirca occidentalis* (41% survival). Survival of *Dirca palustris* from Ontario, Canada, was intermediate (56%), but annual stem extension was only 60% that of *Dirca mexicana* and *Dirca palustris* from Florida. Surviving plants of *Dirca mexicana* and *Dirca palustris* from Ontario showed minimal winter injury, but tips of some stems of *Dirca palustris* from Florida and *Dirca occidentalis* were killed. Our data on survival, winter injury, plant heath, and stem extension of the California-endemic *Dirca occidentalis* suggest it will be especially challenging to identify genotypes adapted for use in the Upper Midwest. In contrast, another narrowly endemic species, *Dirca mexicana*, has potential as a new shrub for horticulture. Our results provide evidence

for variation in cold hardiness and annual stem extension of *Dirca palustris*. Although over half of plants from Florida had died after the first two winters, no additional mortality occurred over remaining years, and survivors were more vigorous than plants from Ontario. This suggests that exploitable variation in cold-hardiness and vigor exists among and within populations of this broadly distributed species.

4:30–4:45 PM

Nursery Tree Production and Transplant Success of *Pyrus calleryana* 'Glen's Form' (Chanticleer®) Influenced by Container Types and Overwintering Treatments

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The most commonly used container type for nursery tree production is the black plastic (BP) container. Roots of plants grown in BP can be injured by the wide diurnal temperature fluctuations that occur during most of the growing season. The longer trees remain growing in BP, the greater the potential for the development of circling and malformed roots. Root injury sustained during production may negatively affect tree health when planted in the landscape. Our research uses *Pyrus calleryana* Decene. 'Glen's Form' (Chanticleer®) to compare tree production using two non-conventional, fabric container types (Root Pouch®, Averna & Associates, Hillsboro, OR, and Smart Pot, High Caliper Growing-Root Control, Inc., Oklahoma City, OK) along with BP containers. Our hypothesis is that the use of fabric containers will reduce the severity of root zone temperature fluctuations seen with BP, promote the development of healthier root systems, enhance tree growth rate, shorten production time, and produce trees that show less stress and establish more quickly when planted in the landscape. Trees are being grown in a nursery production setting using current industry standards. In addition to container type, two overwintering treatments are being examinedtrees are either consolidated pot-to-pot in a block, or left "lined out" in rows. Standard tree growth measurements are taken throughout the growing season. A portion of the trees were destructively harvested in the first and second seasons following initial planting in containers. Trees are planted into the landscape during the first through third growing seasons; trees will be fully excavated and harvested (after one, two, and three growing seasons) through air spading to compare transplant root and shoot growth. Post-transplant stress of trees will be determined during the growing season using pre-dawn leaf water potential and infrared leaf temperature. In 2010 there were no statistical differences in height, dry leaf weight, dry shoot weight, and dry root weight among the three container types. Trees growing in BP had more circling roots than those produced in both fabric container types. In 2011 there were statistical differences within the three container types for caliper, height, leaf area, leaf moisture percent, bottom root matting, and root ball quality. The 2010–11 overwintering treatments were significant for height, dry leaf, root and shoot weight, and leader growth; consolidated plants had significantly larger root and shoot systems. BP containers had the greatest temperature fluctuations in both overwintering treatments compared to fabric containers.

Special thanks to the Colorado Agricultural Experiment Station, Colorado Department of Agriculture, Colorado State University Department of Horticulture and Landscape Architecture, Colorado Nursery and Greenhouse Association and the Colorado Nursery Research

4:45–5:00 PM

Performance of Alternative Containers and Plant Growth and Water Use of *Euonymus fortunei*

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Euonymus fortunei 'Roemertwo' were planted in three types of #1 (~3.8 L) containers (treatments): 1) polyethylene PF400-SM (control) (Nursery Supplies Inc., Chambersburg, PA); 2) Western Pulp 7X7RD (WP) (Western Pulp Products Co., Jacksonville, TX); and 3) Kord 07.50 Fiber Grow Nursery Pot (Kord) (Texon

Polymer Group Inc., Waco, TX). This one-factor completely randomized design experiment was conducted in Michigan, Kentucky, Mississippi, Texas, and West Virginia from July to October 2011. Substrate moisture content was determined by EC-5 moisture sensors (Decagon Devices, Inc., Pullman, WA) in 2 subreplicates per replicate. Plant water use (PWU) was calculated as water content after irrigation minus water content before the following irrigation period. All plants were irrigated to replace 100% PWU for all treatments. Irrigation was scheduled by a programmed data logger (CR1000, Campbell Scientific Inc., Logan, UT) with irrigation applications occurring twice per day starting at 7:00 AM and 7:00 PM. There were no differences between container types in plant growth and biomass according to the data from Michigan and Texas. There was no difference in PWU between WP, Kord, and control containers in the first 50 days, however, WP and Kord started showing differences in PWU from that of control containers after day 50. The PWU of WP and Kord was 544% and 297% higher than the control treatment based on the average PWU of entire experimental duration. The substrate temperature of WP and Kord were 29% and 20% lower than that of control containers on average. The electric conductivity (EC) and pH of the leachate were similar across the three treatments. Compression strength and water vapor barrier of Kord and WP decreased over the 4 months of exposure to outdoor growing conditions. Plant mortality was 13% in the plastic containers, and 2% in WP and Kord container. Overall, the WP and Kord containers had more moderate root zone temperatures and lower plant mortality; however, fiber containers required much more irrigation water than plastic container and were more likely to decrease their water vapor barrier and strength after one growing season.

Specified Source(s) of Funding: NIFA–SCRI MSU GREEEN

5:00–5:15 PM

Nutrient and Biomass Accumulation of Container-grown Landscape Trees with Controlled Release and Organic Fertilizer

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Nutrition management is one of the most critical elements of container nursery production. In particular, understanding crop nutrient demand is essential to developing optimal fertilization programs that provide adequate nutrients for tree growth and health but reduce the potential for nutrient leaching or run-off. In this project we developed water and nutrient budgets for two nursery tree crops; shade trees (*Platanus ×acerifolia* 'Bloodgood') grown in #25 containers and conifers (*Picea pungens* and *Abies fraseri*) grown in #7 containers. All trees were grown in a soilless substrate consisting of 80% composted pine bark and 20% peat moss. Trees were irrigated once daily with an automated miscrosprinkler system. Irrigation was adjusted periodically to provide 10% to 20% leaching fraction. Within each nursery section, trees were fertilized with either controlled release fertilizer (Osmocote 15–9–12, $N–P_2O_5–K_2O$, Everris, Inc.) or an OMRI-listed organic source (blend of NatureSafe 8–5–5 and NatureSafe 10–2–8). A third group of trees in each section was not fertilized. We measured height and caliper on all trees at the beginning and end of the season. A subsample of trees was destructive sampled at the end of the season to develop allometric equations of stem, foliage and root biomass as a function of trunk caliper and height. Nutrient concentrations were also determined for stems, foliage, roots, and remaining substrate of subsampled trees. Biomass accumulation of stems, roots, and foliage was estimated for all trees based on the allometric equations. The total nitrogen accumulation was calculated from biomass estimates and stem, foliage, and root nutrient concentrations. For shade trees and conifers, the biomass accumulation was similar between fertilizer sources and greater for fertilized trees than unfertilized trees. Nutrient accumulation in trees and nitrogen leaching were lower with the organic fertilizer source than with the controlled release fertilizer. Our results indicate that organic fertilizer can produce acceptable growth and quality but understanding nutrient release will be critical to ensure adequate nutrition in container culture.

5:15–5:30 PM

On-farm Evaluation of Mesh Wireless Network for Monitoring Moisture of Containerized Ornamental Crops

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As the availability of water decreases and the cost of water and energy increases, ornamental nursery producers are becoming uncertain of water security, increasing concern about changing regulatory pressure and the potential impact these factors may have on their budgets. This has resulted in nursery professionals exploring new methods to improve irrigation efficiency. Container production systems pose many challenges including variation in species and plant architecture, container size, soilless substrate composition and cultural management practices (use of plant growth regulators, pruning). Furthermore, containerized

crops require intensive irrigation management with a small water buffering capacity when compared to field crops grown in soil. With the assistance of PureSense Environmental Inc., mesh wireless networks equipped with remote substrate moisture sensing technology were deployed in 2010 and 2011 at two Oregon nurseries, Woodburn Nursery and Azaleas Inc. and Bailey Nurseries, Inc., to evaluate its potential to improve irrigation management decisions in ornamental container production systems. The two sensor types deployed were load cells and capacitance-based VWC sensors. Each set of sensors was connected to an eKo Node that communicated with a centralized base station. The nodes transmitted sensor data to the base station once every 15 minutes. Data was then automatically uploaded to servers via a cellular modem and made accessible using either a website or mobile application. The system was effectively deployed in the following production systems: open-air nursery, pot-in-pot production and retractable roof greenhouse. Growers valued the ability to identify instances of over-irrigation, which led to several opportunities to refine irrigation practices. In some situations managers observed improved communication with, and education of their irrigation staff. Growers shared a concern of cost for implementing this technology on a commercial scale, especially considering the diverse number of plant species and production scenarios that occur at a typical nursery. Alternative strategies are being considered to reduce the scale at which this system is deployed such as focusing on troublesome crops or to help refine irrigation practices for new and existing crops.

Specified Source(s) of Funding: Horticulture Research Institute, Floriculture Nursery Research Initiative

5:30–5:45 PM

Water Uptake of *Hydrangea macrophylla* and *Gardenia jasminoides* in Response to a Gradually Drying Substrate

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Due to the lack of quantitative data regarding specific water requirements of ornamental species, precision irrigation of these species is a difficult task for nursery growers. Substrate moisture release curves have been used to predict the amount of plant available water in many soilless substrates, yet there is no information about whether there are differences among species in their ability to extract water from substrates. The objective of this study was to determine how water uptake in *Hydrangea macrophylla* and *Gardenia jasminoides* was affected by decreasing substrate volumetric water content (VWC) due to withholding irrigation. Plants were studied in growth chambers under continuous lighting to prevent diurnal fluctuations in water use from obscuring changes in transpiration occurring in response to decreasing VWC. Whole plant transpiration rates were calculated by weighing pots with load cells every hour over a period of 2-1/2 weeks, while the substrate gradually dried from container capacity to the point where the plants died. The rate of weight loss was used to quantify evapotranspiration rate. Evaporation from the substrate surface was minimized by covering the substrate surface. Water use by *H. macrophylla* 'Fasan' started to decrease at a higher VWC (26% to 28% v/v) compared to that of *G. jasminoides* 'Radicans' (VWC of 18% to 20% VWC). Plant water uptake stopped completely at a VWC of 18% to 19% in *H. macrophylla* and 12% to 14% VWC in *G. jasminoides*. The results show that *H. macrophylla* is less adept at extracting water from a drying substrate compared to *G. jasminoides*. Traditionally, plant available water in soilless substrates has been studied using substrate moisture release curves, but our data suggest that there are important differences among species that cannot be detected by utilizing moisture release curves alone. The technique utilized in this study can be combined with water release curve data to develop a better understanding of species-dependent differences in water uptake, especially at low VWC.

Specified Source(s) of Funding: USDA-NIFA-SCRI Award no. 2009-51181-05768

Thursday, August 2, 2012 Trade Room

Water Utilization and Management

Moderator: Jongyun Kim
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4:00–4:15 PM

Sensor-based Automated Irrigation System Can Save Water in Pot-in-Pot *Acer rubrum* Caliper Tree Production

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To investigate the feasibility of using a sensor-based automated irrigation system in pot-in-pot tree production and to determine the optimum substrate moisture contents at which the irrigation events should be triggered to turn on, a trial was conducted in a commercial nursery in Southwest Ontario, Canada, in the growing season of 2011. *Acer rubrum* (~2.5 cm caliper size) trees were potted in 62-L pots with artificial growing substrates at the beginning of the season and irrigated at five different regimens

(treatments). The five treatments included a control, and four automated irrigation regimens. For the control, the timing and amount of water that each tree was irrigated was determined at the grower's discretion. This represents the current common practice in Ontario. For the automated irrigation regimens, trees were irrigated automatically whenever the substrate moisture content reached 36%, 29%, 22%, or 15%. A soil moisture sensor was buried in the centre of each pot and the moisture content was read and sent to a computer once every 30 minutes wirelessly. These substrate moisture content readings were used to trigger irrigation events for the automated irrigation treatments. Measurements at the middle and end of the season indicated that the caliper and height growth of the trees were not affected by the irrigation treatments; only more frequent temporary wilting events were observed for some of the trees in the 15% treatment during the growing season. Trees in the 22% treatment were not significantly different in performance (i.e. caliper and height increase, visual appearance) from trees in the control, 29%, and 36% treatments, but used 55% less water than the control. Results suggest that pot-in-pot *Acer rubrum* caliper trees can be irrigated using a sensor-based automated irrigation system and irrigation events can be triggered at a substrate moisture content as low as 22% to save irrigation water.

Specified Source(s) of Funding: Landscape Ontario, Canada Agricultural Adaptation Council, Agriculture and Agri-Food Canada

4:15–4:30 PM

Quantifying Root Zone Sensor and Substrate Volumetric Water Content Variability in Pot-in-Pot Tree Production

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An 8-month study was conducted in 2011 to quantify (a) capacitance sensor variability and (b) the spatial variability of substrate volumetric water content (VWC) within the root zone of two tree species grown in a pot-in-pot nursery production. Dogwood (*Cornus florida*) and red maple (*Acer rubrum*) trees were grown in a 75% pine bark: 25% recycled paper mixed substrate in 57- and 114-L containers, respectively. The water-release curve for this substrate was determined with increasing air pressure using a custom-built tension table, which simultaneously correlated the dielectric permittivity of 10HS sensors (Decagon Devices, Inc., Pullman, WA) to decreasing substrate VWC. 10HS sensors were then inserted at two different depths (15 and 30 cm) in 10 dogwood and 10 red maple trees in two blocks in the nursery. All cultural practices and irrigation events were followed according to standard practices. Substrate VWC and environmental data were recorded every 15 minutes using EM50R nodes, utilizing a wireless network system and DataTrac software (Decagon Devices, Inc.). We quantified 10HS sensor variability by analyzing steady-state VWC data between 4 and 5 AM, removing daily temporal variability in VWC induced by daily irrigation events from March through October. In dogwood, substrate VWC was maintained at an average of 0.54 ± 0.05 $m^3 \cdot m^{-3}$ at 15 cm and 0.55 ± 0.04 $m^3 \cdot m^{-3}$ at 30 cm depth. Results obtained for red maple were very similar (an average VWC of 0.54 ± 0.05 $m^3 \cdot m^{-3}$ at 15 cm and 0.55 ± 0.06 $m^3 \cdot m^{-3}$ at 30 cm depth). Throughout the study period, there were no significant differences between the VWC readings of the 10 HS sensors at each depth for either tree species. Standard error (SE) values were used to determine the variability of the sensors across the replicates. SE between sensor VWC values ranged from 0.004 to 0.027 $m^3 \cdot m^{-3}$ at 15 cm and from 0.006 to 0.041 $m^3 \cdot m^{-3}$ at 30 cm in dogwood; similar sensor to sensor variability was seen in red maple (with SE values from 0.006 to 0.025 $m^3 \cdot m^{-3}$ at 15 cm and from 0.006 to 0.047 $m^3 \cdot m^{-3}$ at 30 cm depth) indicating the uniformity of the 10HS sensors in measuring substrate VWC. These 10HS capacitance sensors proved reliable for VWC measurement in this substrate with an acceptable variation of < 10% over the season, providing precise VWC information to the grower for scheduling daily irrigations.

Specified Source(s) of Funding: USDA-NIFA-SCRI Award no. 2009-51181-05768

4:30–4:45 PM

Amelioration of Irrigation Alkalinity by Changing Calcium and Magnesium Source and Rate

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Urban sprawl has caused increased water usage and expanded water quality issues. Salt water intrusion and dropping aquifers are major concerns in the ornamental industry. Bedding plant production is dependent on good water quality and suitable nursery medium. High alkalinity irrigation gradually increases medium pH and Na, and often requires a decrease in lime rate to maintain a slightly acidic medium. The objective of this study was to determine the optimum medium Ca and Mg rate and source in greenhouse production using a moderately alkaline water source. Petunia plugs were planted into medium filled jumbo six trays. Plants were fertigated daily with a balanced soluble fertilizer six days a week using a moderately alkaline water source. Media treatments consisted of a 60% pinebark:40% perlite mixture amended with either no amendments (control), dolomitic lime (2 lb/cubic yard), gypsum+slow release epsom salt (2+2 lb/cubic yard), dolomitic lime (4 lb/cubic yard), dolomitic lime (2 lb/cubic yard)+gypsum+slow release epsom salt (2+2 lb/cubic yard), gypsum+slow release epsom salt (4+4 lb/cubic yard), dolomitic lime (4 lbs/cubic yard)+gypsum+slow release epsom salt (4+4 lb/cubic yard), dolomitic lime (4 lb/cubic yard)+gypsum+slow release epsom salt (2+1 lb/cubic

yard), dolomitic lime (4 lb/cubic yard)+gypsum+slow release epsom salt (2+2 lb/cubic yard). Plant growth, dry weight and color resulted in significant differences among treatments and sources. Interveinal chlorosis was evident in the control and low rates of Ca and Mg especially after 6 weeks. Plant growth measurements and dry weights indicated a decrease in growth with low Ca rates. Overall growth differences did occur for both source and rate of Ca and Mg. If rate of lime is decreased due to increasing medium pH, supplemental Ca and Mg applications may be beneficial.

4:45–5:00 PM

A Survey of Key Attributes to Consider When Selecting Alternative Water Treatment Technologies

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Irrigation water in ornamental greenhouse and nursery operations can be a source or dispersal mechanism for diverse biological problems including algae, biofilm and pathogens. Growers face the challenge of selecting between alternative treatment technologies such as chlorination, copper ionization and ozone for control of waterborne microbial problems. An online modified *Delphi* survey was carried out to identify the perceived key attributes of water treatment technologies for control of [algae, biofilm, and pathogens] that growers should consider in technology selection. A panel of three Expert Types (43 ornamental growers, 28 water treatment industry suppliers, and 34 research and extension faculty) was asked to rate their level of agreement, on a Likert scale from 1 (strongly disagree) to 5 (strongly agree), on the importance of 23 listed financial, social, technical, and environmental Attributes when selecting between treatment technologies. Response rate was 60%, including 27 growers, 15 suppliers and 21 faculty. There was a significant interaction between Attribute and Expert Type ($P < 0.05$). Attributes with an average rating above 4.5 for all Expert Types included residues that are not phytotoxic, effective control of plant pathogens; effective control of biofilm; ease of monitoring; worker safety; low risk of environmental impacts; and suitable for large operations. Cost was also perceived as an important attribute, with low operating cost per volume having a higher rating (4.17 ± 0.64, mean ± standard devn.) than low installation cost (3.37 ± 1.15), with no statistical difference between Expert Types. Control of target microorganisms varied in perceived importance from plant pathogens (4.63 ± 0.56), algae (4.39 ± 0.781), and biofilm (4.31 ± 0.81). A lower rating for human food safety pathogens (3.61 ± 0.90) was probably influenced by this ornamental grower population and nursery application of the technologies. All 23 attributes had an average rating of at least 2.9 both across and within Expert Types. Results suggest that selection of water treatment technologies for the control of waterborne biological problems encompasses technical, economic, environmental and social attributes.

5:00–5:15 PM

The Difficulties of Watering Your Lawn While Conserving Water

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Orange County, FL, is facing a looming water crisis. The St. Johns River Water Management District has determined that the county, which includes metropolitan Orlando, will reach the limit of its consumptive use permit in 2013 and no additional groundwater withdrawals will be allowed. The largest waste of potable water is in the landscape, specifically on the lawn. Homeowners can't keep up with home owner association demands and do not understand the maintenance needs of their yards or the technology of their irrigation system. The most common response for homeowners is to set their irrigation timer and forget it, not making adjustments based on rainfall or the needs of the lawn. Traditional public education programs used by County Extension offices face a daunting task when confronted with these complicated behaviors and attitudes. Several classes were held. Participants were taught about how much water, when to water and the efficiency of irrigation systems. Each class had 15 irrigation clocks all functioning. Participants worked in small groups based on the type of clock they had at home. All participants touched the clock and made adjustments. Pre-test of current knowledge score was 20% out of 100 and the post-test score was 85% (a 65% gain in knowledge). Results from the classes pre-test and post-test prompted the use of a survey called Your Florida Yard and You. The goal was to understand how Floridians think about their yards and care for them. A fifty question survey was mailed to addresses that were identified as high water users by their water utilities company. A total of 1000 surveys were mailed and 292 were completed and returned. The survey data will be discussed and the survey results will be used in the near future to create a program using community based social marketing concepts to increase water conservation behavior by home owners with automated irrigation systems.

Specified Source(s) of Funding: Florida Dept. of Agriculture and Consumer Services

5:15–5:30 PM

A National Irrigation Management Survey for Greenhouse and Nursery Operations

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Defining operational efficiencies within the nursery and greenhouse industry is challenging for a number of reasons. Production practices are highly variable between field, container-nursery and greenhouse operations. In addition, many individual growers produce hundreds of species and cultivars, and use a variety of production, irrigation, and fertilization methods and practices to minimize nutrient and sediment runoff. Typically it is easy to assess the inherent efficiency of the major irrigation systems, including overhead, microsprinkler and drip systems, but the management of these systems is the key to real operational efficiency. In order to gather specific management information about irrigation, runoff and containment practices, an extensive online survey was developed as part of a larger project focused on the development of wireless sensor irrigation networks for the ornamental industry. Sensor networks have the potential to provide growers with real-time, site-specific information, which has been shown to reduce irrigation application rates through precision scheduling. This in turn, may increase fertilizer uptake efficiency and reduce leaching and runoff, which can increase profit margins for growers by using resources more efficiently. We conducted a survey that asked growers to share information about seven aspects of their operation: 1) General site information; 2) Irrigation and rainfall runoff and collection; 3) Sensor technology; 4) Cost and revenue information; 5) Greenhouse specific information; 6) Container-nursery specific information and 7) Field nursery specific information. The survey was distributed to ornamental plant growers through a variety of methods including contact at tradeshows and through extension agents and grower organizations. Preliminary results indicate that at least half of the growers who completed the survey believe that sensor networks can decrease product loss, increase plant quality and irrigation efficiency and reduce disease occurrence. At least half of the same surveyed growers also were concerned that the cost of installing sensor networks would be too high, the sensors would not be reliable, and the sensors would not control irrigation correctly. Data gathered from this survey are being used to define baseline water management practices currently used by the industry, estimate the perceived value and likely adoption of sensor technology, and help determine the potential economic and environmental impact of better irrigation management techniques.

Specified Source(s) of Funding: USDA–NIFA–SCRI Award no. 2009-51181-05768

5:30–5:45 PM

Evaluating the Water Use and Climate Zone Tolerance of Ornamental Plants for Sustainable Landscapes

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Urban water availability is of primary concern to the summer-dry Western U.S. Unstable supplies have become more uncertain due to increasingly drier winters, and chemical laden runoff from over-watered landscapes threatens the health of waters that receive urban runoff. This has led to regulations on landscape planning and water use. To address these restrictions and concerns, landscapes are being installed or redesigned with water conserving plants, and designers and growers are seeking new plant introductions for this sustainable landscape trend. Despite the obvious advantage of having information on plant water use for Mediterranean climates, there is very little research-based data for landscape species. To address these issues, irrigation and climate zone trials were begun in 2005 on landscape perennials considered by the UC Davis Arboretum to be water conserving, pest tolerant, and disease resistant. Ten species were evaluated in full sun field plantings on 4 levels of irrigation based on reference evapotranspiration (ET_0), the amount of water loss from a reference crop. This experimental design was replicated with 9 shade-loving species under a 50% shade structure. Six replicates of each species and treatment were planted and established on regular irrigation the first year. The following May through October they received an irrigation treatment at 20%, 40%, 60%, or 80% of ET_0. Monthly measurements and qualitative evaluations were made to assess differences between treatments. Many of the same plants were also placed in demonstration gardens in different climate zones across California where UC Master Gardeners evaluated the performance of the plants. In many cases, there were no significant differences between treatments in either plant growth or quality, while a few species showed differences in one or both areas. The plant water use data being generated in these trials is needed to support the necessary transition to sustainable gardens and irrigation strategies in summer-dry Mediterranean climates.

Specified Source(s) of Funding: Saratoga Horticultural Research Endowment; California Association of Nurseries and Garden Centers

5:45–6:00 PM

Considering the Variability of Capacitance Sensors due to Placement in a Greenhouse Production Area

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Substrate volumetric water content (VWC) measurements can provide automated irrigation or irrigation decision support, based on capacitance sensor readings. However, proper sensor placement is critical to ensure reliable VWC measurement over large production areas. We investigated the spatial variability of sensors in a commercial snapdragon production greenhouse (Bauers Greenhouse, Jarrettsville, MD) that uses a closed-system hydroponic/perlite substrate production system. Each production bed was 28 m in length with a 3% slope; each bed contained 6 rows of 15 perlite bags, each row irrigated by two

dripper tubes controlled by a solenoid. The top half of each row in the production area was irrigated from one solenoid; the lower half of each row irrigated from another solenoid at the base of the row. This was done to ensure equal water pressure to each area. Twenty capacitance sensors (EC-5; Decagon Devices, Inc., Pullman, WA) were all horizontally inserted at the same depth into five perlite bags at four different locations in the production area (top and bottom of each irrigation lateral). Substrate VWC ($m^3 \cdot m^{-3}$) was continuously measured every 15 minutes over a 14-week production period. When seedlings were transplanted into each bag, the VWC was maintained at an average of 0.31 $m^3 \cdot m^{-3}$ and there were no significant differences between the locations. However, as plants increased in size and water uptake, the top of the production bed showed a significant decrease in VWC to 0.27 $m^3 \cdot m^{-3}$, whereas the substrate VWC at the bottom of the production area increased to 0.32 $m^3 \cdot m^{-3}$. There were no significant differences between sensors in the five different bags at each location, and the sensor-to-sensor variability had an average standard error of 0.01 $m^3 \cdot m^{-3}$. EC-5 sensors proved reliable in monitoring VWC in this perlite hydroponic system; however, uniform sensor placement both in terms of depth in the bag and within the production area should be carefully considered to reduce variability, especially when those readings are used for control-based irrigation decisions.

Specified Source(s) of Funding: USDA–NIFA–SCRI Award no. 2009-51181-05768

Thursday, August 2, 2012 **Windsor**

Floriculture 2

Moderator: Jonathan Frantz
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4:15–4:30 PM

Response of Poinsettia to Various Air Temperature Drops and Root Zone Temperatures at the Same Daily Integrated Temperature

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Temperature is one of the most important climate factors in greenhouse ornamental cultivation since it not only affects plant growth rates, quality and time of production cycle but also heating costs. It has been known that proper root zone heating could reduce energy consumption without compromising plant growth and quality. However, there has been little research on the interaction between root zone heating and air temperature management in ornamental crop production. Since the highest heating energy use usually occurs during the pre-morning or early morning periods, temperature regimes with temperature drop during pre-morning and/or early morning periods could reduce energy use. In this study, three growth chamber trials were conducted to investigate the response of poinsettia, one of the most important ornamental crops in North America, to various temperature regimes with temperature drops at the same daily integrated temperature and their interactions with root zone heating for conserving energy while ensuring crop quality. Four air temperature treatments (one in each growth chamber): 1) Control; 2) PM2 (with 2-h pre-morning low temperature of 13 °C); 3) PM4 (with 4-h pre-morning low temperature of 13 °C); and 4) PMM2 (with 2-h pre-morning and 2-h early morning low temperature of 13 °C) were applied to poinsettia plants from the appearance of first color until anthesis. The air temperatures in other periods during a 24-h period were adjusted accordingly so that the four treatments had the same daily integrated temperature. Four root zone temperatures (20, 23.3, 26.7, and 30 °C) were applied inside each of the air temperature treatments for 16 hours (18:00 to 10:00). It was found that the air temperature treatment with pre-morning temperature of 13 °C (PM4) seemed only marginally affected plant growth and higher root zone temperature could be used with the treatment, which indicates a good potential for energy savings without compromising plant growth and quality.

4:30–4:45 PM

Use of Controlled Water Deficit to Control Height of Poinsettias (*Euphorbia pulcherrima* 'Classic Red')

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Production of poinsettias involves intensive use of growth regulators to control height. Height control is necessary for visual appeal and post-harvest handling. Growth regulators are relatively expensive and do not always provide consistent height results. Since turgor potential drives cell elongation, and thus stem elongation, drought stress has potential for regulating plant height. Using soil moisture sensors, the severity of the drought stress can be both monitored and controlled. The objective of our study was to compare poinsettia height control using growth regulators (spray, mixture of B-Nine and Cycocel at 1000 ppm and drench, 0.25 ppm Bonzi) to the use of controlled water deficit. Graphical tracking of plant height was used to determine when to apply growth regulators or controlled water deficit. In the water deficit treatment, substrate water content was reduced from 0.4 to 0.2 m^3/m^3 when height exceeded the target height. Growth regulator applications (spray or drench) reduced poinsettia height below the final target level of 43.5 cm. Water deficit resulted in an average height of 44.5 cm, closest to the target height. As expected, control plants were significantly taller (49.4 cm).

Most stem elongation occurred between 14 and 30 days after pinching. There was no effect of drenching or water deficit on bract size, while spraying growth regulators reduced bract size. Bract color was not affected by water deficit or growth regulators. There was no difference in shoot dry mass between growth regulator- and water deficit-treated plants. Lateral growth was reduced by growth regulators while water deficit had no effect on lateral growth. These results indicate that water deficit can control poinsettia height without compromising quality and that soil moisture sensors can be used to control this water deficit.

4:45–5:00 PM

ABA and ABA Analog Foliar Sprays Reduce Evapotranspiration in Pansies

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Spray applications of abscisic acid (ABA) and synthetic analogs of ABA are effective means of reducing evapotranspiration (ET), and have the potential to extend the shelf-life of bedding plants by reducing water loss and limiting growth. However, high concentrations or high volumes of spray of these compounds may produce undesirable phytotoxic side effects. To determine the effect of different doses, we quantified the effects of spray applications of ABA and an ABA analog (8'-acetelyne ABA methyl ester, PBI- 429) on evapotranspiration of pansy (*Viola ×wittrockiana*). Pansies were grown in a greenhouse to marketable size. Well-watered plants were transferred to growth chambers after foliar spray treatment with one of six concentrations of each compound (0–2000 ppm ABA and 0–200 ppm PBI-429, with surfactant). Each plant was treated with approximately 1.5 mL of solution and water was withheld for the duration of the study. Load cells in the growth chambers were used to measure the cumulative ET of each plant. All ABA and PBI-429 treatments effectively reduced ET during the first few days after spray application. The highest concentration spray of each compound resulted in the greatest reduction in ET. The greatest reduction in ET was associated with the highest concentration of ABA, and ABA reduced ET more effectively than PBI-429 at equal concentrations. Control plants wilted after 1 or 2 d, while sprays with ABA or PBI-429 (at a concentration of 20 ppm or higher) extended the shelf life by up to 2 d, with ABA generally appearing to be more effective than PBI-429. However, ABA sprays induced leaf- yellowing at the three highest concentrations (500 ppm and greater), while no phytotoxic symptoms were observed in any plants treated with PBI- 429.

Specified Source(s) of Funding: This research was funded by Valent BioSciences

5:00–5:15 PM

Plant Growth Regulator Impact on Calibrachoa Branching and Performance

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Plant growth regulators (PGR) are often used to enhance branching and hence increase the number of flowering shoots of many ornamental crops. In this study, the effectiveness of three PGRs, Augeo, Configure, and Florel, at two rates as a foliar spray on branching and plant performance of two cultivars of *Calibrachoa* sp. ('Balcanapt' Can-Can Apricot™ and 'Balcanoa' Can-Can Mocha™) were investigated in greenhouse experiments in two Texas locations (El Paso and Overton). Rooted cuttings were transplanted to 4-inch square pots and PGRs were applied as a foliar spray eight days after transplanting in both locations. To compare the efficacy of PGRs, a group of untreated and unpinched plants served as un-pinched controls, and another group of untreated but pinched plants served as pinched controls. Results from El Paso indicated that 33 days after PGR application, plants sprayed with Augeo at 400 and 800 ppm had the best visual quality ratings in both cultivars and had more or a similar number of shoots compared to unpinched and pinched controls. Regardless of application rate, Configure and Florel did not improve branching of either calibrachoa cultivar. In Overton, 33 days after treatments, plants treated with Augeo at 400 and 800 ppm and Florel at 500 and 1000 ppm had better visual quality ratings compared to un-pinched controls, but were similar to the pinched controls. Configure treated plants at both locations did not improve plant branching and overall quality and resulted in a "witches broom" appearance. However, Augeo produced plants comparable to pinching at both locations. At El Paso, only the low rate of Florel produced plants comparable to pinched plants, but at Overton, both rates of Florel produced plants comparable to pinched plants.

Specified Source(s) of Funding: IR-4

5:15–5:30 PM

Short-term UV Light Exposure Can Lead to Long-term Plant Growth Regulation

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Ultraviolet light, especially in the UV-B region (280–315 nm), is a high-energy stressor of plants, causing darker, thicker leaves, increased secondary metabolite production, plant stunting, DNA damage, reductions in photosynthesis, and cell death. In greenhouse environments, production, UV-B is eliminated and UV-A (315–400 nm waveband) is significantly reduced. We sought to determine if short-term doses on seedlings of UV-A + UV-B from an electric lamp have a predictable long-term response in altering plant growth and form. In a series of experiments, we treated 10 species of plants, including both vegetable and ornamentals, at the plug stage with extremely high doses of UV light, and evaluated their immediate and long-term performance. Most species showed an immediate reduction in photosystem II efficiency upon exposure to UV light, and in a few cases, they could not recover long-term. Generally, recovery in growth, based on projected leaf area measurements, occurred 7 to 14 days after treatment. In only a few species, UV treatment caused delays in flowering. Based on these results, we believe brief intense doses of UV-A + UV-B lead to immediate changes in plant growth and function, but the effects are largely reversible after several weeks. This approach or using multiple, shorter-term treatments, may have potential in modifying plant growth in greenhouse production.

5:30–5:45 PM

Dormancy Breaking and Germination Requirements of *Jeffersonia dubia*

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Jeffersonia dubia (Maxim.) Benth. et Hook. has been recognized as a promising horticultural crop which has attractive light purple flowers and heart-shaped leaves. However, seeds of this Korean endemic have proven to be very difficult to germinate. It takes a long time (about 9 months) for the seeds to germinate due to seed dormancy. For a horticultural use, a rapid germination is needed, but little information has been reported. We examined their embryo elongation and germination in regard to the effect of the temperature and gibberellic acid (GA_3). In incubators, seeds did not germinate at 25/15 °C (light 12 h/dark 12 h alternating temperature), 20/10 °C, 15/6 °C, or constant 5 °C with a 12-h light photoperiod for 12 months. Seeds germinated to 88% when incubated for 9 months with a sequence of 25/15 °C (warm stratification) → 20/10 °C → 15/6 °C → 5 °C (cold stratification) → 15/6 °C. In several laboratory experiments, embryos grew at 20/10 °C (light 12 h/ dark 12 h) following warm stratification (25/15 °C or 25 °C). Radicle emerged from seeds with fully elongated embryos at field conditions after cold stratification at 5 °C for 10 weeks. Thus, warm stratification followed by cold stratification is required for germination. GA_3 increased the embryo growth in seeds kept at constant 20 °C, but only 12.6 ± 1.8% of them germinated. Thus, GA_3 substitutes for warm but not cold stratification. However, seeds incubated at 15/6 °C or 20/10 °C for 8 weeks germinated to 74.2 ± 2.9% or 30.1 ± 5.9%, respectively, after addition of 1,000 $mg \cdot L^{-1}$ GA_3. Although seeds require 8–9 months for germination after dispersal in nature, it took only 2 months with the combination of alternative low temperature 15/6 °C and 1,000 $mg \cdot L^{-1}$ GA_3. This will contribute to the rapid propagation of *Jeffersonia dubia* plants for commercial production.

Specified Source(s) of Funding: Korea Institute of Planning and Evaluation for Technology of Food, Agriculture, Forestry and Fisheries

Friday, August 3, 2012 Tuttle

Genetics and Germplasm 2

Moderator: John-David Swanson
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9:30–9:45 AM

Variability of Morphological Characters in Sweet Potato [*Ipomoea batatas* (L.) Lam.] Varieties under Barbados Agro-climatic Conditions

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The morphological variability in 27 varieties of sweet potato [*Ipomoea batatas*(L.) Lam] under Barbados agro-climatic conditions were evaluated The aim of his study was to assess the range of variability and segregation pattern for different morphological characters recorded as well as the moisture, dry matter and ascorbic acid content analyzed. Twenty-five descriptors were used in the morphological characterization under three categories viz., vine, leaf, and storage root characters of sweet potato vines and great morphological variability recorded among the vine characters and leaf outlines and in storage roots highest variability was recorded in shape, size, skin color, and flesh color. The dendrograms were obtained using the 25 descriptors separated the twenty-seven varieties into two major clusters with a Euclidean distance ranging between 0.6–1.0 using complete link. A positive correlation was observed between light flesh color (cream and white) varieties and dry matter content with only few exceptions. Dry matter content is one of the important trait for consumer preference in the market.

Specified Source(s) of Funding: The University of the West Indies

9:45–10:00 AM

Blackberry Markers and Their Application to Fingerprinting and Gene Identification

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Cultivated blackberry is bred to display traits such as increased fruit size, yield, pathogen resistance, primocane fruiting, and pricklelessness. Molecular marker applications in blackberry are still in their infancy, but recent work has shown advancement in the areas of fingerprinting and microsatellite marker design. However, a standard set of blackberry fingerprinting markers has yet to be developed as well as the characterization of genes for important traits in blackberry. We have employed a variety of molecular markers designed for crops closely related to blackberry to achieve two goals. First, we developed a set of ten microsatellite markers that are able to produce unique fingerprints of twenty blackberry cultivars. Fingerprint data derived from this study may provide a quick and relatively inexpensive way for breeders to identify cultivars in order to avoid excess homozygosity due to inbreeding and protect their intellectual property rights. Second, we identified genes that may be associated with prickle development in blackberry using bulked segregant analysis (BSA) and random markers. Information gained through the isolation of genes involved in prickle development may aid in future efforts toward marker-assisted selection in blackberry breeding and the development and early identification of prickleless blackberry cultivars.

Specified Source(s) of Funding: USDA–CREES

10:00–10:15 AM

QTL Mapping for Cold Tolerance and Flower Type in a Reciprocal F_1 Florida Avocado Mapping Population

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Avocado (*Persea americana* Mill.) farmers in South Florida have traditionally grown West Indian and Guatemalan × West Indian hybrid cultivars because they are more suitable to prevalent growing conditions. Currently, there is a growing interest in expanding the avocado production to other areas of the state as an alternative crop to citrus. However, the West Indian and Guatemalan × West Indian hybrids are sensitive to cold damage. The objectives of this research were to a) evaluate cold tolerance in a F_1 avocado mapping population of the reciprocal cross of two Florida cultivars, 'Simmonds' and 'Tonnage', b) identify DNA markers associated with cold tolerance and flower type, and place them in their respective linkage groups. A total of 800 trees were used to collect phenotypic data for traits of horticultural interest during three years. A single QTL has been identified for cold tolerance using composite interval mapping. The cold tolerance QTL is located on LG1 and accounts for more than 25% of the total phenotypic variation for this trait. A marker-trait association analysis for flower type (type A vs. type B) identified four markers associated with flower type located on two different linkage groups (LG 10 and LG4). This is the first QTL identified for avocado and these are the first marker trait associations identified for flower type. This mapping population, as well as a second population developed from a reciprocal cross of 'Hass' and 'Bacon', will continue to be evaluated for the next 5–10 years and additional QTL will be identified.

10:15–10:30 AM

Comparison of Genes in Apple [*Malus ×domestica* (Borkh.) 'Royal Gala'] Responding to Simulated Drought and Recovery

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Water is the most limiting resource in the environment. During episodes of drought, crop losses can be substantial due to both direct and indirect effects of dehydration. Even irrigation alternatives are not entirely satisfactory toward solving this problem due to their expense and to competition for urban water needs. It is therefore urgent that drought resistant and/or more water use efficient crops be identified or developed. Fruit trees are particularly difficult to monitor in the long term because of the limitations associated with most drought measurements. We have used suppression subtractive hybridization (SSH) to identify genes from apple root, bark and stem responding to simulated drought (40% of full saturation) and subsequent recovery. Very few genes identified as up- or downregulated in response to treatment overlapped between treatments. In addition, very few genes overlapped between tissue. In order to understand more fully the mechanisms associated with fruit tree defense against dehydrative stress, we compared expression of select genes in root, bark, and leaf tissue from treated plants and their well- watered controls. Similarly, comparisons

involving drought-recovery conditions were made, involving the resumption of normal watering of plants which had been maintained in drought-simulated conditions. The results demonstrate the importance of applying different approaches to analyze the transcriptome and to emphasize gene expression differences in tissues in response to drought.

Specified Source(s) of Funding: USDA–ARS

10:30–10:45 AM

Gene Expression Profiles for Two Auxin Transporters during Apple Fruit Maturation and Ripening

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The maturation and ripening patterns of apple varieties differ greatly due to their long history of cultivation, self-incompatible nature and the high-level heterozygosity of the apple genome. The ripening season across elite apple cultivars can span more than 3 months. Apple maturation and ripening is a tightly regulated genetic process which can result in considerable variation in fruit quality and storability. Ethylene biosynthesis and its response play a central role in apple ripening; auxin metabolism may also critically affect apple fruit maturation patterns. While climacteric ethylene production is the primary indicator of ripening for either early or late-ripening cultivars, auxin may control the timing of activating climacteric ethylene biosynthesis through its cross-talk with ethylene pathways. Previous transcriptome analysis on apple cultivar 'Honeycrisp' and 'Cripps Pink' suggested that auxin transport and availability of auxin may be a key factor regulating the different ripening patterns and quality attributes between these two cultivars. In this study, the gene expression patterns of two auxin efflux carrier encoding genes, PIN 1 (MDP0000138035, Pin-formed protein) and AECFP (MDP0000344085; Auxin Efflux Carrier Family Protein), were characterized during apple maturation and ripening in six apple cultivars. Using a qRT-PCR method, their gene expression profiles of relative transcript abundance and dynamic changes showed distinguishable features and correlated with the ripening season of the 6 cultivars investigated. Tissue-specificity expression indicated that the seed and core region are highly expressed sites for both genes, with lower expression in cortex (flesh) and peel tissues. The potential direction of auxin transportation (from core to outer cortex) seems to correspond with the ethylene production and starch clearing patterns progressing from the inner core outward. To get more insight of genotype-specific regulation mechanisms for these two genes, the genomic copies including the promoter region, 5'UTR, 3'UTR, introns and exons were cloned and their sequence features were analyzed.

Specified Source(s) of Funding: Washington Tree Fruit Research Commission

10:45–11:00 AM

Field Performance of Transgenic 'M.26' Apples Overexpessing a Peach CBF Gene

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The ability to cold acclimate and undergo a period of dormancy is essential to temperate woody plants in order to survive freezing winter temperatures. *CBF* genes have been shown to regulate a large number of cold-regulated (*COR*) genes whose products are thought to contribute to freezing tolerance. The role of *CBF* genes in cold response and acclimation has been well documented in both herbaceous and woody plants. Our previous research has demonstrated that overexpression of a peach CBF gene in 'M.26' apple increased freezing tolerance of non-acclimated plants, initially reduced growth, and surprisingly, resulted in short-day induced dormancy (Wisniewski et al., 2010. *Planta* 233:971–983). The current study reports on the field performance of transgenic 'M.26' apple overexpressing a peach CBF gene (T166) and transgenic 'M.26' apple in which the expression of a native CBF gene was silenced (T186). Performance of these lines was compared to untransformed (wt) 'M.26' trees. Self-rooted trees were planted in the field on 7 Oct. 2010 and various phenotypic characteristics have been monitored since then. In Fall 2010, the T166 line exhibited an immediate response to cool temperatures and short photoperiod after planting. T166 trees exhibited a large increase in anthocyanins in their leaves followed by a rapid senescence. By 4 Nov. 2010, T166 trees had lost all their leaves while wt, and T186 trees still had green, intact leaves. In spring of 2011, the T186 (CBF-silencing line) was the first to break bud and began to leaf out prior to the wt 'M.26' trees. Last to break bud were the T166 trees. The mean date of leaf emergence varied by over a week between the three lines. Current year shoot growth, stem diameter, and the number of laterals were all reduced in the T166 line overexpressing the peach CBF gene. The pattern of leaf senescence and drop in the fall was similar to that observed in the previous year. Thus it appears that overexpression of a peach CBF gene in apple has significant, long-term effects on several phenological events in apple. Observations for budbreak and other growth characteristics for 2012 will be presented.

Friday, August 3, 2012 Windsor

Teaching Methods 2

Moderator: Pamela B. Trewatha
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9:45–10:00 AM

Two Unique Horticulture Classes Capture Diverse Student Interest

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There are many opportunities to expand the reach of horticulture well beyond traditional settings and students through unique courses. This presentation showcases two successful approaches to teaching undergraduates with diverse interests, from every major. An *Art of Horticulture* experiential survey course offers a deep exploration into self, the classroom, and community, by engaging with the plant world in a creative context. There are two distinct units that overlap throughout the semester: plants used in/as art, and plants as a subject of art. Students explore the ways in which plants can be used in or as art, such as living sculpture methods (including turf-works and tree sculpture, for example), and as a subject of art, including botanical illustration, and watercolor painting. An *Experiential Garden-Based Learning in Belize* class provides students with a deeply reflective experience in garden-based learning by working collaboratively with one another, and through working directly with a non-governmental organization in the Toledo District of Belize. This working partnership enables students to help to establish new school gardens, assess and make improvements to existing gardens, form linkages between the gardens and the school curriculum, to collaborate with Mayan teachers. The presentation will include an overview of assessments and evaluation measures used as an alternative to traditional testing, creative final project requirements, a participation rubric, and reflective writing guidelines.

10:00–10:15 AM

Providing Course-based Research Experiences though the Implementation of Lab Modules in a Large Enrollment Undergraduate Course: Assessment of Crop Diversity

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Being involved in hands-on independent research as an undergraduate student has been positively correlated to the pursue of careers in science. A well-established method of students gaining such experiences has been by conducting an independent project in a research laboratory of a faculty member of their home institution. Unfortunately, only a fraction of students are able to participate due to reasons ranging from a lack of knowledge of opportunities, lack of faculty resources, lack of space in research labs, lack of exposure to research, family commitments, etc. Recognizing these limitation and the benefits of engaging students in the scholarship of science as early as possible, faculty and departments have begun to successfully implement research- or inquiry-based laboratory exercises in small-, medium- or large-enrollment courses throughout different curriculums. Here, we present a model for the large-scale implementation of guided-research on a topic of cultural relevance to increase interest in research. Cassava (*Manihot esculenta*), a crop of immense importance to humans worldwide, is also widely consumed in Puerto Rico though not as a staple food. Despite this, the genetic diversity of cassava in the Caribbean is poorly understood. A laboratory module was implemented in upper-division genetics course where the enrolled students collected samples from different townships in Puerto Rico and applied molecular biology techniques to assess the genetic make-up of each cassava sample. The tabulation of the data led to the successful evaluation of cassava diversity in Puerto Rico, which is the first study of its kind in the Caribbean. This lab module impacts 600+ students per year by providing hands-on experience in using modern molecular biology tools. Assessment of content and learning perceptions revealed that our novel approach allowed the students to learn while engaged in an authentic research project. At the completion of the lab module the students reported an enhanced understanding of scientific process, increased proficiency with molecular methods and increase in confidence as researchers. The nature of this lab module and its focus on assessing genetic diversity makes the module easy to modify to study genetic diversity of other important crops but more importantly provides opportunity for hands-on inquiry based research activities allowing undergraduate students to feel the excitement and self-investment that is related to discovery of new knowledge.

Specified Source(s) of Funding: NSF-CCLI

10:15–10:30 AM

Comparison of Two Delivery Methods Used to Produce an Online Lecture Entitled "Worldwide Technology for Controlled Environment Plant Production"

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Distance education is growing at a rate more than 10 times that of traditional higher education. Nearly one-quarter of faculty responding to a recent nationwide survey are reportedly teaching

online; over one-third have taught an online course in the past, and the majority of those responding cited the needs of students as the main reason for teaching online. A number of studies have shown learning outcomes of distance education courses to be comparable or even superior to traditional face-to-face courses. Yet, student satisfaction and attitudes often decline if the online learning environment does not engage the students, foster interaction, and utilize technology appropriately to support the learning objectives. With the onset of novel and ever changing distance education technologies, a multitude of approaches can be used by faculty to deliver their content asynchronously. In an effort to upgrade an existing UA-CEAC Controlled Environment Systems Course (ABE 483/583), into a hybrid format, identical content was recorded using two different delivery methods: a lecture capture system, and a narrated presentation program. The lecture was recorded in an e-learning classroom utilizing an Accordent Capture Station that synchronizes multiple sources including audio, video and content from a computer monitor. The narrated presentation was produced in a studio using a computer running Articulate software which records a written script and spoken words in synch with changing PowerPoint slides. For comparison, the lecture entitled "Worldwide Technology for Controlled Environment Plant Production" can be viewed at http://irrecenvhort.ifas.ufl.edu/topical_lectures.html. This online lecture contains original photography and content of controlled environment greenhouse production in Europe, Italy, Spain, Holland, Turkey, China, and North America. Students who are more visual learners often prefer the lecture capture format where the speaker is viewed simultaneously with the slide content, while audio learners find this distracting and prefer the narrated presentation. Regardless of the format chosen, students like the flexibility of maneuvering through thumbnails, quick access to added resources, concurrent viewing of lecture notes, and the option of learning the material anytime and anywhere.

10:30–10:45 AM

Teaching Undergraduate Nursery Management as an Online Course: Instructor and Student Perspectives

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The desire for increased availability of online courses across all collegiate curriculums has created a demand and need for online college-level courses in horticulture. Frequently, the transition of courses to online has been those that were lecture-only, where experiential learning was not a major component. At Missouri State University, we now utilize the online format for teaching undergraduate nursery management, but combine it with experiential learning through required group or self-arranged nursery site visits. The course format includes lecture PowerPoints, outside readings, online discussions, written assignments and tests delivered through Blackboard (an online course delivery and management system). This is combined with the requirement of five field trip activities over the course of the semester. The instructor sets up five regional field trips for students in the area, plus assists distance students in setting up their own field trips near their home institution. Information on the benefits and disadvantages of online delivery from the instructor's standpoint, along with student feedback on the format will be presented.

10:45–11:00 AM

Incorporating Study Abroad into the Undergraduate Organic Crop Production Program

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A new study abroad course on organic production and marketing was developed to add a significant international perspective to the horticultural science undergraduate program especially the organic crop production specialization at the University of Florida (UF). The course was established as a result of a partnership with the Polytechnic University of Madrid (UPM) that was funded by a USDA International Science and Education grant. Ten undergraduate students participated in this two-credit study abroad course in 2009, while six students were enrolled in 2011. During a one-week period, students visited the UPM campus and organic garden, diverse organic and biodynamic farming operations, processors, and marketplaces around Madrid, as well as the Valencian Institute for Agricultural Research (IVIA), a horchata factory, and organic farms in Valencia. The course activities were designed to provide students with direct interactions with UPM faculty, students, and organic producers, and allow students to compare the organic food systems, standards, and issues between the U.S. and Spain—the leading organic producer in Europe. Students were required to complete a reflective daily travel journal and a comparative final report. For the final report, each student selected a farming operation from the places visited and analyzed critically different aspects of production practices, holistic management, and marketing strategies. Course evaluation results indicated that participants in both years were greatly satisfied with the accommodations and arrangements. They perceived this study abroad course as an invaluable opportunity to obtain an important global perspective for professional development, which is not commonly offered by regular courses. The study abroad experience enabled students to achieve a comprehensive understanding of organic and sustainable agriculture within a global context, encouraging them to think more critically about their role in sustainable food system development at local, national, and international levels. Meanwhile, the cultural exchange was deeply appreciated by students and was regarded as another valuable aspect of the international experience. The students all stated that they would highly recommend this study abroad course to their peers. Feedback was also provided by students for further enhancement of course organization. Some students commented that the

program period could be extended to allow for more interactive activities at each site. More cultural exposure and time for reflection were also suggested. Although students indicated that benefits outweighed the cost of the study abroad program upon completion of the course, financial support was identified as a primary concern of students during recruitment.

Specified Source(s) of Funding: USDA–ISE

Friday, August 3, 2012 Sandringham

International Horticulture and Issues

Moderator: S. Alan Walters
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11:15–11:30 AM

Interamerican Society for Tropical Horticulture from an ASHS Regional Group to Over 60 Years of History

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The InterAmerican Society for Tropical Horticulture (ISTH; www.iasth.org) was founded 61 years ago (1951) in the USA, as the Caribbean Group of the American Society for Horticultural Science (ASHS). During the initial period (1951–1957) were memorable the efforts of Wilson Popenoe, since he was the Society's first Secretary-Treasurer-Executive. For several years the personal dedication of others important selfless volunteers, such as Ernesto H. Cásseres (1958–1970), Carlos Enrique Fernandez (1972–1976), Franklin W. Martin (1977–1983), Carl W. Campbell (1984–1997), and Richard J. Campbell (1998–2008), also was decisive to existence and maintenance of the group as a scientific society. At the beginning, founders aimed to establish a party of countries from the Caribbean Region to reunite more often not only to exchange information on tropical horticultural crops, but also to disseminate it through newsletters and a scientific journal. The group is, ever since, the only tropical American scientific society dedicated to gather and spread information on tropical horticultural production. As time passed and people from other countries joined in, the name was changed to ASHS–Tropical Region, in 1966. Another change happened in 1986, when, for legal reasons, the group was separated from the ASHS adopting its current name. Since 1957 The Proceedings of the ISTH had been the main scientific publication. During more than 50 years we had the free contribution of various dedicated and committed editors, such as: Ernesto H. Casseres, J. Robert Hunter, Robert. P. Armour, Luis A. Montoya, Danilo Ríos-Castaño, Carlos Enrique Fernández, Simon E. Malo, L. Antonio Lizana, Mary Lamberts, Bruce Schaffer, Carl W. Campbell, Jonathan H. Crane, and Richard J. Campbell. From 1951 to 1966 it was published as Proceedings of the ASHS–Caribbean Region (ISSN-0066-0116), from 1967 to 1985 as Proceedings of the ASHS–Tropical Region (ISSN-0254-2528) and from 1986 to 2008 as Proceedings of the ISTH (ISSN-0254-2528). Because of this and others reasons, the active members of ISTH deliberated for a new a change, following the evolution of all scientific societies. Therefore, from the volume 53 is being published as Journal of the ISTH and with new ISSNs (Print 2237-4256 and Online 2237-4264). Each paper published in the whole collection of volumes are available to download (www.journal.iasth.org) by active members. Furthermore, from now on, as a result of an agreement, it was be also possible to access the papers in PubHort (www.pubhort.org) from International Society for Horticultural Science (ISHS).

Specified Source(s) of Funding: Embrapa, ARS/USDA, and ISTH

11:30–11:45 AM

International Horticulture Food Security Issues

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With the increase in production and consumption of fruit and vegetables worldwide, there has been acceleration in movement of fresh and processed products across the nation and across the continents, and from food abundance to food deficit areas. According to FAO, presently one billion people worldwide are suffering from hunger and malnutrition, which demands for both national and international intervention to mitigate food insecurity. The International Conference on Horticulture (ICH–2009) held in Bangalore during Nov. 2009 highlighted the importance of horticulture and recognized that it is (a) a strong supporter to food security, (b) a major contributor to nutrition security, (c) a promoter of health improvement, and (d) an important source of employment and income generation. In this context, the presentation to the ASHS Annual Conference 2012 will discuss the present global scenario, rising challenges, constraints, and thrust areas to be addressed.

Specified Source(s) of Funding: PNASF

11:45–12:00 PM

Water for Horticultural Crop Production in Afghanistan

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Improved agricultural productivity is important for achieving and maintaining social stability and sustainable economic development in Afghanistan. Water is the most important factor that limits agricultural expansion in Afghanistan and is especially crucial for optimizing the productivity of horticultural crops. Afghan farmers suffer from water shortages because of limited fresh water resources and the inappropriate use of watersheds, aquifers, river basins, and irrigation methods. Most of the fresh water resources originate from melting snow pack and glaciers in the Hindu Kush Mountains; and, canal systems that provide irrigation for horticultural crop production depend on this fresh source of water via various major rivers. In years with little snowfall, this often results in drought conditions the following summer. Drought conditions are further exacerbated by inefficient use of available water and are often devastating for fruit and vegetable production in Afghanistan. Although Afghanistan has an advantage for producing several high-value horticulture crops, the potential for increased supply and international marketing cannot be realized unless capacity is improved through better field production and management methods which unfortunately directly relates to the availability of fresh water resources through irrigation. Until a more broadly functional means of distributing water becomes available, on-farm practices, especially improved water management, represent the best opportunity to improve farmer livelihoods and develop a sound agriculture-based economy.

Specified Source(s) of Funding: Afghanistan Water, Agriculture and Technology Transfer (AWATT) funded by U.S. Agency for International Development, Agriculture Development for Afghanistan Pre-Deployment Training (ADAPT) funded by U.S. Dept. of Agriculture Foreign Agriculture Service

12:00–12:15 PM

Developing a Professional Society for Agricultural Professionals in Afghanistan

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The views expressed in this abstract are those of the author and do not represent the views of USDA. A youth club was created to provide an animating environment for junior staff of the provincial Directorates for Agriculture in northern Afghanistan. The concept was to overcome Soviet-era rigidity and help make the offices a positive place where staff can access both professional and recreational opportunities. Early activities included English and computer classes, field trips, sports, and a weekly lunch. Recently, USDA was able to co-organize a series of capacity-building workshops for the agriculture directorates in the northern provinces. We asked the youth organization to manage the funds and organize the workshop. This, we hoped, would give the organization additional credibility with their colleagues and administration. The youth organization successfully organized local arrangements, logistics, budgets, participant evaluations, and reporting for two workshops attended by staff from several provinces. Workshop attendance stayed constant over four days, a sign of staff interest (past workshops typically experienced drop-outs). Encouragingly, a small but significant number of women were able to participate. Between the two workshops, funding cuts eliminated the salaries of a number of ag directorate staff who were members of the youth club. They have subsequently been rehired through a different funding source. However, during the stressful time of unemployment and uncertainty, as youth club members they had a context for continuing to work on the successful second workshop. These experiences have led to the idea of developing the youth club into a professional society. It has shown value as way to organize activities that benefit the members and thereby, indirectly, the quality of service that Afghanistan will receive. Moreover, something rare in a developing country, it has provided a professional identify and focal point for qualified members, even in an event of budget cuts and job loss. This is a valuable function in an uncertain future. If this club is developed into a professional society, what are the next steps? And, should it be expanded to include university members, and perhaps members from NGOs, in order to encompass agricultural research, extension, education, and services? Advice from a mature professional society is welcome.

12:15– 12:30 PM

Development and Promotion of Ultra Low Pressure Drip Irrigation in Myanmar

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Low-cost, locally manufactured drip irrigation systems are rare in Southeast Asia, and it is primarily wealthier farmers who benefit from more expensive imported systems. In addition to relatively high costs, there are significant perceptual barriers to drip adoption as many farmers are accustomed to applying copious amounts of water to horticultural crops and are unfamiliar with either drip or their crops' actual water requirements. Working with a non-profit (IDE-Myanmar, now Proximity Designs), whose mission is to help boost small farm incomes, the authors began testing gravity-fed drip system configurations in Myanmar in 2006. While beginning with basic components similar to older 'spaghetti tube' emitter systems of the 1960s, our improvements include filters designed for ultra-low pressures, easy-to-use fittings, and inexpensive collapsible header tanks. Important design criteria include not only high flow at low pressures, but also manufacturing simplicity. After hundreds of controlled tests and farmers' field trials, our locally manufactured drip sets were first offered for sale by private dealers countrywide in 2008, supported by our network of promotion staff located in most of the country's states and divisions. We continue to develop system improvements and support an on-farm demonstration and

farmer education program to promote this "new" technology. Support materials include illustrated installation guides, system design software, videos, and an easy-to-use water requirement calculator (the *Water Wheel)* for fruit and vegetable crops. Over 5000 small farm drip systems have been installed in Myanmar since 2008 and the number of satisfied customers is increasing at an accelerating pace.

Friday, August 3, 2012 **Windsor**

Viticulture and Small Fruits 3

Moderator: David R. Bryla
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11:15–11:30 AM

Nutrient Foraging in Grapevine Rootstocks

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The ability of grapevine rootstocks (101-14, 3309C, Riparia Gloire, St. George) and self grafted vine roots (Pinot noir, 115 clone) to exploit nutrient patches in soil was investigated in a low nutrient sandy loam soil. Rooted cuttings of vines were grown in 1.6–L pots with 4 different soil patches (50-mL plastic tubes that allowed root access through 1.5-mm window screen covered holes) enriched with either nitrogen, phosphorus, potassium, or a control (non-enriched) placed within each pot. Vines were harvested after 8 or 14 weeks and shoot dry matter and nutrient uptake were quantified. Roots growing within each 'enriched patch' were quantified and analyzed based on number and length of different root orders. Roots differed in their capacity to exploit nitrogen patches and phosphorus patches, but no differences among rootstocks were found in potassium or the control patches. Vines on 101-14 roots had higher numbers and lengths of all roots, and greater root weights in nitrogen patches, compared to all other rootstocks. Vines on their own roots had greater fine root length and total root weight than vines on St. George roots in phosphorus patches. Shoot dry mass and nutrient uptake were highest in vines grown on 101-14 roots, and lowest in self-rooted vines. The ability of roots to forage in the nitrogen enriched patch among rootstocks was highly correlated to shoot growth and nutrient uptake for most macro-elements. Although intrinsic differences in root characteristics (such as ratio of fine roots to woody roots, average root length in different classes, or average root diameter of fine roots) were found among different rootstocks, these characters did not clearly relate to root proliferation in the nitrogen patch or to shoot growth. Rather, it appears that the ability to sense and to stimulate root growth in the nitrogen enriched soil explains these findings.

11:30–11:45 AM

Skin Mechanical Properties and Fruit Cracking in 'Flame Seedless' Tablegrapes

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Fruit cracking leads to bunch rots in both tablegrapes and winegrapes and increased packing costs in tablegrapes. Biophysical, anatomical, and cultural factors associated with cracking were investigated in the cracking prone cultivar Flame Seedless by varying ethephon, irrigation, and girdling practices over two seasons in a commercial vineyard, and evaluating cracking and skin properties. Berry skin has been widely regarded as a "thin shell" that bears pressure from the internal flesh, such that berry cracking in the form of skin failure should be associated with either a high internal pressure or a weak skin. In ripe fruit, tissue failure under an applied load has generally been attributable to cell separation, but scanning electron microscopy of field and water soaked cracked berries clearly showed that skin failure was by cell wall fracture, suggesting either that skin cells have particularly strong intercellular bonding, that failure may be caused by high skin cell turgor, or both. Overall skin strength was tested in the laboratory using a custom device (the "berry balloon system," BBS) designed to apply multiaxial stress to an entire, intact berry skin. Under field conditions, ethephon sprays caused the largest increase in cracking, followed by irrigation and girdling. In all treatments, skin stress and strain at failure decreased markedly over berry development, indicating that cracking susceptibility does increase as berries ripen. Skin mechanical properties did not differ for berries with or without ethephon spray in the field, however, exposing the berry skin to an ethephon solution (1.5 μM) during BBS testing caused about an 18% reduction in skin strength. Also, intact berries soaked in an ethephon solution cracked in one-half the time of berries soaked in water. These results strongly suggest that cracking susceptibility increases very soon after exposure to ethephon. The failure to detect differences in skin properties using field sampled berries may be due to the fact that only sound (non-cracked) berries were selected for the lab tests, and these may not have been typical of the berries that did crack in the field. Irrigation treatments in both years caused clear differences in midday stem water potential (SWP) over a range of –1.1 to –0.3 MPa. Berry firmness was positively correlated with SWP and cell turgor pressure. In general, cracking, berry size, and firmness were all reduced by reducing water, and there may be a threshold SWP of about –0.8 MPa for these values to show decreases.

Specified Source(s) of Funding: AVF and CTGC funded all or part of the research associated with this abstract

11:45–12:00 PM

Ten Years of Western Nebraska Grape Cultivar Trials

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In Spring 2001, a grape cultivar trial was established at the University of Nebraska Panhandle Research and Extension Center in Scottsbluff, NE. Initial plantings included 15 genotypes and subsequent additions brought the total number of genotypes to 37. Yield results for harvests from 2003 to 2009 were recorded and evaluated. Cultivars that exhibited good potential for western Nebraska conditions included Frontenac, Valiant, Leon Millot, Marechal Foch, Elvira, and deChaunac, with yields exceeding an average of 10 lb per plant. Challenges experienced for grape production in western Nebraska included spring freeze damage, inability to overwinter consistently, insect damage, and high pH-induced nutrient deficiencies. Advantages noted include low disease pressure related to the dry climate and thus a potential for organic grape production. Yield data and images of insect problems and nutrient deficiencies will be presented.

12:00–12:15 PM

Temperature Thresholds to Freeze Damage in Cranberry

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Sprinkler irrigation is required for frost protection of cranberry and is arguably the most important cultural practice used in production of the crop. Growers struggle however with questions on what temperatures to begin sprinkler frost protection, how much water is needed, and at what stages of development are the plants most susceptible to frost. If applied too early or too often, irrigation water may run out. When missed or applied too late, crop damage will result. A study was initiated in a commercial bed of 'Stevens' cranberry located in Langlois, OR. The objectives are to identify temperature thresholds to freeze damage and to determine the amount of sprinkler water required to protect the plants from frost. Temperature-control units were developed to expose the cranberry vines to freezing temperatures at various stages of plant development under field conditions, and a grid of thermocouples was installed to monitor temperature within the bed. Ambient temperatures within the bed were similar inside and on top of the crop canopy (approximately 7.5 and 15 cm above the soil surface) but as much as to 2.4 °C warmer at 15 and 30 cm above the canopy surface. Ambient temperature on top of the canopy was also as much as 1.1 °C warmer than cranberry leaf temperature at the same location. Temperatures thus varied with both height and location in the bed, illustrating the importance of thermocouple position when setting up a frost alarm. The temperature data will be used next to evaluate frost prediction models for cranberry. The temperature-control units were tested at –12 °C on 9 June 2011. Bed temperature was maintained near the set temperature but fluctuated as the freezer motor cycled on and off. Plants were also frosted following the test and died within a few days. The units were modified and tested again at –5 °C on 15 Nov. 2011. Chamber temperature varied < 1.5 °C during the second test and the plants all survived following the test. The units were used in Spring 2012 to expose different patches of plants within the bed to a range of temperatures above and below ambient. Tests were run during frost events whenever possible. Evaluation of the plants following each test is ongoing and will be completed this fall.

Specified Source(s) of Funding: Northwest Center for Small Fruit Research

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Friday, August 3, 2012 **Tuttle**

Propagation

Moderator: Matthew Chappell
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11:15 –11:30 AM

Seed Germination at Different Seed Capsule Maturities to Reduce Stratification Requirement of Japanese Tree Lilac

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Woody plant species generally require seed stratification (moist-chilling or moist-warm conditions) to overcome dormancy conditions in the embryo. Seed dormancy is variable in Japanese Tree Lilac [*Syringa reticulata* (Blume) H. Hara] with a recommendation of 30–90 days stratification at 1 °C to 5 °C. Cultivars of Japanese Tree Lilac are propagated either by stem cuttings or by grafting. Grafting is generally done onto seedling rootstocks of *S. reticulata* seedlings. It would be advantageous to rootstock seedling production to be able to reduce or eliminate the need for seed stratification. The objectives of this research were to determine time at which seed stratification requirement commences and to determine percent seed germination at different seed capsule maturities. Seed was randomly collected and combined together from 5 different trees every week on the North Dakota State University campus starting on 22 Sept. 2011 for 7 weeks (22, 30 Sept; 06, 13, 20, 27 Oct; 04 Nov.). Germination test were performed as well as seed moisture content measured weekly. The germination test consisted of 100 seeds per weekly collected seed samples placed in cell packs containing Sunshine® LC1 mix medium, under natural light conditions, temperature of 21 °C ± 3, and were hand watered daily. Seed moisture content was measured for each weekly sample using 4 reps of 10 seeds each rep. Germination percentage was highest (90%) at week two and steadily decreased to 0% germination at week 7. Germi-

nation percentages were 78.0, 90.0, 78.0, 68.0, 25.0, 1.0, 0.0% for collection weeks 1–7, respectively. Seed moisture content was 58.4, 51.5, 50.0, 56.4, 44.2, 28.6, and 8.9% for collection weeks 1–7, respectively. Germination percentage was directly correlated with seed moisture content and decreased as seed capsule matured (natural drying and splitting of capsule seam to disperse seed) during the fall season. Data suggests that the timing of fall seed collection of Japanese Tree Lilac is critical and must be collected prior to maturation of the seed capsule in preparation for dormancy in order to avoid the need for 30–90 day seed stratification.

11:30–11:45 AM

The Effect of Intermittent Misting and Adventitious Root Development on Leafy Stem Propagule Water, Osmotic, and Turgor Potential Values

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Understanding how intermittent misting affects water (Ψ), osmotic (Ψ_s), and turgor potential (P) of leafy propagules is fundamental in improving propagation success rates observed by ornamental nursery and greenhouse producers. The objectives of this study were to determine those environmental and/or physiologic factor(s) that exert the greatest influence on leafy stem propagule Ψ, Ψ_s and P values during adventitious root development; determine how Ψ, Ψ_s, and P values of propagules are affected by adventitious root formation; and determine differences in stock plant and propagule Ψ, Ψ_s, and P values during the adventitious root development process. Environmental factors examined included photosynthetically active radiation (*PAR*) ($mmol \cdot m^{-2} \cdot s^{-1}$), daily light integral (DLI), daily maximum *PAR*, daily mean temperature and daily maximum temperature. Propagule Ψ values of monarda and podocarpus were consistently more negative than stock plant Ψ values, although the differences in stock plant and propagule Ψ values were not significant. At no measurement was there any difference between monarda propagule Ψ_s values and stock plant Ψ_s values. However, monarda propagule Ψ_s were less varied over time than stock plant Ψ_s, likely a result of consistent moisture provided to propagules while under mist. Podocarpus propagule Ψ_s values were consistently less negative than stock plant Ψ_s values with one measurement being different; again likely a result of consistent moisture provided under mist. Turgor potential values of monarda propagules were consistently lower than stock plant P values, yet no significant difference between monarda propagule P values and stock plant P values was found. Turgor potential values of podocarpus propagules were less variable than stock plant P values. During the course of this study three trends were observed: 1) A lack of fluctuation in propagule Ψ, Ψ_S, and P measurements that is likely due to intermittent misting. 2) Fluctuation in stock plant Ψ, Ψ_S, and P measurements that is likely due to irrigation frequency of stock plants. 3) A lack of significance between stock plant and propagule Ψ, Ψ_S and P measurements indicate a lack of water stress in propagules, demonstrating the importance of intermittent misting to maintaining Ψ, Ψ_S, and P in propagules. It is known that misting is required to maintain proper propagule water balance, this study in conjunction with photosynthesis measurements (Chapter 2) and carbon allocation measurements (Chapter 3) demonstrate definitively that misting is vitally important to maintaining photosynthesis in propagules by sustaining adequate Ψ, Ψ_S, and P in propagules.

11:45 AM–12:00 PM

Studies on the Propagation of Jamaican Ackee (*Blighia sapida* L.) by Air-layering

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A study was conducted at the University of the West Indies, Cave Hill Campus, Barbados, in June 2011. The aim was to investigate the effects of indole-3-butyric Acid (IBA) on the air-layering propagation of Jamaican ackee (*Blighia sapida* L.) using four different plants of the same genotype. *Blighia sapida* L. is a woody perennial, evergreen multipurpose fruit tree species native to the Guinean forests of West Africa. The fleshy arils of the ripened fruits are edible. All selected plants were fully grown mature, vigorous, healthy, and disease-free trees, located within the landscape at Cave Hill Campus. Individual trees represented separate blocks. The experiment was laid out as a randomized-block design, with five different concentrations of the rooting hormone (0, 2000, 2500, 3000, and 3500 ppm) IBA. The maximum rooting percentage (100), maximum number of roots (108.00), longest root length (29.1 cm), maximum root fresh weight (11.9 g), and dry weight (3.7 g) per stem were recorded in the treatment of 3500 ppm IBA. The results of this study have some potential for multiplication of true-to-type plants and can be beneficial for fruit growers and nurserymen.

Specified Source(s) of Funding: The University of the West Indies

12:00–12:15 PM

An Ethylene Blocker Delays Epidermal Cell Death at the Location of Adventitious Root Emergence in 'Beauregard' but Not in 'Evangeline' Sweetpotato Cuttings

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In sweetpotatoes, the emergence of adventitious root primordia represents a critical phase in plant establishment and determination of potential storage root yield. Experiments with 'Beauregard' and 'Evangeline' sweetpotato cuttings revealed differential response to 1-MCP application. 'Evangeline' cuttings rooted regardless of 1-MCP treatment. In contrast, 'Beauregard' cuttings treated with 1-MCP showed significantly reduced adventitious root emergence and development relative to the untreated controls. Trypan blue staining of nodal tissue that failed to show emerged adventitious root primordia showed localized dead tissue in the general area where adventitious roots emerge. The degree of staining appeared to correspond with the stage of adventitious root emergence, with the staining becoming more intense around the time an adventitious root primordium eventually emerges through a crack in the epidermis. This response correspond with reported results of ethephon-induced adventitious root emergence in rice nodes. These results suggest that 'Beauregard' and 'Evangeline' cuttings differ in the ability to sense the presence of ethylene. This represents the first evidence of genotype-specific ethylene involvement in adventitious rooting in sweetpotato cuttings.

Specified Source(s) of Funding: AgroFresh

12:15–12:30 PM

Evaluation of *Piriformospora indica*, a Mycorrhizal Fungi, on Adventitious Root Formation of Slow-to-root Annuals and Perennials

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Biological solutions to common production problems are welcomed by growers and consumers as our society continues to raise its expectations for sustainability and reduced chemical inputs. A relatively new mycorrhizal fungi, *Piriformospora indica,* has shown promise to improve overall plant growth and disease resistance of various plant species. One of the reported plant responses of high importance to the floriculture industry is increased adventitious root formation of slow-to-root annuals and perennials. All such vegetatively-propagated species require an application of rooting hormone to produce a successful crop; however, auxin application increases labor time as well as chemical usage. The objectives of this study were to determine: 1) if *P. indica* can work successfully as a root hormone substitute and 2) if the presence of *P. indica*stimulates auxin production in the basal stem tissue of cuttings. Sterilized perlite was inoculated with *P. indica* and then incorporated into a peat-based propagation media at three rates (10, 20, or 30%, v/v) to determine the optimum chlamydospore count per volume of media. Each treatment contained the same total volume of perlite with a varying percentage of inoculated perlite. Species used in this experiment were *Crossandra, Dianthus* (perennial), and *Osteospermum*. Four weeks after sticking the cuttings, the plants were evaluated for the root colonization as well as root fresh weight. *Crossandra* and *Dianthus* cuttings propagated in media with 10% v/v of inoculated perlite produced significant higher root fresh weight ($P < 0.01$). No root weight response was observed for *Osteospermum*. Colonization was not quantified due to previous research stating there being benefits of the fungi simply the presences in the media. Colonization was simply noted but not quantified. Endogenous auxin (IAA and IPA) concentrations were determined on basal sections of cuttings through HPLC-based quantification. Samples were taken from *Dianthus* cuttings grown with (10% v/v inoculated perlite) and without *P. indica* after five days in propagation. Basal sections of cuttings grown with inoculum contained significantly higher amounts of auxin.

12:30–12:45 PM

Chilling Duration Affects the Microshoot Elongation of 'G.30' Apple Rootstock

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Micropropagation is an alternative to regenerate some highly desired and difficult to propagate rootstocks. The multiplication phase requires rapid shoot growth and lateral branching. During the initial phase of nodal culture, shoot elongation can be inhibited which may be caused by endodormancy when cultures are initiated from axillary buds collected in summer. The objective of this study was to overcome the repressed shoot elongation by chilling cultures, which were about 1.5 cm length stem with a single node cultured in MS media. The cultures were put in an incubator at 4 °C for 0, 0.3 (2 days), 4, 6, or 8 weeks. Then cultures were moved to the regular culture room to let shoots sprout. The shoots were transplanted to MS media with 0.5 mg/L GA, 1.0 mg/L BA, 0.1 mg/L IBA, and media pH at 5.6 to 5.8. After 42 days culturing, number of lateral shoots, length of the longest shoot, and number of elongated shoots were measured. As chilling duration increased, the microshoot growth increased. Although the highest number of elongated shoots (0.7) occurred in the cultures chilled for 8 weeks, they had a similar number of lateral shoots (0.9) and lateral shoot length (1.6) as 6 weeks chilling. The highest number of lateral shoots (1.6) and the longest shoot length (1.9) were obtained by chilling the initial cultures for 6 weeks, which was significantly higher than that for chilling 0 (0.4 and 1.3) and 0.3 (0.1 and 0.5) weeks, but not significantly higher than chilling 4 (1.4 and 1.7) and 8 weeks.

High concentration of GA, 4 mg/L, increased microshoot growth compared to 0.5 mg/L, but not as much as 6 weeks chilling. Chilling nodal cultures was the most effective method of promoting microshoot growth in G.30 apple rootstock.

12:45–1:00 PM

Water Quality Effects on Grafted and Non-grafted Citrus

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Citrus production in Texas, currently valued at approximately $75 million, is the third largest citrus industry in the U.S., with Hidalgo and Cameron Counties in the Lower Rio Grande Valley (LRGV) accounting for more than 98% of bearing acres. In recent years, the citrus industry in the U.S. and the LRGV in particular, has been facing numerous challenges with emerging diseases and recurrent droughts. Increased water deficits and other drought-related issues such as increased soil salinity have prompted the need for efficient water management strategies, including alternative water sources, and adoption of stress tolerant varieties to mitigate the effects of drought, salinity, and to meet population needs along the U.S.–Mexico border. Currently, the Rio Grande River provides most of the irrigation and domestic water in the LRGV, but proximity to the Gulf of Mexico limits groundwater use for crop irrigation in this area due to salt-water intrusion. Grafting can enhance plant yield, disease resistance, promote better quality plants, fruits, and salinity tolerance for certain crops. Among the requirements for rootstocks in the LRGV are tolerance to calcareous soils, salinity, and resistance to Citrus Tristeza Virus (CTV). Sour Orange (SO) has been a standard rootstock used when soil conditions are alkaline and clayey; however, alternative rootstocks are being considered due to SO susceptibility to CTV. Several newer rootstock varieties meet the requirements needed in the LRGV and are CTV resistant; C22 and C146 rootstocks are among the most promising. The objective of this study was to assess salinity tolerance of these citrus rootstocks, and determine if low-quality water can be used for irrigation. This experiment utilized a simulated brackish water solution applied at five levels of electrical conductivity to assess salinity tolerance, physiological changes and general tree health of Olinda Valencia grafted on SO, C22, or C146 rootstocks. At 1 dS/m, the average height of seedlings grafted on SO and C22 was increased by approximately 33%, but reduced by nearly 71% for seedlings grafted on C146. However, at salinities higher than 5 dS/m, height was reduced by at least 36% for all grafted plants compared to the control. Non-grafted C22 and C146 plants irrigated with 5 dS/m water showed a 27% and 46% increase, respectively, while SO rootstocks showed a 54% height reduction. The interaction between rootstock and salinity indicates that future research should focus on finding optimal rootstock–scion combinations and alternative incremental irrigation with low quality water.

Friday, August 3, 2012 Balmoral

Marketing and Economics

Moderator: Kristin L. Getter
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11:45 AM–12:00 PM

Do You See What I See? Eye-tracking Research Shows Where Consumers Look in Holiday Plant Displays

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Eye-tracking hardware, adapted from the medical field, is a relatively new and helpful instrument in consumer research. The technology gives researchers more measurable and precise knowledge of what consumers are looking at when they view images. By tracking saccades (eye movement) and fixations (eye movement stops), researchers are able to tell at what consumers are looking and for how long. The number of eye fixations, not duration, is positively related to the amount of information a consumer is able to extract from an advertisement (Wedel and Pieters 2000). The purpose of our study was to evaluate consumer perceptions of holiday displays. We used Tobii (Danderyd, Sweeden) eye-tracking glasses in Nov. 2011 to evaluate three displays containing holiday plants in one Detroit, MI, area garden center. Twenty-seven consumers, after signing an informed consent form, were paid a $10 incentive to wear the glasses and viewed displays. Consumers rated these on attractiveness and how likely they would be to purchase

an item from that display (1 = not at all likely, 10 = extremely likely). Areas of interest were drawn on the display images to evaluate where more of their gaze occurred: top v. bottom and left v. right. Areas of interest are geometric shapes which can be drawn on the image from which gaze data can be analyzed. Results showed that consumers looked more (fixation duration and count) at the bottom of the displays compared to the top and looked more to the right compared to the left. These results can help retail professionals more effectively place information (e.g. price or content) to where consumers' gaze naturally migrates.

Specified Source(s) of Funding: Michigan State University Project GREEEN

12:00–12:15 PM

An Investigation of United States Apple Producers Trait Prioritization—Evidence from Clicker Surveys

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Apple breeders are continually being challenged to meet supply chain members' expectations through developing superior apple cultivars; however, few studies address how apple traits are prioritized. This study was conducted as part of a larger study to determine important apple traits to all of the industry's supply chain members. Specifically, the focus of this study was the importance of fruit/tree quality traits to apple producers; the traits included fruit crispness, fruit juiciness, fruit flavor, brix, sugar-acid balance, shelf life at retail, freedom from storage disorders, disease resistance, and other. An ordered probit model was used to investigate the relative importance of the apple traits to producers. Results show that producers identified fruit flavor and fruit crispness as more important than fruit firmness, shelf life, sugar-acid balance, freedom from storage disorders, disease resistance, °Brix, and fruit juiciness. Regional differences were also noted. Specifically, disease resistance was more important to Southeastern producers than Northwestern producers. Additionally, fruit crispness was more important to Midwestern producers than producers from other regions. Our findings provide insights to producers' preferences for traits which can be of assistance when breeders develop new apple cultivars.

12:15–12:30 PM

Contribution of USAID Firms Project to Develop Horticulture Sector in Pakistan

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The 4-year USAID Firms Project began in May 2009, and is aimed to improve government service delivery and to develop dynamic, internationally competitive firms to accelerate sales, investment, and job growth. Horticulture sector is one of the significant contributors to the GDP of Pakistan and has a high potential of employment generation and export. In view of these factors, the Firms Project first intervened in Pakistan's Mango Sector to improve orchard management systems and cultural practices and to provide technical and financial assistance to farmers for their GlobalGAP certification. In the last three years, the capacity of more than 1000 mango orchards was enhanced to get high yield with good quality. So far, 30 mango farms have achieved GlobalGAP certification with the help of technical and financial assistance of the project. Moreover, 15 new on-farm pack houses, equipped with blast chiller, cold storage, hot water treatment, processing line etc., have become functional, which will accelerate mango export. The project also undertook successful trial sea shipments to high end European markets to prove its viability, which would help export large volume of mangoes to the European Union (EU) with less cost. Pakistan is not in the business of dried mangoes, but is expanding exponentially. The project introduced first-time local dried mangoes in Pakistan and dispatched sample shipments to the United States and the EU to gauge market response. Also, Pakistan is the 4th largest date producer in the world, but it exports 95% of dates in dried form to regional counties with a very small share of fresh dates for table purpose. To improve the economic value generated by the date sector, the Firms Project started work on the entire value chain by improving

production practices and decreasing preharvest losses by introducing Tyvek bags and improving the harvesting, storage, and processing techniques; and providing technical and financial support. In collaboration with the PepsiCo International, the USAID Firms project contracted with 500 potato growers to cultivate the 'Lady Rosetta' potato on their farms with a buy back guarantee of the quality produce in conflict-hit area of Swat (KPK) so that local farmers can get better returns. This initiative also generated immense employment opportunities. FIRM Project strategy revolves around developing the capacity of stakeholders, ensuring sustainability, promoting gender, providing technical and financial support, and developing market linkages. All these are leading to higher sales, more exports and greater number of employment opportunities.

12:30–12:45 PM

The Effects of the Consideration of Future Consequences on Willingness to Pay Decisions for Plant Attributes

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We investigate how differences in the consideration of future consequences (CFC; Strathman, Gleicher, Boninger, & Edwards, 1994) influence consumers' willingness to pay for edible and ornamental plants using data from second-price auction choice experiments conducted in the U.S. and Canada (N = 159). Based the recent empirical and theoretical findings about the CFC effects on individual choice decision making, the present study investigates the relationship between CFC scale and willingness to pay for plant attributes related to production methods, container types, and product origin. Results from conjoint choice analysis showed that participants scoring high in the CFC scale were willing to pay a higher premium for plants grown using sustainable, energy-saving and water-saving production methods. In contrast, participants scoring low on the CFC scale were not interested in paying price premiums for production related characteristics that may be associated with distant environmental benefits. Further, the results showed that higher CFC scores were positively associated with preference and willingness to pay for locally produced plants. Implications for effective marketing of edible and ornamental plants are provided in addition to the theoretical contributions to the CFC literature.

Specified Source(s) of Funding: USDA Federal-State Marketing Improvement Program

12:45–1:00 PM

Influencing Consumer Perceptions and Purchases of Christmas Trees and Poinsettias through a Statewide Marketing Campaign

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Christmas tree and poinsettia sales are static or declining nationally and in Michigan, in terms of number of producers, number of units produced, area in production, and overall profitability. To reverse this trend, an educational media campaign ("Make it a Real Michigan Christmas") was in operation from 1 Nov. to 25 Dec. 2011 to encourage Michigan residents to buy live Christmas trees and poinsettias. The campaign goals were to preserve or increase sales and people employed in plant production with three key messages: buying real products helps preserve or build Christmas traditions while being an economically, emotionally, and ecologically beneficial choice. To partly assess the effectiveness of the campaign, a pre- (27 Nov. 2011 through 29 Nov. 2011) and post- (17 Jan. 2012 through 20 Jan. 2012) online consumer surveys were conducted. The surveys queried participants past year purchases of Christmas trees and poinsettias, asked attitudinal questions about the benefits of real versus artificial foliage, and had participants rank their favorite and least favorite poinsettias (pictures) by color (traditional red, pink, multicolored, blue, and white). A total of 999 respondents (508 in 2011 and 491 in 2012) participated with a mean age of 60.3 years, of which 66% and 33% were female and male, respectively. Almost half of respondents had a self reported income of $20,000–$59,999 per year. Roughly 30% of participants purchased Christmas trees (real or artificial) and at least one poinsettia for both survey years. Of the purchased Christmas trees, over half (62.5% and 61.1% in the 2011 and 2012 survey, respectively) were live trees. The Number of purchased poinsettias and Christmas trees did not differ between survey years, which may be due to the low awareness of the campaign (4.1%). However, post-participants did more strongly agree with the statement that purchasing a real Christmas tree or poinsettia supports Michigan businesses and farmers than pre-participants. Red poinsettias are still purchased more often than other colors and fewer poinsettias in general were purchased from mass merchants in 2011 than 2010. Participants with higher incomes purchased more poinsettias and live Christmas trees than participants from lower income brackets. Higher income participants favored traditional red poinsettias more than lower income participants and higher income participants disliked blue poinsettias more than lower income participants.

Specified Source(s) of Funding: Specialty Crop Block Grant Program–Farm Bill

Friday, August 3, 2012 **Sandringham**

Consumer Horticulture and Master Gardeners

Moderator: Christine Coker
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12:30–12:45 PM

Armed Forces Retirement Home Green Roof Assessment

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The Armed Forces Retirement Home–Gulfport (AFRH–G) closed its doors after almost 30 years of operation in Aug. 2005 as a result of Hurricane Katrina. Residents were evacuated from the facility and many chose to live at the Armed Forces Retirement Home–Washington (AFRH–W) until they could return to Gulfport. Congress authorized approximately $240 million for the rebuild of the Gulfport home. Construction began in Jan. 2008. Under current regulations, Federal agencies are required to ensure that new construction and major renovation of agency buildings comply with the *"Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings"* set forth in the Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding. Additionally, Federal agencies must ensure that 15 % of the existing Federal capital asset building inventory of the agency as of the end of fiscal year 2015 incorporates the sustainable practices in the "Guiding Principles..." One of these guiding principles is the pursuit of cost-effective, innovative strategies, such as highly reflective and vegetated roofs, to minimize consumption of energy, water, and materials. To meet these sustainable building criteria, the design of the new AFRH–G included nearly 2 acres of accessible green roof. The green roof was installed in April 2010. Care for the green roof was to be maintained by the grounds keeping contractor. No specific guidance was given to the grounds crew or the Director of Campus Operations as to how to care for a vegetated roof. As a result there has been low plant survival, which increases the maintenance costs and decreases the environmental benefits of the green roof. Not only does this green roof provide environmental benefits, it is also accessible to residents living on the second floor of the complex. For residents of higher floors, the roof provides an aesthetic view shed. In 2011, Certified Green Roof Professionals from the Mississippi State University Coastal Research and Extension Center began working with the facility to rehabilitate the existing roof and provide a maintenance plan. A strategy was developed to better maintain the green roof's environmental integrity and to improve the residents' experience with the green space. Collection of baseline information will allow researchers to assess the performance of the green roof, providing much needed information regarding green roof vegetation, design, and environmental tolerance for the Gulf South.

12:45–1:00 PM

CSU Lawncheck: Colorado's On-site Lawn Diagnostics Service

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Lawn problems rank among the top three horticultural concerns brought to Colorado State University Extension offices in most urban and suburban counties. Begun in 2006 using an Extension-funded venture capital grant, Lawncheck is a fee-based ($75 per visit), on-site, lawn consultation and diagnostic service offered by six urban Front Range Colorado counties. Because agents and specialists participating in the CSU Lawncheck program have no vested interest in marketing products, equipment, or lawn services, customers can confidently verify the cause of lawn problems (and solutions), knowing it comes from a trusted and unbiased information source. A survey of 198 Lawncheck customers (49% return rate) showed that 92% of respondents felt they "received their money's worth," and 99% said they would recommend the service to someone else; 61% said they saved money as a result of their Lawncheck visit. Notable survey results include: 60% changed their lawn watering practices, adjusted sprinklers (37%), and reduced the amount of water applied to the lawn (22%) as a result of the visit. Forty percent adjusted the amount of fertilizer applied to their lawn and 19% reduced pesticide use on their lawns. The CSU Lawncheck program has become a significant generator of user fees for the six counties

that offer this service. The URL of the CSU Lawncheck website is: http://www.colostate.edu/orgs/lawncheck/index.html

1:00–1:15 PM

Getting Others to Actually Do IPM: A Communications Tutorial

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A communication tutorial was developed to help Extension Master Gardeners (EMG) and Extension Professionals (specialist, agents, program coordinators) understand and use Extended Parallel Process Model (EPPM) to create messages aimed at increasing IPM behaviors. EPPM is a venerable, scientifically driven communication theory designed to help increase adoption of healthy behaviors. This two-factor theory predicts that people tend to evaluate threats of harm in terms of 1) susceptibility and 2) severity. This IPM "train-the-trainer" tutorial fills a gap in existing training material by focusing on behavior change instead of knowledge. It consists of a 16-minute video; a pdf file of the presentation; a 7-question review quiz; and a list of IPM resources. In addition to using EPPM theory, the tutorial also employs a scientific content analysis of a representative sample of gardening questions submitted to the eXtension "Ask An Expert" database. Using both severity (how bad it could be) and susceptibility (how likely is it) messages, EMG articulate the value of IPM by expressing threats to 1) gardeners themselves, 2) others, 3) their plants, and 4) the environment. Part 2 of the tutorial is the presentation as a 17-page pdf file, which participants can download and print for taking notes or future use. A short 7-question quiz is Part 3 of the tutorial and verifies that participants understand the terms efficacy and threat, and encourages them to write a sample message based on typical gardening questions they have received. When completed, the quiz validates their participation with a 1 hour continuing education certificate which can be submitted to their program coordinator. Most EMG programs require continuing education. The final Part 4 of the tutorial is a list of IPM resources on the fundamentals and how to do IPM. The tutorial is in the online campus of eXtension: http://campus.extension.org/ in the Master Gardener section and is free and available to anyone with internet access. This tutorial is a preliminary step in developing new communication methods to encourage gardeners to adopt IPM practices.

Specified Source(s) of Funding: North Central IPM Center

1:15–1:30 PM

Getting Help with Consumer Horticulture Questions

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Extension offices around the country are often a source for consumer gardening questions. With recent budget cuts resulting in reduction in staff in many offices, Extension is left with the question, "How do we handle the gardening questions?" Rather than send the clientele to another source outside of Extension, County office staff can refer them to the eXtension Ask an Expert (AaE) widget located on County home pages, state pages, and other various portals of entry to the University. The AaE program helps to address the issue of not having sufficient staff to answer questions. Minnesota, Michigan, and Ohio have trained Master Gardener volunteers on the AaE widget to be used to assist the Educators and county staff with these consumer gardening questions. This presentation introduces the AaE system developed through eXtension as well as the logistics involved in training volunteers, managing the system, pitfalls to be aware of, and ensuring that research-based information is used by the volunteers. Through the use of the AaE project, Extension offices can remain the "face" of consumer horticulture in the state while at the same time, addressing County Extension office needs.

1:30–1:45 PM

Adopt-A-Tree: A Reforestation Program to Replace Lost Urban Canopy due to Disasters in South Florida

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Miami–Dade County Florida has an average tree canopy cover of less than 10%, compared to the national average of over 30%, with some areas having only 2% canopy cover. This low tree canopy coverage is due in part to losing one-half million backyard trees to the Citrus Canker Eradication Program. Countless additional trees have been lost from hurricanes and floods. To help replace lost tree canopy, Miami-Dade county applied and received a $6,000,000 grant which was used to create the "Adopt-A-Tree" Program. This allows Miami–Dade County homeowners to "adopt" two high quality locally grown trees per year. Tree adoption events are held throughout the county, with priority given to areas with the poorest tree canopy. University of Florida/IFAS Miami–Dade County Extension faculty provided input on program development and horticultural advice, conducted grades & standards workshops for nursery growers, developed bilingual (English and Spanish) educational materials, and staffed "adoption" events. As part of the "adoption" process, homeowners must attend an educational component before receiving trees. This includes a hands-on demonstration of correct planting procedures, which is important for our very shallow soils. Extension's educational materials are distributed to participants as part of the "adoption" process. Since 2001, over 220,000 people have been taught basic tree care; over 164,000 trees have been distributed at "adoption" events. Fruit trees are the most

popular and non-flowering native trees the least popular. Program participants were surveyed one to two years post-adoption. An average of 79.2% trees survived, 96% of participants stated that the program met or exceeded their expectations, and 94% said that the educational materials were useful. In addition to the main goal of reforesting the county, this program has produced several additional effects: increased public awareness of the Extension office as an educational resource, improved quality of nursery trees, and increased knowledge of proper tree care. The number of trees to be distributed will eventually total 184,000 and is by far the largest urban reforestation project of its kind in Florida.

1:45–2:00 PM

Impacts and Lessons Learned from the "Growing a Garden 101" School Garden Project

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A year-long school garden program funded by the Environmental Protection Agency's Environmental Education Grant was developed and implemented to determine if student's environmental stewardship would increase as a result of participation in outdoor learning environments, namely school gardens. Eleven schools (middle and high school level) that did not have a school garden program were recruited for the project. One to two teachers from each school attended a full day school garden workshop. The teacher workshop included information ranging from designing a garden to garden construction, maintenance, planting schedules, a site visit to a school garden and curriculum to tie the garden to their classrooms. Teachers were given pre and post workshop surveys as well as an end of the year survey to determine their comfort levels in teaching a new subject area. Teachers returned to their individual schools with technical horticulture information and $700.00 in supplies needed to start a small garden. Participating students were given pre and post Children Attitudes Toward the Environment (CATES) surveys to assess their environmental stewardship levels both before and after participation in the school garden. Each school was visited twice during the year and regular email correspondence occurred between the teachers and the program investigator. In addition to individual correspondence, participating teachers received a quarterly school garden newsletter highlighting important garden information throughout the year. Results from the study indicated that after attending the workshop teachers were more confident in their ability to design and construct a garden space and also more confident in their knowledge of planting schedules. Although participating students scored significantly higher ($P \leq 0.05$) on certain questions on the CATES survey their overall scores did not significantly increase. All 11 participating schools were successful in establishing and maintaining a garden. All 11 schools were successful in harvesting produce from their gardens. With the exception of one school all participating schools said they would continue growing the garden with students after the grant funded year and most had plans to expand the garden space.
Specified Source(s) of Funding: EPA Environmental Education Grant Region 6

2:00–2:15 PM

Train Extension Volunteers to Track Climate Change by Monitoring Phenology

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Phenology is the study of recurring life cycle changes such as flowering, breeding, migration; their timing; and relationship to weather and climate. Because many such phenomena are sensitive to small variations in temperature, phenological observations provide insight into timing changes as species respond to amplified climate variability and change. Shifts in phenological phenomena have implications for traditional Extension clientele groups from farmers to game managers, gardeners to beekeepers. Giving clientele a method for recording the footprint of a changing climate on the plants and animals they routinely observe, should motivate them to develop adaptation strategies in their own interest. The need for systematic collection of long-term phenological data, and the opportunities for involving citizen–scientists in doing so, led to the 2005 launch of the USA National Phenology Network (USA–NPN) by a consortium of federal agencies, universities and NGOs. Since 2005, the NPN has developed cyber-infrastructure behind a web page *(Nature's Notebook)* for use by citizen–science monitors; developed protocols for data collection and entry; and developed a list of target species for each state. These steps set the stage for Extension faculty to train citizen-scientist observers for the network. The objectives of the presentation are to introduce the idea of reaching out to citizen scientists for assistance with collecting and analyzing phenology data; to demonstrate how these volunteers have been educated to collect accurate, quality driven data; and discuss lessons learned from the experiences in various state Extension programs.

Friday, August 3, 2012 Windsor

Ornamentals/Landscape and Turf 2

Moderator: Brian J. Pearson
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12:45–1:00 PM

Bud Development, Flowering, and Fertilization of *Moringa oleifera* Lam. (Horseradish Tree) Grown in South Africa

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Moringa oleifera is becoming increasingly popular as an industrial crop due to its multitude of useful attributes as water purifier, nutritional supplement and biofuel feedstock. Given its tolerance to sub-optimal growing conditions, most of the current and anticipated cultivation areas are in medium to low rainfall areas. This study aimed to assess the effect of various irrigation levels had on floral initiation, flowering and fruit set. Three treatments namely, a 900 mm (900IT), 600 mm (600IT), and 300 mm (300IT) per annum irrigation treatment were administered through drip irrigation, simulating three total annual rainfall amounts. Individual inflorescences from each treatment were tagged during floral initiation and monitored throughout until fruit set. Flower bud initiation was 65.3% higher at the 300IT and 4.6% higher at 600IT compared to the 900IT. Fruit set however, was 22.0% lower for the 300IT and 4.4% lower for 600IT, compared to the 900IT. Floral abortion, reduced pollen viability, as well as moisture stress in the style were contributing factors to the reduction in fruiting/yield observed at the 300IT. Moderate water stress prior to floral initiation could stimulate flower initiation, this should however be followed by sufficient irrigation to ensure good pollination, fruit set, and yield.

Specified Source(s) of Funding: National Research Foundation, South Africa

1:00–1:15 PM

Planting Systems for Improved Stands of Fall Planted Native Perennials

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Reliable commercial seed production of native plants is needed to restore rangelands of the Intermountain West. Direct seeding of native range plants for seed production has been generally problematic, especially for certain species. Fall planting is important, because seed of many species requires a period of cold to break dormancy (vernalization). Loss of soil moisture, soil crusting, bird damage, and other factors hinder emergence of fall planted seed. In previous research, the complexity of testing single factors has impeded successful stand establishment. A research approach was used testing stand establishment systems consisting of multiple factors. This trial tested the effect of four system components on emergence of seed of six species surface planted in Fall 2010 and Fall 2011: 1) row cover as a protective barrier against soil desiccation and bird damage; 2) sawdust as a substitute for the protective effect of organic debris; 3) sand to help hold the seed in place; and 4) seed treatment for protection from seed decay and seedling loss to fungal pathogens. The treatments did not test all possible combinations of factors, but tested the combinations that might work together to provide adequate stand establishment. All treatment combinations also had rodent control, a drip tape irrigation system if necessary (not used), and distractions for birds. Excellent stands were achieved for problematic species. Averaged over the two years, row cover with seed treatment and sawdust improved emergence compared to no row cover with seed treatment and sawdust for *Achnatherum thurberianum*, *Penstemon deustus*, *Heliomeris multiflora*, and *Balsamorhiza sagittata*. Row cover with seed treatment and sawdust improved emergence compared to no row cover with seed treatment and sawdust for *Penstemon acuminatus* only in 2011. Adding sawdust to row cover with seed treatment did not improve emergence for any species, but reduced emergence for *P. deustus*. The effect of systems with and without seed treatment on emergence differed by year. Adding seed treatment to row cover and sawdust did not improve emergence for any species and reduced emergence for three species in 2010. In 2011, adding seed treatment to row cover and sawdust improved emergence for three species. Precipitation in March, when emergence starts, was higher in 2011 (3 inches) than in 2010 (0.6 inches). Adding sand to row cover, seed treatment and sawdust did not improve emergence for any species.

Specified Source(s) of Funding: Great Basin Native Plant Selection and Increase Project

1:15–1:30 PM

Influence of Pine Bark Mulch and *Salvia farinacea* on Stormwater Runoff and Leachate from Simulated Landscape Soil Boxes

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Application of mulch and modification to soil structure resulting from plant root growth can alter landscape hydrology and influence runoff and leachate volume production. To examine these relationships in a simulated residential landscape, 18 lysimeters were filled with three sandy soil compositions representative of those found in newly constructed residential communities in central Florida. Pine bark mulch was applied to the soil surface and *Salvia farinacea* were transplanted within each lysimeter.

Precipitation designed to mimic natural rainfall was applied at an intensity of 1.3 cm per hour for a duration of 15 minutes to simulate local historical weather data. Relationships between presence of mulch, plant growth, and soil texture as they influenced partitioning between stormwater runoff and leachate will be discussed.

Specified Source(s) of Funding: FNGLA

1:30–1:45 PM

Improving Environmental Performance of Landscapes: Sustainability, LCA, Sites

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Environmental awareness has given way to multiple concrete actions including voluntary standards for environmental metrics. The popular LEED, FSC, SITES programs are prominent examples of green product certifications that have grown in importance to the overall market. Both positive progress and unintended consequences have resulted from companies' efforts to improve the environmental performance of their products. Recently life-cycle assessment (LCA) tools have become more accessible for use by suppliers and consumers in planning and procurement decision-making. The emerging role of LCA and sustainably certified products is the focus point for this discussion. A review of the major sustainability initiatives will show how the leading producers of raw and manufactured products are hewing to a common platform of evaluation criteria. Despite the commonality of these evolving sustainability criteria, both consumers and the producers have much to learn. Today there are far too many certification requirements for growers to address. The Sustainable Sites Initiative, also known as SITES, will be used as an example of a voluntary standard. The goal of improving the environmental performance of landscapes is complex and involves tradeoffs. LCA rating systems provide a new and important method for analyzing tradeoffs required by green designs. The pros and cons of each, and the hard choices available to producers, landscapers and consumers can be viewed through the lens that LCA and sustainable criteria provide. Despite the continuous improvements in efficiency and product quality, modern plant production practices have been largely ignored in the process of formalizing common sustainability metrics. Essential ingredients and processes used in conventional horticulture have been poorly understood and even marginalized. Peat moss will be used as an example of how environmental progress may lead to unintended consequences. An essential product for plant media in the production of plug-and-liner and high-end starter plant industry, peat moss has been vilified without an analysis of the science or practical alternatives of use by the horticultural industry. Today and tomorrow's considerations for sustainable sourcing and the use of LCA in decision-making will continue to evolve.

1:45–2:00 PM

Landscape Evaluation of Roses at the LSU Agcenter

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The LSU AgCenter has a long history of rose cultivar evaluations. Knock Out, Earth Kind, All-America Rose Selections and Griffith Buck roses have been evaluated in landscape settings at the Hammond Research Station in Hammond and at Burden Center in Baton Rouge. Recently completed evaluations include the Drift series roses. The initial 6 cultivars released Red, Pink, Sweet, Coral, Apricot, and Peach have been observed for visual quality and blackspot susceptibility in a randomized complete-block replicated planting at the Hammond Research Station. Data were collected 2009, 2010, and 2011. Plants are located in full sun in raised landscape beds. Fertilization is applied twice annually. Plants are mulched with pine straw for weed suppression. Occasional applications of glyphosate are applied to weeds in the area for post-emergent control. Plants are irrigation via a drip system to prevent stress. Light pruning is conducted mid February and early September annually. Plants are rated for visual quality three times annually (spring peak bloom, early summer, and fall peak bloom) using a scale from 1 to 5 where 1 = dead, 2 = below average, 3 = average, 4 = above average, and 5 = superior performance. Blackspot ratings on foliage are taken at the same times and a rating scale of 1 to 6 is used with 1 = 0% foliage with blackspot, 2 = 1% to 10% foliage with blackspot, 3 = 11% to 25% foliage with blackspot, 4 = 26% to 50% foliage with blackspot, 5 = 51% to 75% foliage with blackspot, and 6 = 76% to 100% foliage with blackspot. Most cultivars have shown only minor susceptibility to blackspot. Visual quality ratings have consistently indicated above average landscape performance for all Drift rose cultivars.

2:00–2:15 PM

Impact of Biopots on Plant Performance and Pot Degradation in Landscapes

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Horticulture industry professionals and consumers are interested in biodegradable pots as alternatives to plastic pots given their perceived environmental sustainability. Research is underway investigating the impact of biopots on plant growth and development, durability of biopots for commercial production and shipping practices, and pot degradability after being planted in landscapes. This presentation reports first-year results on the impact of seven plantable biopots and one plastic pot on the performance of three ornamental species, *Impatiens* × 'Sunpatiens Compact Magenta', *Cleome* × 'Senorita Rosalita', *Lantana* x 'Luscious Citrus' in five landscape locations (IL, KY, MS, WV, and TX) and the degradation of these biopots at the end of the growing season. The seven biopots were Jiffy pot (peat moss), SoilWrap (bio-polymer), Fertilpot (wood pulp), coir (coconut fiber), Cowpot (composted cow manure), NetPot (slotted pressed rice hulls), and straw pot (rice straw). As a comparison, 4-inch plastic pot was included. Rooted cuttings of the above plants were potted into these eight types of pots and grown in the greenhouses at five locations until marketable sizes before being transplanted to respective landscapes. The experiment was a completely randomized design with three replications and three subsamples. Due to differences in climate conditions among different locations, the experiments were terminated in each location when the growing degree day reached to 4630 with a base temperature of 40 °F. Upon termination, shoot dry weight was determined after oven dried. All pots were dug out, cleaned, rated visually, and dried in the oven. The degradation percentage was determined by comparing the dry weight of the dug pots with the dry weight of the new pots. Results from El Paso, TX, indicated that plant species did not affect the pot degradation. The degradation percentages of the seven biopots at the end of the growing season were 92%, 82%, 66%, 50%, 49%, 39%, and 5% for SoilWrap, Cowpot, Fertilpot, Jiffy pot, straw pot, coir, and NetPot, respectively. The impact of pot type on plant growth varied with time. Based on the bi-weekly measurement of plant growth index, plants in SoilWrap grew better, followed by NetPot and Jiffy pot, and plastic pots produced smallest plants. However, the effect of pot type diminished as plants grew. The final shoot dry weight of lantana was greatest in SoilWrap and smallest in plastic pots, but no differences were found among other pot types.

2:15–2:30 PM

Deficit Irrigation of Mixed Landscapes Based on Turfgrass Coverage and ETo

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Landscape irrigation can exceed half the water consumption of residential properties. To reduce this, our research tested two hypotheses. First, that irrigation frequency based on turfgrass water needs is sufficient for irrigation of woody shrubs and trees within a mixed landscape. Second, that warm season *Stenotaphrum secundatum*, St Augustine turfgrass can maintain an aesthetically pleasing appearance at irrigation volumes and frequencies less than predicted by Penman-Monteith ETo. Data was collected during the first year after plant establishment from 1 June 2010 to 31 May 2011 from nine drainage lysimeters in central Florida. Lysimeters had a surface area of 13 m^2 each and were greater than 1 m deep. Each contained two *Viburnum odoratissimum*, one *Magnolia grandiflora* 'D.D. Blanchard' magnolia, and 9.7 m^2 of 'Floratam', St. Augustine turfgrass. Irrigation regimes of 60%, 75% and 90% of ETo were adhered to throughout the year and adjusted for rain events. Irrigation occurred when cumulative depth of ETo exceeded 1.90 cm. All magnolias and viburnum hedges displayed aesthetically pleasing quality, independent of deficit irrigation level (DI). Turfgrass quality varied among DI levels, yet were above the minimum acceptable quality. Results indicate 'Floratam' turfgrass can be irrigated at 60% of ETo equation in central Florida during a dry year, and still maintain acceptable aesthetic quality. This frequency also maintained acceptable quality of magnolia trees and a typical woody hedge when concurrently irrigated at 43% ETo based on horizontal projected canopy area.

Specified Source(s) of Funding: Southwest Florida Water Management District

2:30–2:45 PM

Response of Selected Landscape Roses to Low-input Cultural Practices, High Disease Pressure, and Severe Heat and Drought Conditions

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The major purpose of this 5-year Earth-Kind® research study was to document the responses of 100 cultivars of landscape roses to low-input cultural practices and heavy black spot disease pressure, followed by severe heat and drought conditions. Cultivars, over half of which are winter hardy to at least Zone 5, were chosen based on their reputations of being strong performers in low maintenance landscapes and represent a range of floral characteristics, release dates, and plant habits. Planted in moderately alkaline, calcareous clay soils in a public park in Farmers Branch, TX, a suburb of Dallas, these roses received no soil amendments, no fertilizer, no pesticides of any kind, no removal of spent blooms, and almost no pruning. A three-inch-thick mulch of raw wood chips mixed with tree leaves was applied to the soil surface and maintained at this thickness throughout the study. During the fourth year of the study, the plants were subjected to an 89.3% reduction in supplemental irrigation during the worst drought in this area in the past 75 years. Landscape performance, including disease tolerance, was exceptional for approximately 20% of the cultivars. Many of the cultivars have equaled or exceeded the mature height and width dimensions listed in reference sources. Some cultivars were resistant to black spot, whereas other cultivars were heavily infected with this disease. Only a few cultivars displayed significant levels of powdery mildew, Alternaria petal blight, or Cercospora leaf spot. Reaction to severe, prolonged heat (up to 110 °F) and drought conditions (12 month duration) were mixed: approximately 10% of the cultivars were severely impacted, 50% of the cultivars showed significant drought stress, and the remaining 40% exhibited only minor symptoms of foliar drought stress. The plants received supplemental irrigation only three times during this very stressful 12-month period. Results of this study identified multiple rose cultivars suitable for growing in low-input landscapes consistent with the Earth-Kind management strategy.

Friday, August 3, 2012 **Dupont**

Growth Chambers and Controlled Environments

Moderator: Gioia D. Massa*
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1:00–1:15 PM

Media Effects on Lettuce Growth in "Pillows" Designed for the VEGGIE Spaceflight Growth Chamber

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VEGGIE is a prototype vegetable production unit for space designed by Orbital Technologies Corporation that is being developed to fly on the International Space Station. A modular plant rooting system "pillow" is being designed to support plant growth in VEGGIE under microgravity conditions. VEGGIE pillows are small self-contained packets of media with time-release fertilizer that can wick water passively from a root mat reservoir. Seeds are planted in pillows and the entire root system of a plant is contained as the crop develops, preventing loss into the spacecraft cabin. This study compared five media types and three lettuce cultivars in pillows growing in a VEGGIE analog environment. Media consisted of a peat-based potting mix (Fafard #2, Conrad Fafard Inc., Agawam, MA), and a calcined clay, (arcillite, 1–2 mm sifted, Turface Proleague, Profile LLC, Buffalo Grove, IL) as well as three different blends of the two, 70:30, 50:50, and 30:70. Lettuce cultivars tested were 'Sierra', a bi-colored French crisp Batavia lettuce, 'Outredgeous,' a red romaine lettuce and 'Flandria,' a green butter head variety. Plants were grown for 28 days, harvested, biometric data was obtained, and tissue mineral analysis was performed. For all cultivars, lettuce plants grown in the media blends were more productive than those in the individual media types. All cultivars showed bell-shaped curves in response to increases in arcillite/decreases in Fafard #2 for leaf area, fresh, and dry mass. Plants in 100% Fafard #2 and in 100% arcillite were stunted, but only those in higher levels of Fafard #2 (70% and 100%) had reduced shoot percent moisture, possibly indicating that mechanisms causing stunting differed. Variation in tissue nutrient content are consistent with this, with Mg and Mn highest in plants grown in 100% Fafard and decreasing as the concentration of arcillite increased. Color also varied with media, especially in the 'Sierra' lettuce, with plants grown in increasing levels of Fafard #2 being much more red and those in 100% arcillite almost completely green. The red-leaf cultivar 'Outredgeous' showed increasing chlorophyll (SPAD values) with increasing percentage of arcillite. In all cultivars tested it appears that a mixture of media types, usually 50:50 or 30:70 Fafard #2: arcillite, sustained healthier, more productive plants. Smaller, less productive plants in either of the individual media may indicate stress issues, however more work is needed to understand the reasons for this sub-optimal growth.

Specified Source(s) of Funding: NASA

1:30–1:45 PM

Light-emitting Diodes (LEDs) as a Sustainable Alternative for Lighting Greenhouse-grown Tomatoes

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Optimal year-round production of greenhouse-grown tomatoes requires the use of supplemental light to complement natural solar radiation in light-limited environments. Electric lighting accounts for a significant percentage of total greenhouse energy costs. Thus, a greenhouse tomato-production experiment was conducted from winter to summer to compare growth, yield, and fruit biomass production per kW-h of energy consumed for two tomato cultivars grown with no supplemental lighting, under overhead high-pressure sodium (HPS) lamps, or with intracanopy LEDs (95% red and 5% blue). An increasing solar daily light integral (DLI) occurred naturally for all treatments, and a constant DLI of 9 mol·m^{-2} per day was provided to the HPS and LEDs treatments. Results from this experiment will be presented. This project is supported in part by NIFA SCRI grant 2010-51181-21369.

Specified Source(s) of Funding: NIFA SCRI grant 2010-51181-21369.

1:45–2:00 PM

Growth and Morphology of Greenhouse Cucumber Seedlings Grown under Varied Daily Solar Light Integrals with Different Supplemental LED Blue : Red Ratios

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Light emitting diodes (LEDs) are a promising addition to current supplemental greenhouse lighting technology. To promote their adoption, supplemental LED light quality requirements for cucumber (*Cucumis sativus* L.) seedlings were investigated. Cucumber is a widely used model species for photomorphogenic studies and it is commonly grown in commercial greenhouses where supplemental lighting is necessary. Previous studies using LED as a sole source of light to grow cucumber plants have revealed the benefits of increasing the blue:red photon flux ratio (Hogewoning et al., 2010) but optimum blue photon flux for supplemental lighting in greenhouse is not known. In our present experiment, cucumber seedlings (cv. Cumlaude) were grown in a greenhouse to reach the second true leaf stage with and without supplemental red and blue LED lighting (*PPF*: 55 μmol·m^{-2}·s^{-1}). Varied levels of blue photon flux at the same *PPF* created different blue:red photon flux ratios examined in this experiment. The treatments were: 1) 0%Blue:100%Red (55 μmol·m^{-2}·s^{-1} red *PPF*); 2) 4%Blue:96%Red (2.2 blue and 52.8 red μmol·m^{-2}·s^{-1} *PPF*), (3) 16%Blue:84%Red (8.8 blue and 46.2 red μmol·m^{-2} s^{-1} *PPF*), and a control without supplemental lighting. Treatments were examined under low or high daily solar light integrals (DLI) (6.1 ± 0.5 and 21.3 ± 2.0 mol·m^{-2}·d^{-1}, respectively) using different shade screens deployed in the greenhouse. The supplemental lighting provided an 18-hour photoperiod (2:00–20:00 hours). Blue and red LEDs had peak wavelengths of 455 nm and 661 nm (FWHM: 20 nm and 15 nm) respectively. Growth parameters such as dry and fresh shoot mass and morphological parameters such as leaf count, stem diameter, hypocotyl length, and chlorophyll concentration showed that the supplemental lighting improved the growth and transplant quality of cucumber seedlings, compared with the control. However, there were no significant differences among treatments with different blue:red ratios regardless of DLI. In addition to growth and morphological parameters, leaf photosynthetic capacity measured under ambient CO_2, ambient temperature and 1000 μmol·m^{-2}·s^{-1} *PPF* also showed no difference among treatments of blue:red ratios. In conclusion, under LED supplemental lighting, no additional benefits for cucumber (cv. Cumlaude) were obtained by increasing the blue:red photon flux ratio in neither high nor low DLI.

Specified Source(s) of Funding: USDA–SCRI grant Developing LED Lighting Technologies and Practices For Sustainable Specialty-crop Production

2:00–2:15 PM

Low Temperature Tolerance of Curcurbit Scion and Rootstock Seedlings toward Development of Low Temperature Storage Techniques in Vegetable Grafting

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Understanding the low temperature tolerance of seedlings of horticultural species provides a base knowledge of seedling storage potential and application. One application of seedling storage is its use with vegetable grafting, a technique that confers disease resistance, abiotic stress resistance, and increased yield. Low temperature storage of grafted vegetable seedlings enables propagators to meet the seasonal demand associated with the narrow window of transplanting in the field. However, information on storage of cucurbit seedlings in low temperature is limited. To evaluate the effect of low temperature storage on selected scion and rootstock cultivars, seedlings of watermelon (*Citrullus lanatus* 'Sweet Harmony' & 'Tri-X-313'), cucumber (*Cucumis sativus* 'Cumlaude' & 'Rembrandt'), muskmelon (*Cucumis melo* 'Olympic Gold', 'Honey Brew' & rootstock 'DRO5018'), and two interspecific hybrid rootstocks (*Cucurbita maxima* × *Cucurbita moschata* 'Tetsukabuto' & 'Strong Tosa') were stored for a period of 4 weeks at 5 °C or 12 °C under 2 μmol·m^{-2}·s^{-1} and 12 μmol·m^{-2}·s^{-1} *PPF*, respectively. After 1 week in storage, all seedlings showed no major decrease in quality. By week 2, 'Sweet Harmony' and 'Tri-X-313' water-

An asterisk (*) following a name indicates the presenting author.

melon and 'Olympic Gold' and 'Honey Brew' scion muskmelon demonstrated the greatest degree of decline among genotypes examined and the decline was severer at 5 °C than at 12 °C. By week 3, plant quality declined further in those cultivars that had demonstrated a previous gradual decline in quality. At this point 'Cumlaude' and 'Rembrandt' cucumber demonstrated a high rate of mortality at 5 °C, but maintained storability at 12 °C. By week 4, most seedlings in the 5 °C treatment had died except for the interspecific rootstocks 'Tetsukabuto' and 'Strong Tosa' whose quality was maintained better at 5 °C than at 12 °C. Our results showed that: 1) 'Tetsukabuto' and 'Strong Tosa' interspecific squash hybrid rootstocks were storable at both temperatures examined; 2) 'Sweet Harmony' and 'Tri-X-313' watermelon and 'Olympic Gold' and 'Honey Brew' muskmelon performed well in the 12 °C treatment up to 2 weeks and poorly at 5 °C overall; and 3) 'Cumlaude' and 'Rembrandt' cucumbers, and 'DRO5018' muskmelon rootstock performed well at 12 °C throughout the 4 weeks but poorly at 5 °C. Further study is needed to see the effects of storage on growth and development of cucurbit seedlings and if rootstocks, with high storability, confer this trait to scions in grafted vegetable seedlings.

2:15–2:30 PM

Comparing Growth Responses of Bedding Plant Seedlings under Different Red Wavelengths from Light-emitting Diodes

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Light-emitting diodes (LEDs) are of increasing interest in controlled environment plant production due to their increasing energy efficiency and narrow bandwidth capability. Red light is generally the most efficient at eliciting photosynthesis, but little research has been published comparing growth responses under different wavelengths of red, especially on ornamental plants. We grew four popular bedding plant seedlings under six sole-source LED lighting treatments that each delivered a *PPF* of 160 $\mu mol \cdot m^{-2} \cdot s^{-1}$ with an 18-h photoperiod. All treatments delivered 10% blue (peak = 446 nm) and 10% green (peak = 516 nm) light, with the remaining light quality percentages consisting of orange (peak = 596 nm) – red (peak = 634 nm) – hyper red (peak = 664 nm) of 20–30–30, 0–80–0, 0–60–20, 0–40–40, 0–20–60, and 0–0–80, respectively. Seedlings of impatiens (*Impatiens walleriana* 'SuperElfin XP Red'), marigold (*Tagetes patula* 'Deep Orange'), petunia (*Petunia ×hybrida* 'Wave Pink'), and tomato (*Lycopersicum esculentum* 'Early Girl') were grown after germination for 31 to 45 d at a constant 20 °C. Growth parameters measured included stem length, shoot fresh and dry weight, leaf area, and leaf number. Although some statistical significance was observed, there were no prevailing growth response trends among light quality treatments. Therefore, we conclude that varied ratios of orange, red, and hyper red light have similar effects on plant growth when background levels of green and blue light are provided. The choice of red LEDs used for plant growth can depend on other factors, such as cost, electrical efficiency, and longevity.

Friday, August 3, 2012 Balmoral

Postharvest 3

Moderator: Christopher B. Watkins
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1:15–1:30 PM

ReTain and Harvista Effects on Maturity and Interactions with SmartFresh on Storage Quality of 'Honeycrisp' Apples from Three New York Growing Regions

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'Honeycrisp' trees were sprayed with ReTain (aminoethoxyvinylglycine) and Harvista (1-methylcyclopropene; 1-MCP) in an orchard from the Hudson Valley, western New York and Champlain regions of New York. Drop data and yield of fruit picked to commercial color requirements were recorded over the harvest period. Harvested fruit were either untreated or treated with SmartFresh (1-MCP) and stored in air or controlled atmosphere (CA). ReTain and Harvista delayed fruit drop and color development. Ethylene production and aroma volatiles of the fruit was inhibited, as were starch indices and flesh firmness, although not consistently so. Little effect of preharvest treatment on firmness, soluble solids concentration (SSC) and acidity after storage was detected. CA stored fruit was superior to air stored fruit, but preharvest treatments sometimes increased risk of carbon dioxide injuries in CA storage. SmartFresh treated air stored fruit had higher titratable acidity, SSC, and lower greasiness than untreated fruit, and quality characteristics were similar to those of CA stored fruit.

Specified Source(s) of Funding: NYFVI; AgroFresh Inc; Valent BioSciences; Federal Formula Funds, NE1036

1:30–1:45 PM

1-MCP Differentially Regulates Metabolic Responses in Stem and Calyx End Flesh Tissue of 'Empire' Apples during CA Storage

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'Empire' apple fruit are more susceptible to flesh browning at stem-end tissues than at calyx-end if treated with 1-methylcyclopropene (1-MCP), an inhibitor of ethylene perception, prior to controlled atmosphere (CA) storage. To better understand the metabolic changes associated with the specific tissue susceptibility to flesh browning, untargeted metabolic profiling with partial least squares (PLS) analysis has been applied to visualize changes in metabolic profile during storage. PLS scoring plots indicated that the metabolic difference was detectable at harvest and metabolic changes occurred differentially during storage. Amino acid levels were higher in stem-end than at calyx-end tissues, especially in 1-MCP treated fruit.

1:45–2:00 PM

Development of Stem-end Internal Browning and Cracking in Cold Stored 'Gala' Apples Is Related to Fruit Size

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'Gala' apple [*Malus sylvestris* (L.) Mill var. *domestica* (Borkh.) Mansf.] fruit can be susceptible to the development of stem-end browning and cracking (splitting) disorders during cold storage. Previous work indicated fruit stem-end browning incidence increases with fruit size. The objective of this work was to further investigate the effect of fruit size on the development of stem-end browning, cracking and other physiological characteristics of 'Gala' apples previously held in cold storage. Fruit segregated at harvest based on size (small: 120–175 g; large: 250–350 g) were stored at 0.5 °C in air for up to 6 months. Large fruit developed more stem-end browning and cracking compared with small fruit during cold storage, and browning and cracking incidence and severity increased during shelf life. Large fruit had lower internal ethylene concentration (IEC) after 6 months plus 0 or 7 days at 20 °C. However, large fruit had higher respiration rate during storage and after the shelf life period. Fruit stem-end lightness (L^*) and hue angle (h^o) declined during and after cold storage, with L^* and h^o decreasing significantly more for large fruit. While small fruit fresh weight and circumference decreased during storage, large fruit circumference increased along with cracking incidence but fresh weight decreased during storage. These physiological changes appear to contribute to the susceptibility of larger fruit to stem-end browning and cracking more so than smaller fruit.

2:00–2:15 PM

Inhibition of Ethylene Action and Biosynthesis Differentially Affect α-Farnesene Metabolism and Superficial Scald Development in 'Greensleeves' Apples

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Ethylene plays a key role in the development of superficial scald in cold-stored apple fruit. The effects of transgenic suppression of ethylene biosynthesis and inhibition of ethylene action by 1-methylcyclopropene (1-MCP) on scald incidence and severity were evaluated in 'Greensleeves' apples stored in air at 0 °C. Three apple lines were used: untransformed (GS); line 68G, suppressed for 1-aminocyclopropane-1-carboxylic acid (ACC) oxidase; and line 130Y, suppressed for ACC synthase. Untreated GS fruit exhibited similar climacteric patterns of ethylene production and respiration during 16 weeks of storage. Respiration rates in transgenic 68G and 130Y fruit equaled those in GS fruit, whereas peak ethylene evolution was reduced by about 90%. 1-MCP treatment prior to storage suppressed ethylene production in all fruit through 16 weeks, after which production in GS fruit recovered. Peel tissue transcript levels of α-farnesene synthase gene *MdAFS1* were on average > 50% lower in 68G and 130Y compared with GS fruit, but effects on accumulation of α-farnesene and its conjugated trienol (CTol) oxidation products were relatively slight. 1-MCP suppressed *MdAFS1* expression and α-farnesene production through 16 weeks; by 23 weeks *MdAFS1* transcript had increased markedly and was proportional to α-farnesene and CTols levels in all fruit. Scald symptoms, evaluated after 7 days shelf life at 20 °C, were evident on > 10% of all fruit stored for 12 weeks. Among the untreated fruit, scald severity was much greater in GS than in 68G and 130Y, but scald incidence was high in all three lines at 16 weeks and close to 100% after 16–23 weeks. In all fruit treated with 1-MCP, scald was substantially reduced but not eliminated. It is concluded that up-regulation of *MdAFS1* is induced by very low levels of ethylene, low to moderate expression of *MdAFS1* is adequate for maximal α-farnesene production, and at least light scald symptoms can arise despite much reduced production of ethylene and accumulation of α-farnesene and CTols.

2:15–2:30 PM

Characteristics of a 'Gala' Apple Fruit Internal Browning Storage Disorder

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Factors contributing to development of an internal browning storage disorder developing primarily at the stem-end in 'Gala' apple fruit were investigated. Initial storage temperature, storage duration, controlled atmosphere (CA) CO_2 concentration, delayed CA establishment, use of diphenylamine (DPA) and/or 1-methylcyclopropene (SmartFresh®), and fruit weight were evaluated. Browning can occur during storage or during a subsequent 7 day shelf-life period. Large fruit are at increased risk of browning development. Browning develops in fruit stored at 0.5 °C in air or CA (1.5 kPa O_2, 1–5 kPa CO_2). Storage at 0.5 °C for 7 days in 17 kPa O_2/3 kPa CO_2 then air or CA does not enhance browning development. In 2 of 3 crop years, SmartFresh®-treated fruit developed browning sooner compared to controls. DPA does not control browning development regardless of storage environment or use of SmartFresh®. Cooling fruit to 0.5 °C after 7 days at 10 °C reduces or eliminates browning development regardless of SmartFresh® use. Delayed SmartFresh® treatment does not impact browning development but results in poor quality if fruit are held 7 days at 10 °C prior to 0.5 °C. The results indicate this disorder may result from chilling injury, and that chemical inhibition of ethylene action can enhance fruit susceptibility. Prompt treatment with SmartFresh® and cooling fruit to 10 °C for the initial 7 days after harvest can reduce or prevent disorder development while maintaining fruit quality comparably to fruit treated with SmartFresh® and cooled to 0.5 °C after harvest.

2:30–2:45 PM

Evaluating the Synchronicity of Flesh and Peel Ripening in Standard and New Cultivars of Apples

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Generally internal ethylene concentration (IEC) and starch clearing index (SCI) are used to evaluate apple maturity for harvest in North America. These two methods provide good information on the flesh maturation of apples. Chlorophyll decline in apple peel was recognized as a potential criterion for maturity assessment in the early 1990s, but has not been practical to use because of the time required to extract chlorophyll from the peel. Recently, non-destructive instruments measuring apple peel chlorophyll using spectral reflectance of two chlorophyll-related near infrared bands has enabled instantaneous assessment of peel chlorophyll and thus allows interpretation of maturity. In this study, 'Royal Gala', 'Golden Delicious', 'Fuji (strain Nagano 1)', Aurora Golden Gala™, Nicola™, SPA493, and SPA365 were monitored for changes in IEC, SCI, and chlorophyll content during maturation in Fall 2011. Decline in chlorophyll content was linear with advance in maturity for all cultivars tested. In most cultivars of apples tested, the IEC, SCI, and chlorophyll changes were well synchronized. This indicates that that non-destructive chlorophyll assessment may be an alternate tool for monitoring apple maturation and could also enable mapping of orchards to improve uniformity of maturity at harvest. In some apples, however, changes in chlorophyll content were not well synchronized with IEC and SCI changes. For an apple such as 'Fuji', it may mean that the harvest criteria using non-destructive technology should be adjusted specifically for that cultivar. In other cultivars, for which peel and flesh maturation is even more asynchronous, at least in Fall 2011, suggesting that there may be concerns for maturation in those cultivars that need further investigation.

Specified Source(s) of Funding: Agriculture and Agri-Food Canada, Growing Forward Program (Developing Innovative Agricultural Products)

2:45–3:00 PM

Changes in Free and Lipid-Bound Fatty Acids as Related to LOX-derived Volatiles in Ripening 'Jonagold' Apple Fruit

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Aldehydes from the oxidation of free and lipid-bound fatty acids are important components of the aroma of apple fruit. These aldehydes are produced during mastication and cellular disruption by the action of lipoxygenase (LOX) and other enzymes of the LOX pathway. Principal among these aldehydes are *cis*-3-hexenal, its isomer, trans-2-hexenal, and hexanal. *Cis*-3-hexenal is produced primarily from linolenic acid (18:3) and hexanal from linoleic acid (18:2). *Trans*-2-hexenal is likely the product of an as-yet uncharacterized isomerase acting upon cis-3-hexenal. We previously reported that, for 'Jonagold' fruit, aldehyde synthesis was, at first, extremely high for normally-ripening fruit such that the concentrations of *cis*-3-hexenal and hexanal were several hundred times higher than their respective odor thresholds. *Cis*-3 hexenal declined markedly for normally ripening fruit, coincident with autocatalytic ethylene formation, even as trans-2-hexenal and hexanal emissions increased. We extended this work by analysis of free fatty acids and the fatty acid components of polar and non-polar lipids of ripening apple

fruit to evaluate changes in the content of the substrates for LOX pathway reactions. Tissue analysis was on fruit ripening over an 8-week period in 2009 and 2010; evaluations were twice-weekly. On each date, internal ethylene, CO_2 production, and volatile profiles were also measured. Of the free fatty acids, 18:1 (oleic) and 18:2 increased several-fold during ripening, but 18:3 content was exceedingly low and was unchanged during ripening. For polar lipids, the 18:1 and 18:2 fatty acid content increased modestly, while the 18:3 content declined sharply as ripening progressed. The increase in 18:2 free fatty acids is mirrored by the increase in emissions of hexanal and hexyl esters during ripening, however, there does not appear to be a similar relationship between 18:3 free fatty acids and *cis*-3-hexenal emissions. Rather, the decline in *cis*-3-hexenal more closely follows the pattern in the 18:3-content of polar lipids. Interestingly *cis*-3-hexenal and *trans*-2-hexenal were almost completely dependent upon cellular disruption for their formation, whereas hexanal was not. The data suggest that the hexanal, and possibly, hexyl esters, may originate from LOX action on 18:2 free fatty acids in intact fruit. The data are also consistent with the production of hexanal from 18:2 free fatty acid and/or 18:2-containing polar lipids following tissue disruption. *Cis*-3-hexenal and *trans*-2-hexenal may be lacking from the volatile profile in intact fruit due to a lack of 18:3 free fatty acid substrate and that their formation following cellular disruption is largely from 18:3-containing lipid precursors.

Friday, August 3, 2012 **Tuttle**

Citrus Crops

Moderator: Jude W. Grosser
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1:30–1:45 PM

Conservation of U.S. Citrus Collections using Cryopreservation

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The USDA–ARS National Plant Germplasm System and the University of California Citrus Variety Collection maintain more than 850 unique accessions of *Citrus*, *Fortunella*, and citrus wild species. We have developed a method to back-up critical screenhouse and greenhouse Citrus collections using cryopreservation. Shoot tips are excised from actively growing vegetative flushes, surface disinfected, and then treated with cryoprotectant solutions. Shoot tips are then immersed in liquid nitrogen, held, and warmed to check for survival. Recovered shoot tips are micrografted onto etiolated 'Carrizo' seedling rootstocks. Regrowth levels are greater than 50% for cultivars representing eight *Citrus* and *Fortunella* species. The method may also be useful for cryotherapy to remove pathogens from infected source plant material.

Specified Source(s) of Funding: California Citrus Research Board

1:45–2:00 PM

Role of Nitrous Oxide in Promoting Abscission in Citrus by the Abscission Agent CMNP

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The following study was conducted to determine if the abscission agent CMNP (5-chloro-3-methyl-4-nitro-1H-pyrazole) can produce nitrous oxide, if nitrous oxide (NO) promotes fruit abscission, and if alcohol dehydrogenase (ADH) can produce NO. One-half of a 'Valencia' tree was sprayed to drip with 300 ppm CMNP in Apr. 2011. Fruit detachment force (FDF) of treated fruit decreased from 80 N to 10 N. NO increased in treated fruit from undetectable to about 1.2 nM/g fresh wt by 48 hours after application and declined to below 0.2 nM/g fresh wt by 120 h. Additional untreated fruit were clipped from a 'Valencia' tree and dipped in a 2.0 mM solution of sodium nitroprusside, which releases NO upon exposure to water. FDF of fruit dipped for 45 min in the solution and held at 25 °C declined similarly as application of CMNP to the field grown tree. FDF of treated fruit held at 10 °C did not decline. Fruit dipped in solutions had ADH activity ranging from 35 nM/min to 0 nM/min for the control and 1.5 mM CMNP, respectively, a result that has been reported previously. Purified ADH in solution with CMNP added produced NO. The results indicate that CMNP applied to field grown trees may be converted to NO by ADH and that the NO promotes abscission of sweet orange.

2:00–2:15 PM

Evaluation of Rapidly Produced Louisiana-grown Satsuma Juice

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As of 2010, the Louisiana citrus industry involved about 550 growers who produced roughly 1000 acres of citrus for an estimated gross farm value of almost $7.5 million; consisting predominately of Satsuma oranges, which have adapted well to the southern Louisiana growing conditions. Unfortunately, the Louisiana citrus industry is subdued by the immense com-

mercial industry in Florida and other states. Estimates from local growers and farmers indicate that roughly 1/3 of the crop falls to the ground and rots yearly. Without methods to process and/or increase the shelf life of Satsuma, both demand and incentive to grow local citrus is diminishing. Subsequently, we attempted to derive a rapid, convenient Satsuma juice (skipping traditional peeler, finisher, and de-pulping machinery) to deliver an acceptable pilot plant, commercial-like, pressed juice product with minimal inputs as a viable means for local producers to begin finding alternative uses for this underutilized crop. Freshly harvested 2011 Satsuma from Plaquemines Parish were commercially sorted, washed, not waxed, and trucked to the Agricultural Research Service, Southern Regional Research Center in New Orleans. Fruit were washed in 100 ppm NaOCl, rinsed in deionized water, air dried then mechanically pressed as whole fruit (including peels) and peeled fruit. Four proprietary enzymes, and mixtures thereof, were specifically chosen to act on pectin, cellulose, protein, oil separation, and bitterness/astringency that would be encountered when whole fruit were pressed with peels intact. These extractions were compared against peeled pressed fruit as well. Color, subjective flavor, and astringency/sourness and sedimentation were evaluated along with volatile headspace extraction. Herein we report volatiles recovered via a DVB/Car/PDMS SPME performed with 10-ml juice in 20-ml vials for 12.5 minute exposure at 40°C, followed by injection into a HP6890/5973 GC-MS with a DB-5 column. Compounds were identified in triplicate runs by HP ChemStation software searched against the NIST, Wiley libraries, and authentic standards. Similar to previous Satsuma juice reports, we isolated limonene, γ–terpinene, p-cymene, myrcene, α-pinene, β-pinene, α-terpinolene, β–caryophyllene, and valecene. Limonene completely saturated the MS profiles in whole fruit pressed with their peels, even when samples were diluted 10-fold. Limonene was also the predominant peak in all peeled juice samples. Removal of the peel indeed allowed for characterization of more subtle (non-terpenoid) compounds such as lower molecular weight alcohols and ketones. We are processing data to ascertain if enzyme treatments significantly altered the volatile profiles of peeled versus whole pressed juices.

2:15–2:30 PM

Involvement of Micro RNA Expression in Physiological Effects of Grafting: Experiments with Citrus

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Grafting is an important, widely used plant propagation technique in horticultural crops, but its physiological effects are as yet insufficiently understood. Recent studies indicate that movement of proteins and small RNAs through the graft union might be involved. Micro RNAs are known to play a significant role in regulation of higher plants' developmental and metabolic traits. A distinction can be made, however, between major, ubiquitous, strongly expressed micro RNAs and minor, species-specific micro RNAs. The objective of the present study was to examine the possibility that micro RNAs play a role in the modulation of grafting effects. We adopted a screening approach, determining the expression of a broad range of micro RNAs in citrus leaf petioles, as affected by grafting. Four stock/scion combinations ('Merav' mandarin and 'Star Ruby' grapefruit scions × 'Troyer' citrange and *Citrus* 'Volkameriana' rootstocks), rootstock autografts and the non-grafted rootstocks were examined. Microarray comparisons of miRNA expression revealed significant differences in major as well as minor micro RNAs. All grafting combinations caused a dramatic reduction in the expression of the major miR156 (and miR157) that appear to be associated with reduction of juvenility in perennial woody plants. Expression of miR894 also declined upon grafting. Differential, rootstock and scion-dependent expression of the minor miR397 was found in petioles of grafted scions, while in non-grafted rootstocks the expression of miR397 was barely detectable. Bioinformatic analysis confirmed the presence of miR397 in the citrus genome, validated its sequence and demonstrated its ability to form a stem loop. The differences in miR397 expression might be related to copper and other micronutrient requirements of citrus stock-scion combinations. Differences in other micro RNAs' expression will also be presented. These results suggest an involvement of specific micro RNAs in engendering physiological effects of grafting, although the precise mechanism remains to be elucidated. Supported by funds of the Israeli Citrus Marketing Board.

Specified Source(s) of Funding: Supported by funds of the Israeli Citrus Marketing Board.

2:30–2:45 PM

Quantification of *Candidatus* Liberibacter Asiaticus in Plant Extracts—From Ct to Biologically Meaningful Units

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Candidatus Liberibacter asiaticus (CLas) is a phloem-limited bacterium associated with the citrus disease Huanglongbing (HLB), regarded to be the most devastating disease of citrus. HLB has been confirmed in all citrus producing counties in Florida and threatens viability of the citrus industry. In the early stages of HLB, diagnosis is difficult because disease symptoms are easily confused with other disorders, especially micronutrient deficiencies. Initially, quantitative real time PCR

(qPCR) of CLas 16S rDNA was used to confirm CLas infection in citrus trees with suspect HLB symptoms. Confirmatory testing is a dichotomous no/yes assay. Typically, qPCR results are expressed simply as crossing threshold (Ct) and values below an arbitrary Ct are interpreted as CLas positive. However, Ct values alone have no biological context and variability in qPCR protocols among laboratories makes the reliability of arbitrary Ct values for diagnostics questionable. Increasingly, qPCR is being used as a quantitative assay in experiments related to host–pathogen interactions and in attempts to quantify resistance to CLas. Conversion of Ct values to biological units (i.e. amount of CLas per mass tissue) provides biological context and allows for meaningful comparisons among laboratories. We developed a standard curve to convert Ct to biological units (CLas genomes) and have determined that the working range for qPCR quantification of CLas is 0 to 7 logs and that qPCR can detect a single copy of CLas 16S rDNA, indicating that it is not possible to develop an assay with greater sensitivity than qPCR for CLas detection. Conversion of CLas genomes to mass reveals that Ct values less than 18 are nonsensical because the amount of CLas would exceed > 1% of total DNA, suggesting that the upper limit of CLas titer in plant tissues is 10^7 to 10^8 CLas genomes/g. Using our standard curve to convert Ct values to CLas genomes/g tissue for 20,000 field samples collected by commercial scouts reveals that: 1) the majority of samples were CLas-negative (Ct > than 38.5); 2) CLas-infected, asymptomatic leaves have CLas titers of 10^0 to 10^4 genomes/g tissue (Ct 38-30); 3) the titer of CLas in HLB-symptomatic tissues is 10^6 to 10^7 genomes/g tissues (Ct 24-19); and 4) no samples exceed 10^8 CLas genomes g tissue (Ct < 18). These results confirm the value of the standard curve method for conversion of Ct to CLas genomes and provide insights into the distribution of CLas titers in infected trees.

2:45–3:00 PM

Periodical Nutrient Dynamics in 'Blood Red' Sweet Orange as Affected by Fungicides Soil Drenching

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Ailing root system of sweet oranges in Punjab, Pakistan, has been suspected to affect nutrient uptake due to rough lemon (*Citrus jambhiri* Lush.) rootstock susceptible to soil born fungal diseases and might be one of the main reasons of low productivity of sweet oranges. A block of 'Blood Red' sweet orange (*Citrus sinensis* L. Osbeck) grafted on rough lemon (*Citrus jambhiri* Lush.) rootstock, with low yielding (200–250 fruit/tree) trees ranging between 12–15 years age, was selected for this research work growing at Experimental Fruit Garden Sq. #9, Institute of Horticultural Sciences, University of Agriculture, Faisalabad, Punjab, Pakistan. The main objective of the research was to induce the sweet oranges in main streamline of citrus industry by improving their root health by fungicides treatments ultimately enhancing mineral nutrient uptake from soil. The experiment was laid out according to RCBD replicated thrice, taking single tree as a treatment unit. The fungicides used in the experiment were Ridomil Gold (Matalyxl) and Alliette (Fosetyl-Al) alone, in combination with each other and Copper sulphate ($CuSO_4$) making 9 treatments including control. Periodic changes in nutritional status of tree leaf macronutrients (N, P, and K) as well as micronutrients (Mg, Fe, Mn, Cu, and Zn) from flowering through fruit set were monitored at fortnight intervals in relation to different fungicides treatments. During two years trials a detailed data was collected. The fungicides treatments improved nutrient uptake by correcting the health of root system and had profound effect on health and vigor of trees under trial. It was further revealed by enhancement of fruit quality and yield of treated trees compared with control. It was concluded from the trial that best management practices could improve yield and quality of sweet oranges emphasizing on health of root system.

Specified Source(s) of Funding: Punjab Agriculture Research Board (PARB)

3:00–3:15 PM

Exploiting Somaclonal Variation to Deliver Improved Sweet Orange Cultivars for Processing and the Fresh Market

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Sweet orange (*Citrus sinensis* L. Osbeck) is the most horticulturally important and widely grown *Citrus* species in Florida and worldwide. Approximately 90% of Florida orange production and more than 30% of the world crop are used for processing. Frozen concentrate orange juice has historically been the primary product of the Florida industry, but more recently there has been a strong shift to the more profitable fresh pasteurized not-from-concentrate (NFC) product. The development of higher quality oranges with expanded maturity dates will facilitate this change and increase the competitive ability of the Florida industry.

Improved clones that are seedless, more attractive and easier to peel have potential to improve the competitiveness of sweet oranges in the fresh market. No true sweet orange cultivars have been produced by conventional breeding techniques due to its complex biology including large plant size, extended juvenility, and nucellar polyembryony. Commercial sweet orange cultivars probably originated by the selection of chance seedlings well-adapted to a particular area or from a mutation in a particular cultivar or seedling. Thus, over the past 25 years, we have been exploiting somaclonal variation as a source of useful variation for improving sweet oranges. Selected somaclones are exhibiting improved traits such as earlier maturity, later maturity, better juice quality (color and flavor), higher soluble solids, seedlessness, scion-based tree size control, increased yield, and better stress tolerance. The first two released sweet orange cultivars from our citrus variety improvement program are SF14W-62 (Valquarius™), an early-maturing (midseason) processing Valencia-derived sweet orange that matures 6–8 weeks early than standard Valencia; and N7-3 (Valenfresh™), a late-maturing seedless Valencia sweet orange for fresh market or processing. Both of these clones were regenerated from embryogenic cell culture-derived protoplasts. These and several other somaclones selected for release, derived from 'Hamlin', 'Valencia', 'Rhode Red Valencia', and OLL (Orie Lee Late) will be described. Potential contributions of selected somaclones to sustainable sweet orange production in the face of new and severe disease threats will also be discussed.

Specified Source(s) of Funding: FCPRAC, NVDMC

Friday, August 3, 2012 **Flagler**

Plant Biotechnology

Moderator: Alan H. Chambers
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2:00–2:15 PM

"FasTrack"—A Revolutionary Approach to Long-generation Cycle Specialty Crop Breeding

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The American tree fruit industry is facing challenges of climate change, reductions in available labor, the need for reduced chemical inputs, the spread of exotic pests and pathogens, and consumer demands for improved fruit quality. To meet these challenges the development of new improved varieties is more vital than ever. Yet, fruit tree breeding remains a slow and costly process that has changed little over time. Limitations include long juvenility periods which can last 3–10 years or more, the need for large land areas that incur significant field costs, and yearly limitations on flowering and fruiting related to dormancy. Recently, research has focused on marker assisted selection (MAS), germplasm characterization, and genetic engineering (GE) as means to advance tree fruit breeding. However, the impacts of these strategies on breeding are all still limited by the inherently slow generation cycles of fruit trees. To address this problem, we have developed a system to shorten the breeding cycle of fruit trees and other long-breeding-cycle crops. We have overcome the juvenility and environmental limitations of flowering and fruiting by incorporating a gene that induces trees to flower and fruit early and continually. In plum, the crop with which we are now working, we have reduced the generation cycle from 3–7 years to less than one year. We call this rapid breeding system "FasTrack." The system will allow for the rapid incorporation of important traits into plums and other long-generation-cycle crops, and then in the final generation, when substantial improvements are clearly evident, only seedlings that do not contain the early flowering gene would be selected. These trees would not be genetically engineered. The selected trees may then be used directly as new varieties, or improved lines for further breeding. Such an approach would provide tree fruit and other long-cycle crop breeders with the ability to respond to new market demands, climate changes, and invasions of new diseases and pests in a way never before possible.

Specified Source(s) of Funding: CSREES–SCRI and California Dried Plum Board

2:15–2:30 PM

A Floral Transcriptome for *Hippeastrum* (Amaryllidaceae)

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Two transcriptomes have been constructed from floral tissue of two *Hippeastrum* (Amaryllidaceae) species, *H. brasilianum* (Traub & J.L.Doran) Dutilh and *H. papilio* (Ravenna) Van Scheepan. The former has fragrant flowers, while flowers of the latter do not produce floral fragrance. RNA was isolated and shipped to the Beijing Genomics Institute for cDNA library construction, sequencing and assembly. For *H. brasilianum* (the data for *H. papilio* have not yet been received) we obtained 51,814,100 clean reads comprising 4,663,269,000 nucleotides

with a quality score of 95.44%. The mean GC content was 45.36%. Total number of contigs formed was 200,756 with a mean length of 254 nt. The total number of unigenes identified was 71,532, with a mean length of 594 nt, of which 67,327 were distinct singletons. The functional classification of the unigenes will be discussed. We are interested in performing in silica subtraction on both transcriptomes in the hopes of isolating genes implicated in the production and expression of floral fragrance. F_1 hybrids and back cross populations have been created to assist in the understanding of the genetics of fragrance expression in *Hippeastrum*. We are also interested in developing a library single nucleotide polymorphisms (SNPs) for the genus.

2:30–2:45 PM

Virus-induced Gene Silencing Optimization in Petunia

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Virus-induced gene silencing (VIGS) elicits RNA interference, which can be used to down regulate genes of interest within plants. The efficiency of VIGS is dependent on the proliferation of viral infection and systemic movement. Although VIGS has been successfully used in petunia (*Petunia ×hybrida*), it has not been thoroughly optimized. Here we report the findings of VIGS optimization using the *Tobacco rattle virus* (TRV) in five areas: 1) inoculating methods, 2) evaluating petunia cultivars, 3) measuring silencing efficiencies among plants grown under three different growing temperatures, 4) developing a control that overcomes the empty vector viral symptoms, and 5) determining an effective developmental stage for inoculating petunias. From our research, we utilized a simple shoot apical meristem inoculation method that was both effective and consistent in silencing. This method displayed silencing 3 days before any other method evaluated. From an evaluation of 11 species, we identified a compact petunia variety, 'Picobella Blue,' that exhibited a 1.8-fold higher efficiency in chalcone synthase silencing than any other variety tested. We also determined that a lower daytime temperature of 20° with a night temperature of 18 °C provided an environment that induced stronger gene silencing than 23 °C and 26 °C daytime temperatures. Severe viral symptoms of the empty vector control confounded experimental results. To overcome this, we created a recombinant TRV vector that contains a fragment of the green fluorescent protein gene which eliminated viral symptoms and served as a viable control. Our research also determined that efficient silencing can occur on petunia seedlings from 3 to 4 weeks old. This research provides essential information on the development of an efficient method of VIGS for petunia that is both simple and consistent, as this does not require the formation of stably-transformed genetic lines. We will use this method for high throughput characterization of genes associated with production timing and postproduction quality.

Specified Source(s) of Funding: DC Kiplinger Floriculture Endowment

2:45–3:00 PM

Over Expression of a β-1,3-Glucanase Gene in Transgenic Citrus in Efforts to Inhibit Phloem Plugging Caused by Citrus Greening Disease (Huanglongbing)

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Citrus greening, also called Huanglongbing (HLB) or yellow dragon disease, is considered the most serious diseases of citrus. HLB, caused by *Candidatus Liberibacter* asiaticus, is a phloem-limited fastidious pathogen transmitted by the Asian citrus psyllid, *Diaphorina citri*, and appears to be an intracellular pathogen that maintains an intimate association with the psyllid or the plant throughout its life cycle. The main dehabilitating symptom of the disease is the blocking of the phloem by β-1,3-glucan callose, which leads to inhibition of photosynthate transport and starvation. Transgenic approaches to achieve overexpression of the citrus β-1,3-glucanase gene using constitutive and phloem specific promoters were performed in efforts to counteract this effect. Citrus β-1,3-glucanase cDNA (1011 bp) (GenBank accession number AJ000081) was amplified from Valencia leaf and embryogenic callus using PCR with adding cMyc tag (to facilitate subsequent western analysis). The final PCR product (1059 bp, designated BG3) was purified, and following multiple sub-cloning ended in transformation vectors designated as p35SBG3 (constitutive promoter) and pSuc2BG3 (phloem specific promoter). Both plasmids contain GFP/NPTII fusion gene as a selectable marker and were transformed into Agrobacterium. Using a modified Agrobacterium-mediated transformation protocol, 40 transgenic sweet orange (Valencia and Vernia) shoots were regenerated containing p35SBG3 and 24 containing pSuc2BG3 to over-express the citrus β-1,3-glucanase gene. All have been micro-grafted to Carrizo citrange to expedite their greenhouse evaluation. Twenty transgenic Carrizo citrange (rootstock) shoots were also recovered containing p35SBG3. More than 200 GFP positive somatic embryos were recovered from experimental sweet orange OLL#20 using an embryogenic callus transformation system with the β-1,3-glucanase gene. From these, more than 100 transgenic shoots were transferred to rooting medium and then micro-grafted. Also, about 50 GFP positive embryos and shoots from Jin Cheng and Valencia sweet oranges were recovered. Regeneration of stable transgenic plants from these cultivars is underway.

PCR analysis on a subset of these transgenic plants revealed that 90% are showing the specific band for the BG3 gene. All recovered transgenic clones were micropropagated, producing 4–5 replicates of each clone for further testing, including the HLB challenge. A population of these transgenic plants containing BG3 will be moved to a "hot psyllid" greenhouse for natural psyllid inoculation with HLB to determine if infected transgenic plants can maintain adequate functional phloem and normal development as compared to non-transgenic/non-infected control plants. Molecular analyses for these plants including Southern and western blot analyses and RT-PCR are underway and results will be provided.

Specified Source(s) of Funding: CRDF

3:00–3:15 PM

Identification of Candidate Genes Related to Water Stress in Grapevine by Co-expression Analysis and Comparative Genomics

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Grapevine is one of the most important fruit crops in the world. Water shortage restricts where grape can commercially be grown and drought stress threatens the yield and quality in non-irrigated growing regions. Understanding of molecular responses to water stress is critical for sustainable global grape production. We combined gene coexpression network analysis and comparative genomics approach to identify candidate genes responding to water stress in grapevine. We first obtained 241 *Arabidopsis* genes that had the experimental evidence responding to water stress by searching the PubMed publications. Then these 241 genes were used to retrieve 1,145 coexpressed genes via querying the *Arabidopsis* coexpression database. In grapevine, 727 genes were obtained as orthologs to the water stress-responding genes in *Arabidopsis*. Next, we constructed a grapevine genome-wide gene coexpression network by using 374 available microarrays. In the coexpression network, 3,019 nodes were linked with 13,758 edges, and 196 coexpressed gene modules were identified. Of the 196 modules, 31 modules were found to be enriched with GO terms or KEGG pathways, providing systems-level functional modules that contain the coexpressed genes. Finally, we used grapevine orthologous genes to those in *Arabidopsis* as a query to search the water stress-responding genes in the grapevine coexpression network. We identified 447 genes in 31 modules which were considered as candidate water stress-responding genes. Of the 447 genes, 98 genes were identified as differentially expressed genes based on grapevine microarrays containing treatments of water deficit and the non-deficit conditions. These grapevine genes are high likelihood candidate genes for responding water stress in grapevine. We are in the process of validating the functions of some of these genes.

3:15 –3:30 PM

FaNES1 and Linalool Characterization in Diverse Strawberry Genotypes

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An earlier report showed that a truncated form of the Nerolidol Synthase 1 (FaNES1) protein in cultivated, octoploid strawberry catalyzed the production of linalool, a consumer-favorable volatile (Aharoni et al., 2004). The biochemical mechanism for this phenomenon showed that the truncated protein lacked a plastid signaling peptide and was therefore localized to the cytoplasm where it was hypothesized to interact with substrates for linalool and nerolidol. The truncated, linalool-producing variant was present in all octoploid material tested and not in any of 12 apparent diploids used in the study. In an attempt to identify the presence/absence of the allele in potential breeding materials, as well as to understand the origin of the variant, we expanded on this original report to include a more diverse collection of cultivated germplasm and all ploidy levels within *Fragaria*. Our results show that the truncated FaNES allele is detectable in all 112 tested *F.* ×*ananassa* genotypes representing cultivated material from both Europe and the United States. The FaNES1 allele was absent from all diploid, tetraploid, and hexaploid genotypes in our study. Also investigated were 46 wild genotypes in the *Fragaria* supercore and all were positive for the truncated allele except for three *F. virginiana* genotypes. These *F. virginiana* accessions were negative for the FaNES1 allele yet the two that produced berries under our growing conditions still produced linalool. These findings suggest that there may be an alternative method to produce linalool in some *F. virginiana* genotypes, and that the variant with the linalool phenotype most likely arose recently after polyploidization in an ancestral octoploid.

Specified Source(s) of Funding: University of Florida Plant Molecular Breeding Initiative Florida Strawberry Growers Association

Friday, August 3, 2012 Concourse 1

Floriculture 3

Moderator: Jinsheng Huang
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2:00–2:15 PM

Effects of Compaction on Physical Properties of Propagation Substrates

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Substrates for production of seedling plugs and cuttings include loose-filled trays and stabilized paper-wrapped plugs such as Ellepots™. Substrate handling, tray-filling equipment and irrigation practices can lead to variable compaction levels in substrates. Compaction in turn affects substrate pore size, pore continuity, gas diffusion, and crop germination and rooting. The objective of this research was to develop a protocol to measure compaction in loose-filled and stabilized propagation substrates, and quantify the effects on porosity. Tested substrates included one plug seedling mix (fine particles, with 65% peat/20% perlite/15% vermiculite by volume) and one cutting mix (coarse particles, with 70% peat and 30% perlite). Compaction was created by using different forces to hand-fill a 128-cell plug tray or varying vacuum settlings to manufacture 50 mm Ellepot plugs. Growing substrates were brought to container capacity using sub-irrigation. Substrate compaction was then measured using a digital force gauge attached to a 25 mm diameter disc, by pushing the disc into the loose-filled cell to 6 mm depth or compressing the stabilized substrate by 10 mm. In a loose-filled tray with both fine and coarse substrates, the greatest changes in physical properties occurred as compaction increased from 125 (fine substrate) or 168 (coarse) to 200 g/cm^2, whereby settling (loss of volume after subirrigation) decreased from approximately 1 cm to zero, water holding capacity increased from approximately 15 to 20 ml/cell, dry bulk density increased from approximately 2 to 3 g/cell, and air porosity decreased from 20% to 5% in the fine substrate and 9 to 2% in the coarse substrate. Increasing compaction above 200 g/cm^2 resulted in increasing dry bulk density, and had minor impacts on water and air holding capacity. With stabilized substrates, increased compaction from 111 to 412 g/cm^2 resulted in a decline in air porosity, increased water holding capacity, and increased dry bulk density. Subsequent trials demonstrated that commercial stabilized plugs vary in compaction and porosity, and that over-filling or under-filling of loose-filled trays can result in variable porosity and plant growth. The research protocol could be adapted as a quality control procedure for young plant production.

2:15–2:30 PM

Evaluation of a Rapid, Automated Titration System for Evaluating Lime Requirements for Peat-based Substrates

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Determining lime requirements for peat-based substrates is a critical yet time-consuming process for substrate formulators. Typically, the substrate is incubated with lime over a period of days to allow the base sufficient time to react. Automatic acid-base titration offers a quicker solution that requires only hours to generate a multipoint, smooth curve that allows accurate interpolation for determining the needed base to achieve a target substrate pH. However, the titration parameters that give the best fit to lime-incubation data have yet to be fully evaluated. Samples of screened sphagnum peat moss (1.5 g dry weight) were titrated using 0.1 N HCl and 0.1 N NaOH by means of an automatic titrator (Titralab®856, Radiometer Analytical SAS, Villeurbane Cedex, France). Degassed, deionized water was used to raise peat samples to 50 g. Samples were then taken through two pH cycles between pH 3 and 11. The first cycle promoted hydration of the peat, and the second cycle was used to determine the pH buffer capacity. We varied titration parameters to run samples under eight regimes: titrating at fast, moderate, and slow rates (maximum 7.00, 2.00, and 0.33 mL acid/base per minute, respectively); fast rate with slowed addition near endpoints; changing the forward titration endpoints from pH 11 to pH 8 for one or both cycles; and titrating at a moderate rate after shaking for 2 hours or 24 hours at approximately pH 11. The volume of acid or base added was then converted into the moles of hydroxyls or protons bound per gram peat. Hysteresis and pH drift were observed. To determine which parameters were most closely aligned with actual incubation pH data, rates for $CaCO_3$ were calculated from automatic titrator curves, and samples of 20 g screened peat were incubated with reactive $CaCO_3$ for 7 days. The curve generated by shaking for 2 hours at pH 11 (maximum 2.00 mL acid/base per minute) was closest to the actual incubation pH data. All curves underestimated the amount of $CaCO_3$ required; however, parameters that allowed more exposure time to high pH (slowing addition near endpoint, shaking) came closer to the actual incubation data. Thus, for substrate formulators wishing to use automatic titrators to determine lime requirements, a conversion factor will be required. These parameters offer a quicker and more accurate

An asterisk (*) following a name indicates the presenting author.

approach. Additionally, our methodology describes a protocol for evaluating parameters and comparing them with incubations of novel substrates.

Specified Source(s) of Funding: Rockwell Farms; The Fred C. Gloeckner Foundation, Inc.; and USDA-ARS

2:30–2:45 PM

Effect of Biochar on Growth of Chrysanthemum and Tomato Plants in Containers

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Biochar (BC), the byproduct of fast pyrolysis of pine wood, was investigated as potting substrate on greenhouse-grown chrysanthemum (*Chrysanthemum nankingense*) and tomato (*Lycopersicum* 'Heritage') in containers. Biochar was mixed with pine bark (PB) or a commercial substrate (SB) at 0, 20%, 40%, 60%, 80% or 100% (vol.) ratio. Tomato seedlings and chrysanthemum rooted cuttings were transplanted in containers with the BC-based substrates. Compared to 100% PB, growth index (GI) of chrysanthemum was not significantly higher or lower when BC was blended in the potting mix at 20%, 40%, 60%, 80%, or 100% ratio. The number of flowers was similar for all mixes except 80% BC/20% PB. None of the fresh weight and dry weight of chrysanthemum plants grown in potting mixes with BC was lower than that of plants grown in 100% PB. Growth index of chrysanthemum plants was higher for all mixes with BC than 100% SB. Plants grown in mixes with BC had more flowers than 100% SB and their fresh weight and dry weight were higher than those grown in 100% SB. For tomato plants, in BC/PB mixes, plants grown 20%, 80%, and 100% BC had only slightly lower GI than plants in 100% PB, and plants in 40% and 60% BC had slightly higher GI than those in 100% PB. In BC/SB mixes, GI of tomato plants grown in mixes with BC was similar to that of plants in 100% SB. Plants grown in mixes with up to 60% BC had similar or higher fresh weight and dry weight than 100% SB. The pH of mixes with BC may be higher than 100% PB on 16 days after planting (DAP), but was lower than 100% PB on 44 DAP. EC of BC/PB mixes was similar at 16 DAP and 30 DAP, but EC of potting mixes was generally higher with higher percentage of BC in the potting mixes on 44 DAP. The pH of mixes with BC was higher than that of 100% SB on 16 DAP and 30 DAP, but was similar to 100% SB on 44 DAP. EC of mixes with BC was lower than 100% SB at 16 DAP and 30 DAP, but was similar to 100% SB on 44 DAP.

2:45–3:00 PM

Nutrient Reallocation during Flower Petal Senescence

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The life span of a flower is terminated by either petal wilting or by the abscission of a fully turgid corolla. In many flowers, petal wilting is accompanied by the degradation and systematic dismantling of cellular constituents. This senescence program allows the plant to recover some nutrients from the dying corolla before it is shed. In comparison to leaves, petals are fairly nutrient poor and remobilize fewer nutrients than leaves. We have shown that during the age-related senescence of unpollinated petunia flowers only nitrogen and phosphorus are remobilized from the petals. When petunia flowers are pollinated, additional nutrients, including potassium, sulfur, iron, molybdenum, and zinc show decreases in abundance consistent with nutrient reallocation from senescing petals. The objective of this research was to investigate nutrient changes during the death of flowers with different senescence syndromes. We investigated nutrient changes during flower development and senescence in ephemeral flowers compared to longer lived flowers, in ethylene sensitive and insensitive flowers and in those that senescence by wilting or by abscission. Petal fresh weight, dry weight, and nutrient content were measured at five or six stages of development from closed buds to advanced senescence. Flowers included *Petunia ×hybrida* 'Mitchell Diploid,' *Digitalis purpurea* 'Camelot Rose' (foxglove), *Alstroemeria* 'Ivana,' *Hemerocallis* 'Stella d'oro' (daylily), *Hybiscus moscheutos* 'Luna Red,' and *Antirrhinum majus* 'Sonnet Rose' (snapdragon). Corollas or sepals and petals were dried at 60 °C for 3 days. The dried tissue was ground to pass a 2-mm sieve and all nutrient analyses were completed at the Service Testing and Research Laboratory (The Ohio State University/OARDC, Wooster, OH). Ephemeral flowers that open and senescence within 1 to 2 days, including daylilies (ethylene insensitive) and hybiscus (ethylene sensitive), remobilized P and N with no significant remobilization of micronutrients. The life span of *Alstroemeria*, foxglove, and snapdragon flowers ended with corolla abscission. No nutrient remobilization was indicated in these corollas, when nutrient levels were compared between fully open flowers and those that had abscised. Proteolytic activity and the expression of cysteine protease and phosphate transporter genes correlated with nutrient changes in petunia flowers.

Specified Source(s) of Funding: Ohio State University DC Kiplinger Floriculture Endowment

3:00–3:15 PM

Effect of Biochar on Yield of Lettuce and Basil in Containers

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Biochar (BC), the byproduct of fast pyrolysis of pine wood, was investigated as potting substrate on greenhouse-grown lettuce (*Lactuca sativa* 'Black-seeded Simpson') and basil (*Ocimum basilicum*) in containers. Biochar was mixed with pine bark (PB) or a commercial substrate (SB) at 0, 20%, 40%, 60%, 80%, or 100% (vol.) ratio. For lettuce, in BC/PB mixes, none of the growth index (GI) of plants grown in mixes with BC was lower than that of plants in 100% PB, and plants grown in mixes with up to 60% BC had higher fresh weight than 100% PB. In BC/SB mixes, GI of lettuce grown in mixes with BC was similar to that of plants in 100% SB, and plants grown in mixes with BC had higher fresh weight than 100% SB. For basil, in BC/PB mixes, fresh and dry weight of plants grown in mixes with BC was similar or higher than that of plants in 100% PB. In BC/SB mixes, fresh and dry weight of basil grown in mixes with BC was similar or higher than that of plants in 100% SB.

Friday, August 3, 2012 Sandringham

Fruit Breeding 2

Moderator: Ed Stover
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3:15–3:30 PM

Genetic Diversity and Population Structure of *Prunus umbellata* Elliot in Florida

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The *Prunus* L. genus belongs to the subfamily Amygdaloideae (=Prunoideae) of the Rosaceae family. It is distributed around the world, with approximately 200 species. Species native to southeastern United States include *P. americana* Marsh., *P. angustifolia* Marsh., *P. geniculata* Harper, and *P. umbellata* Elliot. The existence of several wild plum species in Florida creates a unique opportunity for the study of allelic variation associated with important economic traits that can then be targeted and rapidly transferred to domesticated plum using molecular markers. The main objective of this research is to analyze the genetic diversity and population structure of *P. umbellata* in Florida. A total of ~70 genotypes of *P. umbellata* ranging from North to South Florida were fingerprinted using 41 SSRs distributed across the peach genome (~15–25 cM). Number of alleles per locus (A), effective number of alleles (Ae), observed heterozygosity (Ho), expected heterozygosity (He), Wright's fixation index (F), polymorphism information content (PIC), and Nei's genetic distance (GD) per locus were calculated. An unrooted Neighbor–Joining tree was constructed using Nei's genetic distance. Population structure was analyzed. *Prunus umbellata* represents an underutilized resource for association genetic studies of adaptive and commercial traits in plums.

Specified Source(s) of Funding: Stone Fruit and Citrus Breeding and Genetics Program at University of Florida, Gainesville, FL. and USDA–ARS grant 5306-21000-018-00D

3:30–3:45 PM

Breeding a Grower Friendly Peach Tree

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The domestication and selective breeding of peach has increased fruit size, fruit blush, firmness, palatability, and decreased acidity and bitterness compound levels relative to wild peaches. However, there has not been a concomitant change in tree structure and there is little difference between a tree of a wild peach such as *P. davidiana* and a tree of 'Redhaven' peach. Changes in labor regulations and improvements in wages have increased the interest in mechanized pruning and fruit thinning to reduce production costs. However, the complicated architecture of current peach varieties does not lend itself for mechanized fruit production. As part of our peach breeding effort, we are trying to get a better understanding of peach tree architecture. For this purpose we have made interspecific hybrids between peach and closely related species, generated segregating populations, and performed QTL analysis for branching traits. Candidate gene analysis of genes involved in meristem formation and extension growth from peach, almond and kansu wild peach was performed. Gene specific haplotypes were generated for representatives of the three species and the data used to design markers for mapping and QTL analysis. Data will be presented on the mapping and QTL analysis of branching and node development in peach × (peach × almond) and peach × (peach × kansu peach) backcross populations.

3:45–4:00 PM

Citrus Scion Breeding in Florida Affected by Endemic Huanglongbing Disease

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The citrus disease Huanglongbing (HLB), recently established in Florida, greatly weakens and often kills trees. HLB in Florida is associated with *Candidatus*Liberibacter asiaticus (CLas), vectored by the Asian citrus psyllid (ACP), and infections typically remain latent for many months. Citrus breeding by the USDA has been ongoing for 120 years and developing cultivars with HLB-resistance has become a priority. Unfortunately this disease has also pervasively influenced and impeded many aspects of citrus improvement. Soon after HLB was first identified in Florida during 2005, one of our two farms quickly became infected with HLB. HLB/ACP is largely uncontrolled on this site to facilitate resistance screening and testing of control measures. However, since most recent segregating hybrids are on this farm, we must accelerate identification of promising selections before they are too weak to assess. Extensive efforts have been made to rescue priority material field-infected with HLB. Marked reduction in CLas is achieved, but systemic infection and latency make it uncertain when rescued budwood can be declared clean. Antibiotic and other treatments are being used in an effort to prolong life of infected trees, to permit more thorough assessment and permit use as parents. HLB-infected seed-parent trees drop many fruit, reducing program efficiency. CLas in anthers from field-exposed trees counter-indicate transfer of pollen from infected to HLB-free areas. In addition, several studies indicate CLas may sometimes be transferred in seeds, restricting options for growing hybrids elsewhere. Prudence and Florida law requires that citrus nursery production now occur in ACP-proof structures, and retrofitting greenhouses cost our program > $400,000 (US). At the second USDA farm, aggressive ACP control began in 2008, requiring new equipment and many expensive sprays. However, in Nov. 2011, HLB-infected trees were found here also. At this farm, aggressive spraying continues along with annual scouting and removal of infected trees, all at substantial expense. ACP-proof screenhouses are being established to house ground-planted parent trees and to protect high-potential new hybrids in high-density plantings, where horticultural manipulations are used to rapidly overcome juvenility. It is anticipated that citrus production and breeding will continue in Florida, but in a much more challenging environment.

4:00–4:15 PM

Mapping QTLs Associated with Resistance to Bacterial Spot (*Xanthomonas arboricola* pv. *pruni*) in Peach

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Bacterial spot, caused by *Xanthomonas arboricola* pv. *pruni* (*Xap*), is a serious disease that can affect peach fruit quality and production worldwide. This disease causes severe defoliation and blemishing of fruit, particularly in areas with high rainfall, strong winds, high humidity and sandy soil. The molecular basis of its tolerance and susceptibility in peach is yet to be understood. To study the genetics of the peach response to *Xap*, an F_2 segregating population between two peach cultivars, 'Clayton', a resistant phenotype, and 'O'Henry', which is very susceptible to *Xap*, was created. Phenotypic data for leaf and fruit response to *Xap* infection were collected over three years at two locations: Sandhills Research Station, Jackson Springs, NC; and Sandhill Research and Education Center, Pontiac, SC. Sixty-three individuals exhibiting high tolerance/resistance to *Xap* were genotyped with an IPSC 9K peach SNP array v1. Out of 8,144 SNPs 1,341 were used to construct a genetic linkage map. This map covers a genetic distance of 421.4 cM with an average spacing of 1.6 cM and is used for mapping QTLs responsible for *Xap* in peach. The order of 95% of the mapped SNP markers was consistent with the marker order on the peach genome v1.0 assembly. A QTL analysis revealed 14 QTLs involved in *Xap* resistance: 3 on linkage group (LG) 1; two each on LG2, 3, 4 and 8; and one each on LG5, 6, and 7. One major QTL, *Xap.Pp.CO-4.1* on LG4 was associated with *Xap* resistance in leaf, and two major QTLs, *Xap.Pp.CO-1.2* and *Xap.Pp.CO-6.1* on LG1 and 6, respectively, were associated with *Xap* resistance in fruit. In addition, one major QTL, *Xap.Pp.CO-5.1* on LG5, was associated with *Xap* resistance on both leaf and fruit. Breeding for bacterial spot resistance in peach using marker assisted selection will be discussed.

Specified Source(s) of Funding: Clemson Experimental Station

4:15–4:30 PM

Mapping QTLs for Red Skin Color in Peach

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Red skin pigmentation develops through the flavonoid and anthocyanin pathways. Both genetic and environmental stimuli and their interaction (genotype x environment) control the regulation of this pathway. Sunlight induces the progression of red skin development. To study the genetic control of red skin pigmentation or blush in peach a controlled cross between two cultivars with contrasting phenotypes, 'Zin Dai' (~30% red skin) and 'Crimson Lady' (~100% red skin), was made. One F_1 hybrid, BY02p4019, with intermediate levels of blush (~65% red) was selfed to generate a segregating F_2 blush population (ZC^2). The segregating population was phenotyped for blush for four years (2007, 2008, 2010, 2011) using a visual rating scale (0–5) and in 2011 using a colorimeter (L*, a*, b*). Twenty-five individu-

als, exhibiting a blush range from 0 (0% red) to 5 (100% red) and a normal distribution for this trait, were genotyped with an IPSC 9K peach SNP array v1. A ZC^2 genetic linkage map was constructed with 1,335 SNP markers, comprising 14 linkage groups. This map covered a genetic distance of ~452cM with an average marker spacing of 2.38 cM/marker and an average number of 95 markers per LG. A major QTL for blush was located on LG3, spanning ~8.94cM (LOD2), and depicting 74% blush (R^2). QTL analysis for four different seasons confirms the identification of this major QTL for blush in peach, and supports its stability. In addition, three minor QTL's were located on LG's 4, and 7 indicating the presence of minor genes involved with blush development. Candidate genes involved in skin and flesh coloration of cherry (*PavMYB10*) and apple (*MdMYB10*) are located within the interval of the major QTL on LG3 suggesting the same genetic control for color development in the Rosaceae family. Application of standardized phenotyping and potential for using marker-assisted selection for blush in peach breeding will be discussed.

Specified Source(s) of Funding: Clemson Experimental Station, South Carolina Peach Council

Friday, August 3, 2012 **Windsor**

Vegetable Crops Management 4

Moderator: Carol A. Miles
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3:00–3:15 PM

Active and Passive Microenvironment Management Effects on Temperature Profiles and Crop Yield in Ohio Low and High Tunnel Systems

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Passive heating by low and high tunnels as well as active root-zone heating systems are proven tools in horticultural production. However, impacts of their individual and combined application on vegetable crop yield, composition and plant microclimates are often under-reported. In two studies at the Ohio Agricultural Research and Development Center in Wooster, OH, we set out to enhance the record of management strategy effects on abiotic environmental conditions and cropping variables in open field and high tunnel settings across a number of years and seasons. In total, temperature data were recorded at 15-min. or 30-min. intervals over 7 years in up to five high tunnels (4 measuring 6.4 × 14.6 m and 1 measuring 9.1 × 24.4 m) covered with a single layer of 6-mil. film and managed per the requirements of cool- and warm-season crops. The 4-year study involving the smaller high tunnels involved year-round production of several crops with temporary raised beds and floating row covers. The 3-year study involving the large high tunnel involved the spring and fall production of lettuce in raised beds which were either covered with a clear 0.8-mil. low tunnel, subsurface heated with cables, covered and subsurface heated or uncovered and unheated. An identical set of plots was established outside near the same high tunnel. Despite significant variability in temperature and light data, trends were evident. Temperature and light profiles and crop yield followed management and local conditions. Yield appeared to alternate between periods of light and temperature dependency. Investments in active subsurface heating did not always result in temperatures or yield that exceeded those in plots with passive aerial heating. And, datasets such as the ones developed here are useful in testing hypotheses, developing farmer decision aides and assisting farmers in optimizing microenvironment management.

3:15–3:30 PM

The Effect of Grafting on Vigor, Yield, and Verticillium Wilt of Eggplant (*Solanum melongena* L.) in Open Field Production

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Eggplant, a high value crop in Washington State, sustains significant losses from Verticillium wilt (caused by *V. dahliae*). Producers need tools other than soil fumigation for disease management. Grafting has been used to manage soilborne diseases in solanaceous crops throughout the world. Vigor, yield, and Verticillium wilt severity were evaluated for 'Epic' eggplant grafted on *Solanum aethiopicum* and 'Beaufort' rootstocks as well as non-grafted and self-grafted 'Epic' eggplant in two fields (eastern and western Washington) in 2010 and 2011. *S. aethiopicum*–grafted plants were less vigorous and had lower yields and more severe disease than the other treatments at both locations. Beaufort-grafted plants had greater stem diameter and plant height than the other treatments at both locations, but there was no consistent difference in plant dry weight among treatments. Beaufort-grafted eggplant total marketable weight was 45% greater than the other treatments in 2010 ($P = 0.0093$) and 28% greater than the other treatments in 2011 ($P = 0.0567$) at the eastern Washington location. Beaufort-grafted eggplant had significantly less disease severity at eastern and western Washington locations in 2010 ($P = 0.0062$ and $P = 0.0030$) and 2011 ($P = 0.0010$ and $P = 0.0002$), respectively. However, interveinal chlorosis, v-shaped necrosis, and wilting were observed in Beaufort-grafted plants and *V. dahliae* was isolated from stem tissue.

The reduced disease severity and increased yields of Beaufort-grafted eggplant suggests that Beaufort rootstock has partial resistance to Verticillium wilt. Grafting eggplant onto vigorous disease tolerant rootstocks reduced Verticillium wilt severity without compromising yield or vigor and may be an effective alternative to soil fumigation.

3:30–3:45 PM

Grafting and Number of Layers of Polyplastic Film Affected Growth and Yield of Heirloom Tomatoes in High Tunnels

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High tunnels have become a powerful tool allowing season extension for vegetable growers. The USDA–NRCS High Tunnel Environmental Quality Incentives Program has greatly increased the number of high tunnels in Missouri. Despite the size and style of high tunnels, farmers have to choose either a single-layer or double-layer of polyplastic film as a covering. Tomato grafting is an emerging technique in the United States which has the potential of providing disease resistance and enhancing vigor and yield for heirloom tomatoes in high tunnels, where rotation is limited. The objective of this study was to investigate the effect of grafting and the number of layers of polyplastic film on growth and yield of high tunnel heirloom tomatoes. Heirloom tomatoes German Pink and Ananas Noire were grafted onto Beaufort, Maxifort, and Emperador rootstocks in Mar. 2011. Grafted transplants were then planted in two 30 ft × 96 ft Zimmerman brand high tunnels (with ridge-vents) covered with either a single-layer or double-layer 6 mm polyplastic film. The growth and yield of the two heirlooms were affected by grafting and the layers of plastic. Ananas Noire/Emperador had the highest yield in both tunnels while Ananas Noire/Beaufort had a higher early yield in the double-layer plastic tunnel. German Pink had similar yield regardless of rootstocks in the single-layer plastic tunnel, but it yielded most when grafted onto Beaufort in the double-layer plastic tunnel, although yield was higher for all grafted plants. Summer 2011 was extremely hot, which might have contributed to the productivity of grafted and non-grafted tomatoes in the high tunnels with different layers of plastic.

Specified Source(s) of Funding: 1890 Extension.

3:45–4:00 PM

Rootstock Assessment for Root-knot Nematode Management in Grafted Honeydew Melon

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Root-knot nematodes (RKN) are one of the most damaging soilborne pathogens of honeydew melon (*Cucumis melo* var. *inodorus*). Currently their management is dependent on soil fumigation. Vegetable grafting with resistant rootstocks may be an effective approach for RKN management in the sustainable production of honeydew melons. However, RKN-resistant rootstocks for melon grafting currently are not commercially available. *Cucumis metulifer* has been shown to be resistant to RKN, but little is known about its suitability as a rootstock for grafted honeydew melons. In this greenhouse study, we grafted honeydew melon 'Honey Yellow' onto *C. metulifer* ('Honey Yellow'/*C. metulifer*) and a commercial cucurbit rootstock 'Strong Tosa' (*Cucurbita maxima* × *C. moschata*) ('Honey Yellow'/'Strong Tosa'). Non-grafted and self-grafted 'Honey Yellow', *C. metulifer*, and 'Strong Tosa' were included as controls. Plants were inoculated with eggs of *Meloidogyne incognita* race 1 at a density of 5,000 eggs/plant and grown in 3 L pots for eight weeks. Results showed that non-grafted and self-grafted *C. metulifer*, and 'Honey Yellow'/*C. metulifer* had significantly lower ($P < 0.05$) gall and egg mass ratings compared to non-grafted and self-grafted 'Honey Yellow' and 'Strong Tosa', and 'Honey Yellow'/'Strong Tosa'. No significant differences were observed between non-grafted *C. metulifer* and 'Honey Yellow'/*C. metulifer*. In addition, nematode eggs extracted from roots of non-grafted *C. metulifer* and 'Honey Yellow'/*C. metulifer* were 2,395 and 3,339 eggs/plant, respectively, which were significantly lower than that extracted from non-grafted 'Honey Yellow' (110,027 eggs/plant), non-grafted 'Strong Tosa' (145,280 eggs/plant), and 'Honey Yellow'/'Strong Tosa' (68,003 eggs/plant). These results suggest that *C. metulifer* was resistant to *M. incognita* and grafting the susceptible melon scion onto *C. metulifer* did not affect its resistance. In addition, self-grafting did not impact resistance of *C. metulifer* or susceptibility of 'Honey Yellow' and 'Strong Tosa' based on galling and egg mass ratings and extracted egg numbers. 'Honey Yellow'/*C. metulifer* showed significantly higher shoot dry weight but did not influence shoot fresh weight, stem length, and total leaf area, compared to that of non-grafted 'Honey Yellow'. Despite the susceptibility to *M. incognita* in the 'Strong Tosa' rootstock, 'Honey Yellow'/'Strong Tosa' demonstrated higher shoot dry weight and larger total leaf area than non-grafted 'Honey Yellow' and 'Honey Yellow'/*C. metulifer*. Field evaluations need to be performed to fully assess the potential of *C. metulifer* as a suitable rootstock for managing RKN and improving fruit yield in honeydew melon production.

Specified Source(s) of Funding: Southern Region SARE

4:00–4:15 PM

Grafting Compatibility in Heirloom Tomatoes

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Heirloom tomatoes have always been popular at farmers' markets for their heritage, novelty and premium price. However, the lack of pest-resistance and vigor limit the production of heirloom tomatoes for most farmers' market vendors. Tomato grafting is an emerging technique in the United States which has the potential of providing disease resistance and enhancing vigor and yield for heirloom tomatoes, if appropriate rootstocks are utilized. The objective of this study was to investigate the grafting compatibility of heirloom tomatoes to selected rootstock species. Twenty-one heirloom varieties were chosen in the 2011 growing season and grafted onto Maxifort and Beaufort rootstocks using the silicon tube grafting method. Grafting success was above 90% for all combinations, reflecting no incompatibility issues. Grafted transplants were then planted in the field with non-grafted scion varieties as controls. The experiment was conducted as a completely randomized design with three replications. Visual observations on plant growth during the growing season did not indicate any incompatibility among grafted plants. Longitudinal slices at the grafted unions did not show any interruption in xylem and phloem tissues. Stem diameters measured at ½ centimeter below and above the graft union did not show significant difference, as indicated by the ratio of 1.05. Grafted Beefsteak, Brandywine, Durzba, Kentucky Beefsteak, and Auntie Ruby's German Green had thicker stems than the non-grafted controls. In conclusion, all 21 heirloom tomato varieties grew well on Maxifort and Beaufort rootstocks and did not show any incompatibility problems. Yield and growth data of grafted versus non-grafted heirlooms will be discussed.

Specified Source(s) of Funding: NCR-SARE

4:15–4:30 PM

Tomato Rootstock Performance under Non-fumigated Open Field Conditions

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Using grafted tomato plants in open field vegetable production must overcome numerous challenges before it is accepted by the industry in the United States. Studies were performed on grafted tomatoes in a raised bed system under plasticulture with both drip and seepage irrigation. Experiments were conducted in Palm Beach Gardens, Florida. The rootstocks tested include 'Aloha', 'Camel', 'Multifort', 'BB',' HI-7997', and 'FL-91'as the controls, which were self-grafted and used as the scion. All plants were grown for 30 days under greenhouse conditions. After reaching a stem diameter between 1.5 and 2.0 mm the plants were grafted. The experiments were a randomized complete-block design with 4 replicates. Total yields were calculated in 11.4 Kg boxes per hectare. In the Palm Beach trial, 'Aloha', 'Multifort', and 'Camel' had yields of 2845, 2821, and 2727 boxes, respectively. Yields for 'BB', FL-91 (control), and 'HI-7997' were 2529, 2317, and 2087 boxes, respectively. The increase in yield for 'Aloha' and 'Multifort' was 22% or greater than the 'FL-91' control. The rootstock 'HI-7997' had significantly less yield and smaller fruit size than the other rootstocks.

Specified Source(s) of Funding: USDA-ARS and Methyl Bromide Alternatives

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Tuesday, July 31, 2012 Grand Ballroom

Computer Applications in Horticulture

(095) Reaching Pecan Growers Online: The Northern Pecans Blog

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The current revolution in electronic communication technologies requires that extension professionals rethink the methods they use to reach and educate their target audience. I created the Northern Pecans Blog to take advantage of the new media format and provide "real time" information for pecan growers in the northern portions of the pecan belt. The blog format allows me to harness the power of color photography, has no limits on word count, and is easily accessible from multiple platforms. In developing the blog, I have found it important to both educate and entertain my online audience in order to encourage return traffic to the site. Each post tells a story with words, illustrations and photographs. Posts follow the growing season with field observations and reminders of important orchard activities. The blog is also interactive. After attending a pest scouting school, growers report their pest observations via email; I tabulate the data, and then share the data with the online community. The blog also contains "how to" posts, that provide easily-accessible, online training information. Online readership for the Northern Pecans Blog has steadily increased each month since the first post was made in September 2010. Growers report that they actively use the blog to plan management activities in their own pecan groves. The Northern Pecans Blog has developed a national and international following often reaching an audience unaware of Extension or K-State programs.

(096) Use of SMS Technology in Support of Agricultural Decision Making in Florida

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Weather-related information is essential to Florida's agricultural producers for making important decisions. Growers routinely monitor current weather conditions to make informed decisions regarding the use water for irrigation and cold protection as well as the application of chemicals. The Florida Automated Weather Network (FAWN), a program of the University of Florida Institute of Food and Agricultural Sciences, uses data from its 36 automated weather stations to provide growers with a variety of weather-related tools that can aid them in making these decisions. When temperatures are critically low, growers need to be away from the computer and in the field implementing cold protection measures. The FAWN Freeze Alert Tool provides growers with this needed flexibility by sending them a Short Message Service (SMS) text message when certain conditions have occurred at a FAWN weather station. Delivering this time-critical information directly to the field supports optimal protection of crops, cost effective operation of irrigation systems, and conservation of water.

(097) Powering up Multiple Mean Comparisons using the Shaffer-Simulated Method in SAS

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Statistical analysis of continuous data (such as root length or shoot dry weight) in response to classification treatment effects (such as different fertilizer formulations) often requires comparison of multiple treatment means. Several multiple-comparison procedures (MCPs) are available for testing the null hypotheses of no difference between treatment means (pairwise comparisons), while controlling the familywise error rate (FWE; also known as the experimentwise error rate or overall Type I error rate) by providing adjusted *P* values that account for the multiple, simultaneous comparisons. The Bonferroni adjustment and Tukey's (HSD) test are two commonly used MCPs. Fisher's LSD does not control the FWE, except in the case of Fisher's Protected LSD (when significance is indicated by an overall ANOVA *F* test and when comparing no more than three treatment means). Without an adjustment for multiple comparisons, the FWE increases as the number of treatments increases. While MCPs control the FWE, these tests can be conservative, with the actual alpha being less than the specified alpha. Newer MCP methods are now available in SAS/STAT procedures that are more powerful in detecting significant differences between treatment means, while still controlling the FWE. Simulation methods use the actual data to represent the data distribution, rather than relying on an assumed distribution (such as the normal distribution), and can provide additional power for running multiple mean comparisons. Stepdown methods can also be used along with MCPs to improve power. Stepdown procedures involve the ordering of the unadjusted *P* values from smallest to largest, reducing the family size (number of remaining comparisons) for each sequential *P* value, and adjusting of the *P* values accordingly. The power of stepdown procedures can be enhanced by taking into account certain logical constraints among the null hypotheses. The GLIMMIX procedure of SAS includes options under the LSMEANS statement to utilize simulation, stepdown, and logical constraint methods for multiple comparisons. Sample code to product Shaffer-Simulated grouping of treatment least-squared means in a simple case is as follows: PROC GLIMMIX DATA=dataset; CLASS trt; MODEL response = trt; LSMEANS trt / ALPHA=0.05 ADJUST=SIMULATE (SEED=1) STEPDOWN (TYPE=LOGICAL) LINES; RUN;

(098) Center for Landscape Water Conservation: An Integrated Approach to Internet-based Outreach

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Landscape water accounts for over 50% of summer domestic water use in the southwest US. Over half that use can be cut via behavior change, specifically, adoption of xeriscape landscapes and education. At project conception (2008), web-based information for New Mexico and western Texas was scattered and industry professionals were not linked. The Center for Landscape Water Conservation, www.xericenter.com, was established in 2010 as a central resource for homeowners and industry professionals. For homeowners, the Center collects the best, most user-friendly web resources. For industry professionals, the site provides an interactive platform to network with peers and post/share resources. Though the Center was envisioned as a single web portal, the way information is distributed and sought has changed since 2008. Other information sources are now in play. Therefore, the Center produced regional garden tour videos, www.youtube.com/xericenter (13,000+ views) and iTunesU (highest ratings), garden tour photos, www.picasaweb.com/xericenter, Facebook, www.facebook.com/xericenter, and a plant selector app, *SW Plants*, at iTunes. All sites are shared. The primary web portal, www.xericenter.com, took 2 years to complete using part-time student programmers. For testing, we employed a combination of hands-on user testing and a modified Likert survey, the "User-Perceived Web Quality Instrument." Questions assessed design issues essential to the development of a strong user base, namely appropriate site structure, content, usability, and interactive functions. Testing involved a very small Likert survey for initial design check, with overall positive results. At 75% completion, a series of hands-on user surveys was conducted utilizing yes/no and open-ended questions to assess content, usability, navigation, menu hierarchies, and interactive features. Many issues were identified and fixed. A small Likert survey for a follow-up, post-fix check found our search functions still lacking. Search was upgraded and a tag system was installed. A one-shot hands-on survey at 100% completion to assess the final 25% of development and fixes was conducted with positive results. The final survey, a wrap-up Likert survey, involved 60 selected participants, also with positive results. Analytics programs provide insights to the primary website and YouTube channel particularly. For example, our most-watched YouTube video, "How to set up your drip irrigation system" (5500 views), indicates a need for more irrigation content. New users on the primary website are rising steadily. A post-app launch marketing jolt boosted all the metrics. The research and data, plus detailed resource requirements, will provide other outreach organizations a blueprint for designing (and paying for) their own programs.

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Extension

(054) Evaluating the Reach and Collaborative Opportunities of a National Social Media Effort

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The EMG program is conservatively estimated to have over 94,000 volunteers nationwide. The Consumer Horticulture National Committee (CHNC), which provides national leadership for the Extension Master Gardener (EMG) program, has led a social media effort which aligns with three of the CHNC's objectives: 1) facilitate sharing of Extension Master Gardener volunteer project implementation, successes, and learning experiences across state lines; 2) promote national communication and distribution of research-based horticultural information between Extension Master Gardeners and the public; and 3) enhance national recognition and support for the Extension Master Gardener program by utilizing a national logo and encouraging communications through a national website. In Apr. 2010, the Extension Master Gardener (EMG) Blog published its first blog post. Shortly after, organizational Twitter and Facebook accounts were launched in an effort to increase awareness of the blog and cooperative extension horticulture resources, earn return visitors, and facilitate engagement and learning opportunities for EMGs. Through the past several years, the blog, Facebook, and Twitter have grown in contributors, collaborators, comments and conversation. This growth is being explored using a variety of tools, such as Google Analytics, Facebook Insights, Tweetreach, and other social media measurement services. No one social media measurement tool has been employed, but a variety of tools, measures, and tactics have been structured to align with the some of the primary objectives of this social media effort. Through the use of this evaluation plan, project leaders have been able to fine-tune or identify specific milestones and checkpoints, expand reach and engagement opportunities to specific demographics, direct future educational offerings based on interests and needs, and increase awareness of ways to facilitate advocates and supporters through these social networks.

(055) Infographics: A Novel Way to Communicate Program Impact

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Information graphics (infographics) have become popular in the mass media as ways to communicate complex information in an easy-to-understand format with graphic visual representations of information, data or knowledge. Infographics have appeared in major media outlets, green industry outlets and internet blogs. In 2011, a new conference for nursery crop growers, NurseryWorks, was conducted at Kansas State University in Manhattan, KS. Participants (both in person and online) were asked by email to complete a program evaluation via an online survey website (www.axiolearning.org, licensed by Kansas State University) The Office of Educational Innovation and Evaluation at Kansas State University evaluated the survey to ensure proper etiquette and question format. Some information was also obtained from program registration information. Survey response rate was 30% and gender response was the same as participation (31% female, 69% male). Primary results from this survey were compiled into a two-page infographic displaying information about the program participants (age, gender, location, business type), participation methods (in person vs. online, social media), perceived industry engagement, knowledge gained, relevancy of information, motivation to use ideas from the conference, impact statements and preferences for the next NurseryWorks conference. The infographic was created in Microsoft® PowerPoint® for Mac 2011(version 14.1.4, Redmond, WA), an easy-to-use software with which most Cooperative Extension professionals are familiar. Some graphics could be natively created in the software (pie charts and bar charts), but others were created by independently by representing the values obtained in the evaluation questionnaire (change in perceived engagement). A map of participant location was created with Tableau (www.tableausoftware.com/public), a free online data visualization tool. This method of sharing program results communicates program impact quickly, efficiently, and with value. Infographics are ideal for conveying state Cooperative Extension impact to legislators and other stakeholders who need to quickly glean the value of a program or related program. It is also simple enough for most Cooperative Extension professionals to adapt for their own uses.

(056) eOrganic Builds Information Networks for the Organic Agriculture Community

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Land Grant University workplace changes necessitate a more systematic, efficient approach to meeting client needs that includes web-based, nationally coordinated programming. Science-, experience- and regulation-based organic agriculture information must be integrated to produce accurate information of the greatest utility to farmers and agricultural professionals. eOrganic is the organic agriculture Community of Practice for eXtension, the national web initiative for Cooperative Extension and the Land Grant University system. eOrganic works to fill information needs and become an important national source of organic agriculture information by: 1) convening a national community of researchers, extension and other agricultural professionals, farmers, and certifiers at eOrganic.info; 2) facilitating project management, networking and co-learning; 3) supporting collaborative development and publication of peer-reviewed articles, FAQs, and videos at eXtension.org/organic_production; and 4) facilitating engagement with farmers and agricultural professionals through webinars, short courses, Ask-an-Expert, and other interactive tools and activities. eOrganic uses a variety of media to reach its members and public audience. Since its web debut in 2009, eOrganic members have published 227 articles, 50 webinars, and 107 videos. eOrganic's content at eXtension.org/organic_production has seen more than 750,000 views and its videos at youtube.com/eorganic have been viewed more than 500,000 times. Experienced farmers, researchers and extension professionals evaluated eOrganic's articles in winter 2009–10; overall, 92% agreed that the article or video was "very relevant to important farming problems or issues" and 84% that it was "useful and practical and could be applied in real farming practice." A survey distributed to eOrganic members (29% response rate) in 2011 strongly reaffirmed eOrganic's core mission of education and communication.

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Growth Chambers and Controlled Environments

(104) Nighttime Greenhouse VPD Control for Soilless Strawberry Production in Arizona

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While the majority of U.S. strawberries are produced in open fields, greenhouse soilless culture is considered suitable for local production in urban or suburban settings. The University of Arizona Controlled Environment Agriculture Center has initiated a small research program evaluating strawberry (*Fragaria ×ananassa*) as a potential alternative crop grown in semiarid greenhouse since 2009. 'Albion' and 'Camino Real' plantlets were transplanted into two rows of a Styrofoam raised trough

system (Ishiguro Nozai, Japan). The troughs were filled with a mix of 50% coco-coir and 50% perlite. Drip irrigation was applied with the modified Yamazaki strawberry solution twice or three times a day to obtain a target drainage rate of ~30%, pH ~6.5 and EC 1.0. Major challenges include: 1) maintaining optimum root zone environment and 2) preventing tip/calyx burn. The former issue required the selection of substrates having appropriate chemical and physical characteristics and the application of a periodic water flush of root zone to reduce excessive salts. Tip/calyx burn was associated with the relatively high VPD in the greenhouse, causing excessive transpiration and lower turgor to limit calcium supply to the growing meristematic tissues. Earlier study showed that guttation is a plant health indicator for strawberry suggesting a turgor sufficient to supply calcium and can be observed under low night time VPD (<0.1 kPa; Bradfield and Guttridge, 1979). For this reason, we examined a night time application of floating cover on top of strawberry canopy to maintain high humidity (low VPD) inside the cover. A clear polyethylene film was used for the cover and treatment was applied from sunset to shortly after sunrise every day for 40 days (16 Apr.–26 May 2010). Guttation was observed for plants under floating cover almost every morning while no guttation was observed for untreated plants. The night time high humidity treatment exhibited significantly lower percent calyx burn (16.7%) and tip burn (9.0%) than non-treated control (48.6% and 47.2%, respectively) throughout the experiment. When uncovered, 'Camino Real' had more tip/calyx burn (58.9%) than 'Albion' (37.0%). The nighttime average VPD was 0.09 kPa under the floating cover and 0.88 kPa in air inside the greenhouse. No particular difference was observed for disease, as foliage was completely dry during the day (average VPD: 1.6 kPa) For a larger scale operation, automated curtain may be a possibility as a low cost solution of tip/calyx burns for strawberry grown in semiarid greenhouses.

(105) Use of Light Emitting Plasma (LEP) Lamps as a New Source of Artificial Light in Growing Lettuce and Tomato

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The effectiveness of the light-emitting plasma (LEP) light on the growth and development of leaf lettuce and tomato was investigated. Four cultivars of lettuce ('Butterhead', 'Iceberg A', 'Little Caesar', and 'Simpson Elite') were cultured under LEP, high pressure sodium (HPS), and metal halide (MH) lights in a greenhouse and inside a windowless warehouse. When approximate light intensities (350–400 μmol·m^{-2}·s^{-1}) were maintained, the biomass yield was similar under the three different lights. However, the architecture of lettuce plants grown under LEP was more desirable than that obtained under other lights. Chlorophyll content as well as tissue solids varied by cultivars. When four tomato cultivars ('Cobra', 'Geranimo', 'Masada', and 'Trust') were grown with LEP and HPS inside the warehouse, the plants grown under LEP were shorter and more compact than those grown under PHS, while showing higher biomass yield. The solid content of fruits harvested was slightly higher when plants were grown under LEP lamps compared to HPS lighting. LEP lights consumed about 25% less electricity than HPS lights for the same wattage lamps producing similar light intensity. Both LEP and HPS lamps allowed the production commercial quality tomato fruits when used as sole sources of artificial lighting.

Specified Source(s) of Funding: North Dakota Agricultural Product Utilization Commission

(106) Winter Production of Leafy Greens in New Mexico Using High Tunnels

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Replicated yield and temperature data from passively heated high tunnels (hereafter "houses") is lacking, especially in the southwestern United States. Field studies were conducted over three seasons (2009–12) in two locations in New Mexico: a southern site in Las Cruces and a northern site in Alcalde to compare three house models for production of leafy greens during the winter (December–March). Houses were 4.9 m × 9.8 m and oriented with the long edge running east to west. Heavyweight woven plastic (SOLAROOF 172; J&M Industries, Ponchatoula, LA) covered the single layer (SL) model. Double layer models (DL) were covered with a lightweight woven plastic (SOLAROOF 140), followed by a second layer of heavyweight plastic (SOLAROOF 172) inflated with a fan. A heat sink was created using sixteen, 208-L barrels painted black, filled with water, and aligned on the north side of the double layer with barrels (DL+B) model. Soil temperature (7.6 cm deep) and air temperature (30.5 cm above the soil surface) were recorded in six locations near each house (inside the house, inside the house under a floating row cover, and outside the house). Yields of 'Bloomsdale' spinach and 'Flashy Trout's Back' lettuce from two planting dates (28 Oct. and 18 Nov.) were evaluated. Data collection included plant height, fresh weight, dry weight, and stand count at each harvest. At the first harvest in the 2009–10 season in Alcalde, lettuce yield from the November planting was significantly higher in the DL+B model than the SL model. However, in both season one and two, there were no statistical differences between the SL and DL+B models for total, season-long lettuce yields. In the month of January, the mean minimum air temperature inside the SL model was 3 °C warmer than outside. Daily air temperature minimums were highest in the DL+B, followed by the DL, and SL models (2.2 °C, –1.1 °C, and –3.9 °C, respectively). Throughout the growing season, the DL+B and SL models had comparable maximum daily air temperatures (26.7 °C and

26.1 °C, respectively) due to the buffering effect of the heat sink. Row covers (Agribon AG-19, J&M Industries) also had an impact on air temperatures. Minimum air temperature under the row cover and inside the SL house at Alcalde was an average of 6 °C warmer than the air temperature inside the house, but not under row cover. Data collected in this study can help inform the decisions of high tunnel growers and researchers.

Specified Source(s) of Funding: Western Sustainable Agriculture, Research, and Education (WSARE) Program; Hatch; state and federal funds appropriated to the New Mexico Agricultural Experiment Station.

(107) Hydroponic Production of Leafy Crops with Alternative Lighting under Ohio Winter Conditions

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Hydroponic greenhouse production is currently practiced in many U.S. regions, which enables growers to meet increasing consumer demand for local, year-round, fresh vegetables. However, a key limiting factor for hydroponic greenhouse growers in northern climates is the need for supplemental light in winter production. Currently, supplemental lighting in greenhouses is often provided with high pressure sodium (HPS) lamps. However, recent research has focused on light emitting diode (LED) and hydro induction (HI) lighting alternatives with the potential to reduce energy consumption and tailor growing environments to crop needs through provision of specific wavelengths. Therefore, LED and HI lighting could provide growers an opportunity to increase efficiency and/or crop quality in greenhouse hydroponic crops. This work evaluates LED and HI lighting in leafy crops in Ohio winter production. All crops were produced in a polyethylene greenhouse in Wooster, OH. Three commercial lettuce (*Lactuca sativa*) cultivars ('Fidel', 'Multy', 'Ferrari') and 'Genovese' basil (*Ocimum basilicum*) were grown using nutrient film systems with solutions maintained at 1.8 $mS \cdot cm^{-1}$ electrical conductivity and 5.8 pH. Greenhouse aerial temperature, relative humidity, and solar radiation in addition to nutrient solution pH, EC, and temperature were continuously monitored. Seeds were germinated in rockwool cubes (2.5 × 2.5 × 3.8 cm), transplanted to the growing channels after 2 weeks, and harvested after an additional 4 weeks. Fresh shoot weight was measured on all harvested plants along with fresh root weight, dry shoot weight, and dry root weight on a subset of plants. Experiment one (Jan.–Feb. 2010) compared biomass and quality across two solution temperatures (21 °C and 27 °C) and three lighting methods (LED1, LED2, HPS). Results showed no difference between the two solution temperatures, while higher biomass was produced with HPS lighting. However, laboratory and panel evaluations indicated that red-leaved lettuce tended to be more darkly pigmented in some LED treatments. Experiment two (Jan.–Feb. 2012) compared biomass production and energy consumption in HI and HPS lighting systems each programmed to reach a lighting target of 14 $mol \cdot m^{-2}$ per day. Results showed no biomass difference between the two lighting systems, while demonstrating a potential energy savings of 2.3% to 16% for HI vs. HPS lighting. These two experiments indicate opportunities for alternative lighting systems to impact crop yield, quality and energy use during winter leafy crop production in greenhouse hydroponic systems in northern U.S. climates.

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Growth Regulators in Fruit and Nut Production

(199) Foliar Nutrient Sprays and Harvest Date Affect Total Phenolics, Antioxidant Activity, and Titratable Acidity of 'Wonderful' Pomegranate

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Pomegranate (*Punica granatum*) fruit contain phytochemicals that are believed to provide beneficial effects to human health. To assess the effects of foliar nutrient applications and harvest date on the concentration of potentially beneficial phytochemicals in pomegranate fruit, research was conducted at two commercial 9-year-old 'Wonderful' orchards in California's San Joaquin Valley. Zinc sulfate ($ZnSO_4$ at 3000, 4000, or 5000 $mg \cdot L^{-1}$), magnesium sulfate ($MgSO_4$ at 1%, 2%, or 3%), potassium nitrate (KNO_3 at 1%, 2%, or 3%), or a control treatment of deionized water was applied by backpack sprayer at early fruit set (July; fruit green to breaker with caliper ~50 mm). $MgSO_4$ and KNO_3 treatments were applied again at late fruit set (August; fruit red with caliper of ~70 mm). A randomized complete-block design with whole-tree experimental units and 7 blocks were utilized at each site to evaluate total phenolics (TP), antioxidant activity (AA), and titratable acidity (TA). Trees at Site 1 were harvested at the beginning of their commercial harvest period (October) and trees at Site 2 were harvested at the end of their season (November). A subsample of up to 5 unsplit fruit per study tree were collected for evaluation of postharvest parameters, including fruit mass and caliper. Arils were removed and stored at –80 °C prior to phytochemical analyses. TP were measured in gallic acid equivalents (GAE) and quantified via spectrophotometry utilizing the Folin–Ciocalteu reagent. AA was

expressed in percent radical scavenging ability and determined utilizing the DPPH free radical method. TA was quantified using an autotitrator. Early-harvested fruit had lower levels of TP, AA, and TA compared to late-harvested fruit and there was a significant interaction between site and treatment for TP. At both sites, treatments did not result in a significant reduction in any harvest parameter measured. At the late-harvested site, TP were statistically significantly greater in fruit from trees treated with 2% KNO_3 as compared to all other treatments, including the control. Taken together, the results of this study indicate that both foliar applications of KNO_3 and late-season harvests have potential commercial use to increase the levels of desired phytochemicals of 'Wonderful' pomegranate fruit.

Specified Source(s) of Funding: Agricultural Research Institute

(200) Homobrassinolide and Nitrogen Effects on Papaya Seedlings

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Experiments were conducted in Mayagüez to study the effects of seed treatment with aqueous solutions of homobrassinolide (HBR) and nitrogen rates on the chlorophyll concentration, shoot growth, and abundance of aphids in papaya seedlings. 'Tainung 1' papaya seedlings were grown in nursery following standard practices, except for application of HBR (0 to 10 parts per million) and varying nitrogen rates. Increasing HBR and nitrogen rates resulted in increased chlorophyll concentration, enhanced shoot height, and increased shoot dry weight accumulation. Additionally, aphids were less abundant in seedlings exposed to HBR. Papaya transplants treated with HBR and receiving high nitrogen rates were ready to be transplanted to orchards sooner than transplants grown receiving lower nitrogen rates and without exposure to HBR.

(201) Effects of Selected Biostimulants on Mango Fruit Retention and Size

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Research was conducted in southwestern Puerto Rico to determine the effects of two biostimulants on fruit retention and size of 'Villa Flor' mango. The biostimulants evaluated were an agricultural formulation of blended amino acids fortified with potassium (AminoQuelant-K™), and an extract of the alga *Ascophyllum nodosum* (Stimplex™) for agricultural use. The alga extract and the amino acid blend were sprayed separately on the mango leaves until run-off, using the rates of 0 (control), 1, and 2 L/ha per application. The biostimulants were first applied at flowering, and applications were repeated 3 and 6 weeks later. The treatments were established in a complete randomized block design with 5 replications. Inflorescences were selected, tagged, and evaluated for fruit retention every 2 weeks until fruit harvest, when fruit number, size, and weight were determined. Both rates of the two biostimulants significantly increased fruit retention as compared to control plants. The trees treated with the amino acid blend had the highest fruit numbers. However, increasing fruit retention resulted in reduced fruit size and weight, regardless of the biostimulant and rate used. Because fruit size usually is an important attribute for marketing, further research is needed to determine if other application times and rates of these or other biostimulants may be used to attain increased fruit retention without reducing fruit size.

(202) Mode of Action and Efficacy of Abscisic Acid (S-ABA) as a Postbloom Thinner in Apples

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Abscisic acid (S-ABA) is a naturally occurring plant hormone that regulates a number of physiological processes of plants. The most characteristic role of abscisic acid is in the abscission of leaves, flowers, and young developing fruits. Therefore, external application of this plant growth regulator is advantageous where abscission of such plant organs is desired such as by fruit thinning. In the last few years, efforts have been made to evaluate abscisic acid as a postbloom thinner in apples. This study reports research results obtained in 'Golden Delicious' cultivar and over a range of S-ABA concentrations (alone or in combination with 6-benzyladenine) from 50 to 1,000 ppm applied at 10–12 mm king fruitlet size. The most remarkable physiological effect observed was a significant decrease in net photosynthesis of both leaves and fruitlets. Decrease in photosynthesis was concentration-dependent, and leaves and fruitlets recovered from this photosynthetic depression within 10 days. Significant increase in ethylene evolution of apple fruitlets was observed after S-ABA application, generally in a concentration-dependent manner. At 1,000 ppm concentration S-ABA caused leaf yellowing and chlorophyll loss evidenced by the reduction of SPAD values, but not at lower concentrations. Such yellowing and chlorophyll loss were not observed in combined applications of S-ABA with 6-benzyladenine. Final fruit set was generally concentration-dependent, however fruit size was not always closely related to crop load. In summary, external application of S-ABA at 10–12 mm fruitlet size seems to be an effective chemical thinner in apples; it is a photosynthesis inhibitor that enhances ethylene evolution of apple fruitlets, and causes their abscission.

(203) Prevention of Floral Initiation in Highbush Blueberry with Gibberellins

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Highbush blueberries (*Vaccinium corymbosum* L.) are an important horticultural crop, but are slow to establish in colder

regions. Preventing fruit production can hasten establishment by directing more energy towards vegetative growth. Manual removal of floral meristems is effective, but labor intensive. Gibberellins (GA), a class of plant hormones, have prevented floral initiation in highbush blueberries in previous studies. Two field experiments were conducted to test the effectiveness of GA inhibitory properties. The first experiment compared $GA_{(3)}$ and $GA_{(4+7)}$ at 400 mg/L, applied during three time periods from August through September, with cultivars "Aurora', 'Elliott', and 'Liberty'. The second experiment tested $GA_{(4+7)}$ at 200 mg/L or 400 mg/L, applied four times in 10-day intervals from July to August or September to October. Other bushes were sprayed eight times from July through October. Cultivars tested were 'Aurora', 'Draper', 'Elliott', and 'Liberty'. Floral meristems, flowers per inflorescence, and fruit were counted the year after treatments. Floral meristem and fruit numbers were reduced by most GA treatments. Multiple applications over a long time period reduced floral initiation by up to 78%. The most effective treatment period was in late summer to early fall. Flowers per inflorescence were unaffected. No differences in the form or rate of GA were observed. Results suggest that floral initiation in young highbush blueberry plants occurs over a long time period and that multiple GA applications are needed to strongly inhibit floral initiation. Further studies are needed to understand floral initiation patterns and determine why GA only provided partial inhibition of floral initiation.

Specified Source(s) of Funding: Project GREEEN, State of Michigan, AG BioResearch

(204) Effects of Plant Growth Regulator Applications on Branching, Flowering, and Fruiting of *Jatropha curcas* L.

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Jatropha (*Jatropha curcas* L.) is a species that has been identified for biodiesel and jet fuel production, as seeds produce oil of high quality. However, because jatropha is non-domesticated, poor branching and high male to female flower ratio are limitations to achieving high yields at the commercial level. Plant growth regulators (PGRs) have been used to increase branching and yield in various species. Therefore, PGR applications could promote increased flowering and potentially increased fruit production in jatropha. The objective of this study was to evaluate the effects of ethephon and a combination of 6-benzyladenine (BA) and gibberellic acid (GA_{4+7}) on branch induction, and subsequent flowering and fruit production in jatropha. A total of 32 actively growing plants (with leaves) and 32 dormant plants (without leaves) were entirely sprayed with single applications of either ethephon or BA + GA_{4+7}. Final plant size, final number of branches per plant, total number of inflorescences per plant, inflorescence set, total number of fruits per plant, fruit yield (g), total number of seeds per plant, and seed yield (g) were recorded. Plants with leaves showed greater size, fruit yield, and seed yield as compared to plants without leaves. Although plants without leaves showed greater inflorescence set, no differences were found for the total number of inflorescences, and fruits and seeds per plant when compared to plants with leaves. Plants without leaves showed no significant differences for growth, flower, fruit and seed parameters in response to ethephon or BA + GA_{4+7} applications. Plants with leaves showed no increase in the number of branches due to PGR applications. However, plants treated with BA + GA_{4+7} showed greater growth index than plants treated with ethephon. There was no increase in the number of branches or in the number of inflorescences per plant. However, inflorescence set, number of fruits and seeds per plant, fruit yield and seed yield increased to a certain degree as concentration increased, then decreased as concentration decreased. The PGRs here examined appear to have a greater effect on fruit and seed production than on branching stimulation. Multiple applications and higher concentrations might be required to promote branch induction in jatropha.

Specified Source(s) of Funding: FDACS–Farm to Fuel Grants Program

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Ornamentals/Landscape and Turf 1

(227) Evaluating Inorganic and Organic Container Media for the Growth of *Zamia pumila*

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Cycads comprise the most threatened group of plants on earth. Appropriate container media conditions are crucial to successful cultivation of most cycads. At Montgomery Botanical Center inorganic media have improved survival and growth of several very rare and horticulturally challenged *Zamia* species. *Zamia pumila* seedlings germinated at MBC were selected at random and transplanted into 1-gal containers. The following substrates were evaluated: 1) Greens Grade Profile; 2) Turface MVP; 3) 50% silica sand / 50% profile; 4) Axis; 5) Permatil; 6) Perlite, 7) fine Pumice; 8) silica sand; and 9) Fafard Potting Mix #2. Plants were top dressed with 30 g per pot of Nutricote Total fertilizer, 18 N–6 P_2O_5–8 K_2O. Seedlings were transplanted on 1 Oct. 2010 and grown for one year. Media physical properties, leaf growth parameters and nutrient status were measured at the beginning and end of experiment. Sand produced significantly higher leaflet counts than all other substrates. The second high-

est leaflet counts were on plants grown in the Fafard #2, perlite, and pumice. The poorest performing substrates were Turface, Profile, calcined shale, and diatomaceous earth.

(228) Protocol for Verifiying Salt Tolerance in Ornamentals

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There are numerous references that classify plants based on the salt tolerance. However, many of these references are based on observational data and may not be accurate. The objective of this study was to develop a protocol that could be used to verify salt tolerance of ornamental species. Rose of Sharon (*Hibiscus syriacus*) has been reported to be a salt tolerant plant while Sea Hibiscus (*Hibiscus tiliaceus*) has been classified as a salt intolerant plant. Five replicates of 10 rooted cuttings from Rose of Sharon and Sea Hibiscus were placed in 3-L containers filled with 2 L of solutions. The solutions varied in EC concentrations of 0, 1, 2, 3, 4, 5, 6, 7, 8, or 9 dS/m. The solutions were prepared by mixing marine aquarium salt with distilled-deionized water until the desired EC was achieved. Solutions were changed every day and leaf water potential of each plant was compared with control to determine salt stress. For each plant species the lethal concentration that killed 10% of the population were calculated.

(229) Greenhouse and Landscape Performance of Nine Native Wildflowers Grown in Varying Containerized Media

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Increased use of native wildflowers for landscapes supports the need for effective propagation, production and establishment methods. Over the years, a number of containerized media substrates have been developed for improved drainage, root distribution and plant growth. Coastalplain honeycombhead (*Balduina angustifolia*), Florida scrub roseling (*Callisia ornata*), Bush goldenrod (*Chrysoma pauciflosculosa*), Godfrey's goldenaster (*Chrysopsis godfreyi*), Feay's prairieclover (*Dalea feayi*), gopher apple (*Licania michauxii*), Largeleaf jointweed (*Polygonella macrophylla*), October flower (*Polygonella polygama*), and Largeflower jointweed (*Polygonella robusta*) were transplanted into containers filled with one of four commercially available media for 16–20 weeks. The four media treatments (Atlas 3000, Atlas 7000, Fafard 3B, and Metro Mix 300) consisted of varying percentages of peat, pine bark, vermiculite, perlite, sand, cypress dust, and bark ash with physical and chemical properties ranging from 48% to 76% moisture content, 3.3% to 5% air filled porosity, 60% to 68% total porosity, 55% to 61% container capacity, 0.13–0.55 g·cm^3 bulk density, 0.33–1.3 g·cm^3 particle density, 5.8–6.9 pH, 0.09–0.79 mmhos·cm electrical conductivity (EC), and 2.9–14.5 meq·100 g^{-1} cation exchange capacity (CEC). Atlas 7000 contained the lowest initial nutrient composition. After 12–16 weeks in the greenhouse, a media treatment effect was observed for plant height of *Balduina angustifolia, Callisia ornata*, and *Chrysopsis godfreyi*. Plants were transplanted within treatments to the landscape and evaluated monthly for flowering and performance for 40 weeks (March–January). Survival, performance and flower duration varied by treatment and species. Overall, plant survival was poorer for species grown in the Atlas 3000 mix. Among the nine wildflower species evaluated, each has unique ornamental potential for native landscapes, offering a range of flower times and colors. Media substrate composition can extend the visual quality of some species, but other species such as *Balduina angustifolia* and *Polygonella robusta* should simply be used as shorter term annuals.

Specified Source(s) of Funding: Florida Wildflower Foundation

(230) Nutrition Rates and Pot Size Affect Stem Caliper, Flowering, and Market Quality of Potted *Adenium obesum*

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Adenium obesum, commonly known as Desert Rose, are beautiful flowering tropical plants. Worldwide interest by breeders and hobbyists has led to the development of numerous new cultivars with striking floral displays atop enlarged sculptural caudices; however, cultural guidelines based on scientific research using clonal materials have not been published. In this study, 96 uniform rooted cuttings of the *Adenium obesum* cultivar Red were grown in 6- and 8-inch pots, each with four different fertilizer rates using Nutricote Plus (18N–6P–K; Chisso-Asahi Fertilizer Co., LTD, Tokyo, Japan). Plants were grown 20 weeks (July to Dec. 2011) under natural photoperiod and a temperature range of 18 to 35 °C in a greenhouse covered with double polyethylene film, which provided a maximum light level of 6000 μmol·m^{-2}·s^{-1}. Plants produced in the larger pots had significantly greater shoot and root fresh weights than those grown in smaller pots at the equivalent nutrition level. Total flower number, based on weekly counts of open flowers, increased linearly in both 6-

and 8-inch pots as fertilizer level increased. Final open flower totals at the two highest fertilizer rates more than doubled than those at lowest fertilizer rate in both pot sizes. Best overall plant quality was observed at the 7.5 g/pot rate for 6-inch and at the 12 g and 18 g/pot rates for 8-inch pots. Stem caliper increased significantly in a linear manner with increased fertilizer levels for 6-inch pots. Canopy height and canopy width also increased linearly. For 8-inch pots, canopy width and stem caliper increased linearly at higher fertilizer rates but canopy height showed no significant difference.

(231) Evaluation of Suspected Drought Tolerant Species in Oklahoma

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The ornamental industry in Oklahoma is continually searching for unique species for introduction as a way to sustain and expand the specialty market. An emerging niche is introduction of drought tolerant herbaceous taxa. The objective of this research is to provide the Oklahoma ornamental industry with needed information on drought tolerant species selections. Three pots of 10 seeds from 53 different genera including over 150 species were planted at the Oklahoma State University research greenhouses, of which 77 species from 34 different genera had at least one seed germinate per pot. On 10 May 2011, seedlings were planted in research row plots at the Oklahoma State University research station in Perkins. Plants were watered weekly with drip irrigation for establishment. Oklahoma experienced record setting hot temperatures during the summer of 2011. Species that survived the summer included *Amsonia eastwoodiana*, *Amsonia ellipica*, *Amsonia hubrichtii*, *Amsonia tomentosa*, *Anthyllis vulneraria*, *Asclepias eriocarpa*, *Asclepias hallii*, *Asclepias latifolia*, *Baptisia australis*, *Baptisia bracteata*, *Baptisia lacteal*, *Calliandra eriophylla*, *Dalea bicolor*, *Dalea formosa*, *Dalea ornate*, *Dalea pulchra*, *Dalea purpurea*, *Dalea villosa*, *Enceliopsis argophylla*, *Enceliopsis covillei*, *Erysimum* sp., *Euphorbia baselucis*, *Lavendula angustifolia*, *Leucophyllum frutescens*, *Leucophyllum minus*, *Penstemon rostiflorus*, *Penstemon cyanasthus*, *Penstemon pinifolius*, *Poliomintha incana*, *Salvia dorrii*, *Salvia pachyphylla*, *Thermpsis rhombifolia*, and *Trifolium rubens*. The only species to flower and survive the first summer from seed was *Dalea bicolor*. Plants will be evaluated for winter hardiness during Spring 2012.

Specified Source(s) of Funding: Oklahoma Department of Agriculture, Food, and Forestry (ODAFF)Specialty Crop Block Grant Program

(232) Cold Hardiness of Native and Ornamental Grasses in Two Zone Four Locations in North Dakota

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Although native and ornamental grasses provide year-long beauty and interest to landscapes in a wide range of growing conditions and require little maintenance, many homeowners and grounds managers in North Dakota hesitate to use them because of a misconception that they cannot survive our harsh winter conditions. In July 2010, sixty-seven ornamental grass species and cultivars were planted in field trials in Fargo in Fargo silty clay and Mandan in sandy loam to evaluate their cold hardiness in zone 4a. Grasses were arranged in a complete randomized block design with three replications and planted in blocks of small, medium and large according to mature height to avoid shading of smaller plants. After two growing seasons and one winter, data revealed significant growth, quality and vigor differences within year, species, year × species, location, location × species, and rep (location × year).

(233) Morphological and Carbon Allocation Shifts in *Ligustrum japonicum* Thunb. under Varying Degrees of Water Limitations

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Plants of *Ligustrum japonicum* from 11.4-L containers were transplanted into elevated rhizotrons. Moisture levels were maintained at 30% or 70% of plant available water (PAW) by an automated system based on a single capacitance probe per rhizotron. Independently determined saturation volumetric water content (100% PAW) for each rhizotron caused two distinctive irrigation frequencies within each PAW level, resulting in four distinct moisture ranges. All plants in both moisture ranges in the 70% PAW level grew rapidly, with no differences in biomass accumulation or allocation. However at the 30% PAW level, the higher Moisture Limiting-Marginal (ML-Marginal) moisture range reduced total biomass 22%, while the lower Moisture Limiting Fatal (ML-Fatal) range reduced biomass by 42%, compared to plants in the 70% PAW level. Plants within the 30% PAW treatment disproportionally limited allocation to shoot mass, particularly limiting leaf growth. Relatively smaller reductions were measured in root biomass. Plant responses to 30% PAW moisture differed greatly with small variations in irrigation set points. A 3.4% absolute difference in percent volumetric water content (%VMC) was the difference between plant survival and death. ML-Marginal plants received minimal but regular irrigation. This resulted in similar allometric relationships to plants at the lower moisture range of the 70% PAW level. In contrast ML-Fatal plants endured slow dehydration resulting from 0 to 2 irrigation events over 10 weeks which severely restricted new leaf expansion and eventually stopped root elongation toward moist substrate. Only the extreme stress imposed by little to no irrigation for over 10 weeks increased root-to-shoot ratios compared with well-irrigated plants.

(234) Evaluation of Grevillea and Related Taxa for Use in Western Oregon Urban Landscapes

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Grevillea is a genus of about 360 woody, evergreen shrubs or trees native primarily to Australia. Their habit ranges from prostrate and wide-spreading, upright shrubs and tree forms. The common name "spider flower" refers to the unusual flowers which are long and slender and borne in dense bunches. The flowers are found in shades of red, yellow or white. Most of the *Grevillea* cultivars that exist are not cultivated in the Pacific Northwest (PNW), or have been grown only by enthusiasts. Rarely have *Grevillea* and related taxa been used in landscaping and they are currently produced in only small numbers by specialty nurseries in the PNW. The *Grevillea* most commonly used in landscaping in the PNW are *G. victoriae*, *G. juniperina* cultivars, and other hybrid cultivars like 'Canberra Gem'. The primary reason for lack of use is unawareness of this group of plants or the misperception that *Grevillea* lack hardiness or landscape adaptability here. To provide comparative data on the hardiness of these plants in western Oregon, a field evaluation of *Grevillea* and related plants was planted at the Oregon State University North Willamette Research and Extension Center in Aurora, OR on 19 Aug. 2011. A total of 58 accessions of *Grevillea* were planted, along with three *Banksia* accessions, two *Hakea* accessions and two *Lomatia* accessions. All accessions were laid out in a completely randomized design with four replications of each accession. The plot consists of four rows 4 m apart, with plants 1.5 m apart within the row. The plants were hand-watered at planting and overhead irrigated through early fall. No further irrigation or fertilizer was provided after this time. The winter of 2011–12 was mild, with a low temperature of 24 °F on 13 Dec. 2011. Nevertheless, an assessment of cold injury to the collection on 12 Mar. 2012 found many of the cultivars in the collection badly damaged or apparently dead from cold injury. Those that seemed to suffer the least injury included cultivars of *G. victoriae*, *G. juniperina,* and *G. australis*, as well as *G.* 'Canberra Gem' and *G.* 'Poorinda Constance'. Given that these are already cultivated and regarded as some of the hardiest, these results were not surprising. However, other accessions that showed minimal injury included *G. rivularis*, *G. lavandulacea* 'Penola', *Banksia marginata*, *B. integrifolia*, *Lomatia myricoides*, and *L. tinctoria*.

Specified Source(s) of Funding: Washington State Department of Agriculture

Plant Nutrient Management 1

(159) Composition of Hydroponic Lettuce: Rate of Change of Composition of Lettuce in Response to Nitrogen Depletion or Resupply

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Lettuce tissues can accumulate 4000 ppm nitrate on a fresh weight basis when grown under low light intensity in heated greenhouses. Timely removal of nitrate from the nutrient solution in hydroponics may lower tissue nitrate. The time course of changes in composition of hydroponic lettuce tissues were examined over a 6- to 13-day interval of nitrogen depletion or resupply. Most changes in growth were delayed by 6 days or more after changing N supply, except root growth responded in 3 to 4 days. The total reduced nitrogen increased or decreased for 6 days after nitrogen was depleted or resupplied. Tissue nitrate changed more rapidly. Amino acids responded to a change in N-supply within one day in leaf and root. Within 2 days after the start of depletion, all tissues of N-depleted plants had more sugars compared to N-sufficient plants. Effects of N-depletion on tissue concentrations were reversible within 6 days of the start of depletion. Tissue nitrate changed more rapidly than total nitrogen, or growth responses. However, nitrate in petiole tissue changed more slowly than in leaf blade or roots, and larger plants have more biomass in petiole tissue. Thus, clearing nitrate from lettuce by depleting the nutrient solution occurred more slowly for large compared to small lettuce plants.

(160) Characterizing the Physiological Response of Tomato to Phosphorus Deficiency and Recovery

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The plant response to phosphorus (P) deficiency is well defined: plants tend to shift growth to roots in order to explore the soil for more P, root-zone pH declines as the rhizosphere adjust to increasing availability of P, and high-affinity P transporters are up-regulated. If P deficient for prolonged periods, P is reallocated from older to younger leading to marginal, and eventually total, leaf necrosis. At what point a plant can recover from P deficiency is less well understood, and the physiological adjustments to P replenishment have not been characterized. In a series of experiments, tomato plants were grown hydroponically for different periods of time in P-deficient conditions. After defined periods

of time, plants were re-supplied complete nutrient solutions and allowed to recover. We evaluated dry weight, nutrient content, and nutrient regulatory enzymes (chiefly for N and P uptake and regulation) during deficiency and recovery. We found that after only 8 days of deficiency, both the root and shoot mass were significantly less in plants experiencing P deficiency. Additionally, the high-affinity P transporter was up-regulated under these conditions, as was nitrate reductase. Upon recovery, plants tend to accumulate P in their tissue to concentrations greater than control plants (~30% greater), perhaps reflecting improved P uptake efficiency early in the recovery phase. Together, these data illustrate the complex acclimations to P supply, and can provide practical guidance to plant producers to decide if it is feasible to try and recover P-starved plants or start over with healthy, unstressed plants.

(161) Nutrient Density in Lettuce Cultivars Grown with Organic or Chemical Fertilization with Elevated Calcium Concentrations

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This research addresses the potentials for increasing calcium (Ca) concentrations in vegetables. Calcium is a major element for human nutrition, and a diet including Ca-rich vegetables will help in human nutrition. This study explored the potential to increase calcium density of lettuce (*Lactuca sativa* L.) through cultivar selection and nutrient management. Eighteen cultivars including butterhead, romaine, and loose-leaf phenotypes of heritage and modern genetics were tested in a greenhouse experiment. Organic fertilizer [3–0.7–3.3 (N–P–K)] and commercial chemical fertilizer (20–4.4–16.6) factored with three elevated calcium levels (50, 100, 200 mg/L as $CaCl_2$) were the fertilizer regimes. Calcium in whole shoots was analyzed by atomic absorption spectrophotometry of oven-ashed samples. Heritage cultivars had a significantly higher Ca concentration (1.90% dry weight) than modern cultivars (1.57% dry weight). Loose-leaf phenotypes had the highest Ca concentration (2.06%) followed by butterhead (1.66%) and romaine (1.49%). Accumulation of Ca was higher with the chemical fertilizer (1.90%) than with the organic fertilizer (1.58%). Elevated Ca level in the fertility regimes raised the Ca concentration in lettuce from 1.56% at 50 mg/L to 1.86% at 100 mg/L and 1.79% at 200 mg/L. Large differences in Ca concentration occurred among individual cultivars with ranges from 3.05% to 1.27% Ca. 'Salad Bowl', 'Red Deer Tongue', 'Buttercrunch', and 'Bronze Mignonette' were the top in cultivar ranking with mean Ca concentration of 2.50%, whereas 'Adriana', 'Australe', 'Coastal Star', and 'Forellenschluss' were low accumulators with a mean of about 1.33%. Fresh wt of cultivars had no correlation with Ca concentration. This experiment notes that selection of nutrient regimes and cultivars can be utilized to manage Ca accumulation in lettuce.

Specified Source(s) of Funding: UMass Experiment Station, Amherst MA

(162) Zinc Accumulation in Lettuce Cultivars Grown with Organic or Hoagland Based Nutritional Regimes

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Micronutrients are required for growth of human body and for maintaining good health. Zinc (Zn) is a minor element for human nutrition, and Zn-rich vegetables will help to provide this nutrition. This study determined the potential to increase Zn density of lettuce (*Lactuca sativa* L.) through cultivar selection and nutrient management. Twelve cultivars including butterhead, romaine, and loose-leaf phenotypes of heritage and modern genetics were tested in a greenhouse experiment. Organic fertilizer (3–1.5–2) and Hoagland no. 1 solution factored with three elevated Zn levels (0.05, 0.10, and 0.15 mg/L) were the fertilizer regimes with Zn provided as $ZnSO_4$. Zinc in whole shoots was analyzed by atomic absorption spectrophotometry on oven-ashed samples. Modern cultivars had a significantly higher fresh weight yield (32%) than heritage cultivars but accumulated a slightly lower Zn concentration (65 mg/kg dry wt) than heritage cultivars (67 mg/kg dry wt). Butterhead phenotypes had a lower yield (38%) than loose-leaf but had the highest Zn concentration (78 mg/kg dry wt) followed by romaine (66 mg/kg dry wt) and loose-leaf (53 mg/kg dry wt). Accumulation of Zn did not differ between fertility regimes with accumulation being 66 mg/kg dry wt with the organic regime and 65 mg/kg dry wt with Hoagland solution. Elevated Zn level within the fertility regimes also had only small effects on tissue Zn with the concentrations being 65 mg/kg dry wt at 0.05 or 0.10 mg/L and 66 mg/kg dry wt at 0.15 mg/L. Differences in Zn concentrations was significant among individual cultivars with ranges from 91 mg/g dry wt to 42 mg/kg dry wt Zn. 'Tom Thumb', 'Adriana', 'Claremont', and 'Focea' were the top in cultivar ranking with mean Zn concentration of 63 mg/kg dry wt, whereas 'Two Star', 'Black Seeded Simpson' 'Simpson Elite', and 'Winter Density' were low accumulators with a mean of about 51 mg/kg dry wt. Fresh wt of cultivars had a negative correlation with accumulation of Zn concentration.

The results of the experiment signify that selection of elevated nutrient regimes and cultivars may be utilized to increase Zn accumulation in lettuce.

Specified Source(s) of Funding: UMass Experiment Station, Amherst MA

(164) Sensitivity of Romaine Lettuce to Macro- and Microelement Deficiency

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Romaine lettuce is considered as one of the nutrient-dense lettuce varieties with excellent source of vitamins and minerals. However, inadequate information is available on nutritional status of the crop, and tissue macro- and micronutrient standards for optimal quality produce. Therefore, the study was conducted to investigate the impact of macro and microelement stress on the nutritional values of Romaine lettuce (*Lactuca sativa* L. var. *longifolia*), and to generate data on tissue elemental content at various stages of nutrient stress. Plants were grown by providing mM concentration of macro- (N, P, K, Ca, Mg, and S) and microelements (Fe, Mn, B, Cu, and Zn) for control (complete treatment) and the rest were deprived of an element under static hydroponic system in a glass greenhouse. The plant tissues sampled at two different stages (early and late), significantly declined in value in response to the deprived macro- or micronutrient. The sensitivity of lettuce to a particular element based on number of days for the development of visual deficiency symptoms differs with respect to a particular deprived macro or micronutrients. The shoot fresh and dry mass declined significantly, more so at the late deficiency stage. Images of visual deficiency symptoms of macro- and microelements were chronologically documented in the order of appearance for each deficient element. The tissue standards and values associated with various stages of deficiency were also documented. Compared to the nutrient deprived plants, the rate of elemental uptake and partitioning was significantly greater in normal plants.

Specified Source(s) of Funding: International Plant Nutrition Institute

(165) Using the Nugis Software to Track Nutrient Use Trends

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A survey of plant nutrient use and removal was compiled within a GIS for each county in the United States. The on-line tool (nugis.ipni.net) shows the partial nutrient balance derived from data on fertilizer use, animal manure, and nitrogen fixation. This was compared with nutrient removed in harvested crops. The search parameters are selected by the user (the nutrient, time period, geographic region) and interactive maps are produced. Data are also available in tabular form. In order to make consistent comparisons across space and time, we selected years for our analysis where data were available from each source with some degree of consistency in reporting. Data were obtained for 5-year periods, coinciding with the USDA Census of Agriculture from 1987–2007. The nutrient input, removal, and acreage values calculated for the portions of each county were summed by watershed to produce input, removal, and acreage data at the watershed scale. Nutrient Balances, Removal to Use Ratios, and Balances per Cropland Acre were then recalculated using this watershed scale data. This partial nutrient balance does not account for atmospheric deposition, biosolids application, or nutrients contained in irrigation water. It does not account for nutrient losses other than crop removal (such as leaching, erosion, or volatilization). This tool allows the user to select regions of the United States that are of particular interest. A national view reveals that nutrient "Removal to Use" ratios appear unsustainably high in some regions and unsustainably low in others. It highlights the need for more intensive monitoring of soil nutrients and improved nutrient management. A survey of plant nutrient use and removal was compiled within a GIS for each county in the United States. The on-line tool (nugis.ipni.net) shows the partial nutrient balance derived from data on fertilizer use, animal manure, and nitrogen fixation. This was compared with nutrient removed in harvested crops. The search parameters are selected by the user (the nutrient, time period, geographic region) and interactive maps are produced. Data are also available in tabular form. In order to make consistent comparisons across space and time, we selected years for our analysis where data were available from each source with some degree of consistency in reporting. Data were obtained for 5-year periods, coinciding with the USDA Census of Agriculture from 1987–2007. The nutrient input, removal, and acreage values calculated for the portions of each county were summed by watershed to produce input, removal, and acreage data at the watershed scale. Nutrient Balances, Removal to Use Ratios, and Balances per Cropland Acre were then recalculated using this watershed scale data. This partial nutrient balance does not account for atmospheric deposition, biosolids application, or nutrients contained in irrigation water. It does not account for nutrient losses other than crop removal (such as leaching, erosion, or volatilization). This tool allows the user to select regions of the U.S. that are of particular interest. A national view reveals that nutrient "Removal to Use" ratios appear unsustainably high in some regions and unsustainably low in

others. It highlights the need for more intensive monitoring of soil nutrients and improved nutrient management.

(166) Minerals and Metal Content of Four Mango (*Mangifera indica* L.) Cultivar Leaves Grown in South Florida

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The present study was carried out to evaluate the mineral content of five popular mango (*Mangifera indica* L.) varieties in South Florida. The macro/micro nutrients and heavy metal content of 'Haden', 'Tommy Atkins', 'Kent' and 'Keitt' 'Irwin' mango leaves after harvest were determined. Sixty leaves were randomly selected from three different locations (four trees per location) within an 85-ha field at the National Germplasm Repository, Subtropical Horticulture Research Station (SHRS) in Miami, FL. The soil was a Krome (Loamy-skeletal, carbonic, hyperthermic Lithic Udorthents). The precipitation was 1.29 inches from Nov. through Feb. 2008–09 and 9.52 inches from Nov. to Feb. 2009–10. The soil pH ranged between 7–7.5. The mango trees were fertilized every 6 months with an N–P–K rate of 8–4–12 at 1 lb per inch of trunk diameter. Micronutrients applied with fertilizer were: Mg (4%), S (0.56%), Mn (1.01%), Cu (0.05%), Fe (1.36%), Zn (0.14%), and B (0.06%). Sixty leaves randomly selected from the entire tree were harvested and taken to the laboratory for analysis. Preliminary results demonstrated variations among cultivars and locations. Some of these variations could be the result of varietal differences. Furthermore, locations and soil structure, with associated differences in minerals content, may have contributed to differences in the level minerals, heavy metals. Results from this work demonstrated that most of the minerals available in the soil at even low levels could be extracted and taken by the trees in almost enough quantities. This is important because this could impact the amount and type of fertilizer applied during the fertilization process.

(167) Management Tools for Fertilization of the 'Hass' Avocado

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Calculating the appropriate rate of fertilizer to apply is a complex process that involves interpretation of leaf and soil analyses, and a range of orchard and site condition factors. A online computer program was developed so avocado growers can calculate their own fertilizer recommendations (nutrient, application time, and rate) based on tree phenology, a grower-supplied estimate of crop load, and an estimate of vegetative growth. Computer-based fertilizer recommendations have been successfully adopted by growers for crops such as almond and pistachio and will assist California's 6,000 avocado growers match fertilizer applications with tree nutrient demands. In a typical well-managed avocado orchard with reasonably fertile soil, nitrogen, potassium, and zinc are likely to be the only nutrients that need to be applied regularly. Thus, fertilization recommendations are provided for these nutrients. Input for our avocado nutrient fertilization model includes: crop load, canopy size, leaf nitrogen, potassium, zinc, soil texture, and irrigation rate. Avocado trees are unique because the fruits can remain on the tree for 15 to 18 months after full bloom (two growing seasons). The tree must support the growing fruitlets and the maturing fruit from the previous growing season. Moreover, both developing and maturing fruit are strong sink for nutrients. Recent modifications to the avocado nutrient fertilization model included developing fruitlets and maturing fruit in the avocado nutrient model. The model is currently being field tested.

Specified Source(s) of Funding: California Department of Agriculture, Fertilizer Research and Education Program

(168) Seed Germination and Seedling Growth of Tomato and Lettuce as Affected by Vermicompost Tea Treatment

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This study investigated the effect of vermicompost tea on the germination of tomato and lettuce seeds. Greenhouse experiments were conducted twice during Sept. to Dec. 2010. Aerated vermicompost tea was prepared by extracting commercially produced chicken manure-based vermicompost in water at 1:10 dilution rate (vermicompost to water ratio by volume and referred as 10% vermicompost tea) with continuous aeration for 12 h. This extract was further diluted with water to produce 5%, 3% and 1% dilution ratios. Tomato and lettuce seeds were

soaked overnight (9 hr) in 10%, 5% 3%, and 1% vermicompost tea and in water (control). Seeds were sown in peat-perlite medium, fertilized with chicken manure-based compost to provide 300 mg·L^{-1} of N media (150 kg·ha^{-1} of N). Media were sprayed once at the time of sowing with the respective concentration of vermicompost tea used for soaking the seeds. Seedlings were harvested after four weeks of planting. Soaking seeds into vermicompost tea significantly ($P < 0.0001$) increased germination percentage and seedling growth of tomato and lettuce compared to control. The response to concentrations of the vermicompost tea was generally linear. Presence of humic acid (465 mg·L^{-1}) and small quantity (198 ng·L^{-1}) of GA_4 in 10% chicken manure-based vermicompost tea suggests the possibility of hormonal effects on seed germination and better root growth. The earlier emergence and better root growth with vermicompost tea treatment seems to be responsible for better nutrient uptake, growth and faster maturation of the seedlings. The results of this study suggest that vermicompost tea can be a good amendment for vegetable seed germination by increasing the number of seeds germinated and accelerating seedling development.

Specified Source(s) of Funding: Western Sustainable Agriculture Research and Education

Tuesday, July 31, 2012 Grand Ballroom

Postharvest 1

(001) Easy and Economic Production Techniques of Clear Pear Juice

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Asian pear fruit has been used to treat inflammation, cough, fever, constipation or diabetes mellitus due to its rich dietary fiber and phenolic derivatives. Its practical application mostly is limited to pear juice. However, dietary fibers of pear juice are gradually precipitated and resulted in turbid juice from clear juice over time. Therefore, the aim of study is to develop the easy and economic manufacturing processes to keep clear pear juice over time and to characterize physiochemical properties of produced clear pear juice. There were three steps including the filtration, clarifying, and anti-browning in order to produce clear juice. For the filtration with cheese cloth, filter paper (Whatman #4), or centrifugation (10 min at 10,000 rpm), pear juice efficiently filtered with centrifugation since pear juice showed the highest L value (lightness) and lowest yellowness (a value). Among various clarifying agents, gelatin, bentonite or pectinase clarified effectively pear juice but tannin or egg albumin did not. The mixture of gelatin(0.2%) and bentonite (0.5%) did clarify well the pear juice with low turbidity. Among anti-browning agents (0.1%) like L-ascorbic acid, NaCl, or citric acid, ascorbic acid prevented the browning of pear juice with the lowest browning index value (2.62), compared to that of NaCl (2.74), or citric acid (2.87). In conclusion, these results suggest that clear pear juice could be manufactured easily and economically by the combination of centrifugation, 0.2% gelatin plus 0.5% bentonite addition and 0.1% L-ascorbic acid addition

Specified Source(s) of Funding: This study was financially supported by Rural Development Administration (Project No. PJ 907072)

(002) Physiochemical Characterization of Fresh Cut and Juice using Seven Asian Pear Cultivars

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Asian pear (*Pyrus pyrifolia* Nakai) has been processed into pear juice, perry, or fresh cut. However, pear processed products have a tendency to spoil or change easily into brown color. Various artificial additives have been added to prevent color change or fruit spoilage. In this study, physiochemical properties of 7 novel Asian pear cultivars were evaluated to find out the browning or spoilage resistant cultivar for fresh cult or pear juice. A total of 7 cultivars, 'Chuwhangbae', 'Niitaka', 'Noksu', 'Wonhwang', 'Manpungbae', 'Whangkeumbae', and 'Seolwon', were harvested and stored at 2 °C until before processing. Fruit peel was brown color ('Chuwhangbae', 'Niitaka', 'Wonhwang', 'Manpungbae') or green color ('Whangkeumbae', 'Seolwon',

An asterisk (*) following a name indicates the presenting author.

Noksu'). 'Manpungbae' was the most heavy with 750 g per each and 'Chuwhangbae' had the highest acidity content with 0.18%. After peeling off or not, fruits were sliced out as a fresh cut or squeezed out as pear juice. Property change of pear juice or fresh cut was monitored at 0 h and 24 h by color hunter machine, texture analyzer, and UV spectrophotometer (420 nm). Non-peeled pear juice showed the browning reaction in the following order: 'Chewhangbae', 'Noksu' > 'Niitaka' > 'Manpungbae', 'Whangkumbae' > 'Seolwon'. 'Seolwon' showed the strong lightness with high L value (45.7) or low a value (3.1) and kept the whiteness for 24 h. 'Manpungbae' and 'Whangkeumbae' showed the brown reaction at 6 h after processing. There were no difference in browning reaction between fresh cut and fruit juice. In conclusion, 'Manpungbae' and 'Seolwon' were appropriate for juice or fresh cut due to their browning resistance.

Specified Source(s) of Funding: This study was financially supported by Rural Development Administration (Project No. PJ00689)

(003) Multiple Treatments of 'Cortland' Apples with 1-Methylcyclopropene (1-MCP) to Improve Control of Superficial Scald

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Postharvest 1-MCP can inhibit development of the physiological storage disorder, superficial scald, in apple and pear fruit, but the extent of the inhibition can vary by cultivar. Whereas inhibition of scald in 'Delicious' apples after 1-MCP treatment is relatively persistent, scald can develop in 'Cortland' apples as the fruit recover from 1-MCP induced inhibition of ripening. Multiple applications of 1-MCP to horticultural products are now permitted by a label modification of the commercial 1-MCP product, SmartFresh, and therefore such applications might be effective in improving scald control. In this experiment, 'Cortland' apples were untreated, treated with the antioxidant inhibitor of scald, diphenylamine (DPA), on the day of harvest, or with 1 μL/L 1-MCP at different intervals after harvest. Treatment times (days) were 1, 4, 7, 1+4, 4+7, 1+4+7, 7+14, 7+28, 7+42, and 7+84. Internal ethylene concentrations (IECs), flesh firmness, and accumulations of α-farnesene and conjugated trienols (CTols) were measured at harvest, at the time of treatment, and at 21, 42, 84, 126, and 168 days of air storage. IECs and α-farnesene accumulation were similar in untreated and DPA treated fruit, but inhibited by 1-MCP. However, differences among 1-MCP treatments became more persistent with increasing storage periods. Inhibition of both factors was greater in fruit treated on days 1, 4, 1+4, 4+7, 1+4+7, than on day 7 alone. However, double 1-MCP treatments on days 7 and 14 increased inhibition of IECs, α-farnesene and CTol accumulations, but increasing the delay before the second 1-MCP treatment resulted in progressively less inhibition.

Specified Source(s) of Funding: Federal Formula Funds NE1036

(004) Multiple Smartfresh Applications Prior to Controlled Atmosphere Storage

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The SmartFresh label was revised in 2009 to allow for more than one application of 1-methylcyclopropene (1-MCP) to fruit. To simulate the time taken to fill a controlled atmosphere (CA) room over a 7-day period prior to establishment of the storage atmosphere, 'McIntosh' fruit were harvested 3 times in one week. The second and third harvests were 3 and 7 days after harvest 1. At each harvest, fruit were cooled overnight and then 1-MCP applied the following day. Fruit from earlier harvests were treated again or for the first time when each successive harvest was treated. Internal ethylene concentration (IEC) was higher in fruit that were held in storage for longer periods before 1-MCP treatment but was kept low with multiple treatments. CA conditions were established after the last 1-MCP treatment and fruit were stored for 8 months. 1-MCP treated 'McIntosh' from harvest 1 were more firm after storage, but no firmer than untreated fruit if treatment was delayed until day 8. Delaying 1-MCP treatment for harvest 2 until day 4 resulted in lower firmness than treatment on the day after harvest. For harvests 1 and 2, carbon dioxide injury after storage was more prevalent if 1-MCP treatment was soon after harvest. Untreated fruit from all harvests and harvest 3 treated on day 1 showed no evidence of carbon dioxide injury. Senescent breakdown at the end of the storage period was greatest in untreated fruit and when 1-MCP treatment was delayed. Rapid 1-MCP treatment is important to maintain firmness of 'McIntosh', but early and multiple 1-MCP treatments exacerbate carbon dioxide injury if fruit are not treated with diphenylamine (DPA).

Specified Source(s) of Funding: AgroFresh Inc., Federal Formula Funds NE1036

(005) Starch Metabolism in Apple Cultivars

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Starch hydrolysis in apple fruit is easily visualized by staining fruit with iodine. The resulting starch patterns are assigned numbers based on charts that are used to guide harvest decisions. Surprisingly little is known about metabolic processes involved in starch accumulation and hydrolysis, and even less about zonal differences within apple fruit and between cultivars. Our objective is to determine the differences in starch hydrolysis in different cultivars. The starch concentrations and the activities of key starch hydrolyzing enzymes among these cultivars and within the regions of the apple are being investigated. In this

study, 'Empire', 'Gala', 'McIntosh', and 'Honeycrisp' fruit were harvested over several weeks, and the starch concentrations compared with the starch pattern index (SPI) in each fruit. Over the sampling period, the SPI ratings ranged from 1 to 7 for 'Empire' and 'McIntosh', and 1 to 8 for 'Honeycrisp' and 'Gala'. The starch concentrations in fruit of each cultivar varied at a given SPI. At a rating of 1, the starch concentrations averaged 309, 227, 189, and 309 mg/g dry weight in 'Empire', 'Gala', 'McIntosh', and 'Honeycrisp', respectively. However, the variation among cultivars was lower at a rating of 3, where starch concentrations averaged 166, 154, 117, and 146 mg/g dry weight, respectively. In addition, starch concentrations on various tissues zones of 'Empire' and 'Honeycrisp' apples will be presented.

(007) Maturity Effects on Flavor of Mandarin Hybrids: A Two-year Study

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Mandarins (*Citrus reticulata* Blanco) have relatively short maturity windows , typically lasting ≈4–8 weeks. Although maturity windows for standard mandarin cultivars are well know, it needs to be determined for recently developed mandarin hybrids. Our objective was to quantify changes in flavor of new mandarin hybrids over two harvest seasons in order to better define time of optimum maturity; standard commercial mandarin cultivars were included for comparison. Fruit flavor was evaluated by a panel (n = 10) trained to evaluate citrus fruit. Nine descriptors of fresh mandarin flavor were agreed upon by the panelists prior to evaluation. Fruit were harvested in the 2010–11 and 2011–12 seasons. At each harvest, fruit were washed, sanitized, peeled, and halved longitudinally; one half of each fruit was evaluated by the taste panel, and the other half was analyzed for quality parameters (total soluble solids, titratable acidity, and flavor volatiles). Prior to serving, mandarin segments were sliced, cut and mixed in a bowl to assure that each panelist would evaluate a sample from multiple fruits. There was a sharp contrast in weather pattern between the two seasons, with multiple freezes in the first year (2010–11) and unusually warm weather in the second year (2011–12). Fruit harvested in the 2010–11 season had higher TA and lower soluble solids compared with fruit from the 2011–12 season. In general, panelists perception of increased maturity was related to a perceived increase in sweetness, and decreases in sourness and bitterness. 'Murcott' was never rated high for sweetness and tangerine flavor in the first year, while it was rated as very sweet with high ratings for juiciness and floral flavor in the second year. The mandarin × sweet orange hybrid 'Temple' had optimum quality in Feb. 2011 and Jan. and Feb. 2012, with high ratings for fruity and floral flavors, as well as juiciness. The University of Florida hybrid "411" did not reach high levels of sugars until the end of Jan. 2011; bitterness and sourness were rated high in Dec. 2010 and early Jan. 2011. In contrast, 411 tangerine flavor was rated high in early Dec. 2011, and sweetness and fruity flavor were rated high as early as Jan. 2012. The quality evaluation of new mandarin hybrids across their potential seasons of maturity helps to determine optimum harvest.

(008) Effect of 1-MCP Treatment in Polyphenolics and Antioxidants Compounds in Apple Fruit during Ripening

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The apple (*Malus* ×*domestica* Borkh.) is one of the most popular fruit in the world and its consumption is highly recommended for a healthy diet. Polyphenolic compounds of apple fruit play an important role in physiologic functions related to human health. Different polyphenolics have varied biological activities including antioxidant activity. However, information about biological changes in polyphenol compounds during fruit ripening is still lacking. The objectives of this study were to investigate the qualitative and quantitative changes in polyphenolic compounds in apples and to evaluate the effect of 1-MCP treatment on the polyphenolic compounds during fruit ripening. To better understand fruit ripening and effect of 1-MCP on polyphenolic compounds, 'Golden Delicious' apples harvested at pre-climacteric stage were allowed to naturally ripen, or ripening was inhibited by 1-MCP treatment (1.0 $\mu L \cdot L^{-1}$ for 16 h). Postharvest physiological indices including respiration, ethylene production, firmness and chlorophyll fluorescence were monitored for 47 d. Six major polyphenolic groups with a total of 16 identified individual compounds were identified and

An asterisk (*) following a name indicates the presenting author.

quantified. Total antioxidant capacity, total phenolic, flavonols and dihydrochalcones were not significantly changed. Total hydroxycinamics and procyanidin were significantly decreased. No significant change in quercetin and most of its conjugates (quercetin galactoside, rhamnoside, arabinoside, and xyloside) were found, except for quercetin-3-glucoside which was increased by 1-MCP treatment at a late stage. Significant decrease in chlorgenic acid, phloridzin, epicatechin, and procyanidin B2 were found during fruit ripening and were also decreased by 1-MCP treatment. p-Cumarylquinic acid level decreased in response to fruit ripening but was maintained by 1-MCP treatment. Neo-chlorgenic acid was higher in 1-MCP treated fruit than control. The results obtained in this study demonstrated that the complex changes in polyphenolic compounds in apples during ripening. 1-MCP treatment may have limited effect on these changes. This research provided further understanding about polyphenolic compounds in relation to fruit ripening and regulation, which will be helpful for postharvest management on enhancement of health-promoting physiological functions in apple fruit.

(009) Maintaining Fruit Quality and Nutritional Value of 'Star Ruby' Grapefruit by Utilizing Modified Atmosphere Packaging during Prolonged Storage

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Modified atmosphere packaging (MAP) is a commercial technique used to extend the shelf life of fruits by the application of low O_2, high CO_2, and high humidity. Low O_2 and high CO_2 conditions normally slow down the metabolic activity in fruits, which helps to maintain fruit quality and reduce postharvest disorders. However, effect of MAP on the levels of bioactive compounds present in Star Ruby grapefruit is unknown. In the present study, effect of two commercial MAP plastic bags, viz. micro-perforated (MI) Xtend® plastic bags (modified atmosphere and humidity) and macro-perforated (MA) Xtend® plastic bags (modified humidity) on the bioactive compounds present in 'Star Ruby' grapefruit were evaluated. Grapefruits were stored for 16 weeks at 10 °C. Fruits were collected at an interval of 4 weeks; juice samples were prepared by blending 3 peeled whole fruits and analyzed for carotenoids, limonoids, flavonoids and furocoumarins along with fruit quality parameters. β-carotene was highest in control fruits followed by fruits stored in MI bags and was lowest in fruits stored in MA bags. Lycopene was significantly higher ($P < 0.05$) in control fruits, with no significant difference observed between MAP treatments. Furocoumarins namely 6,7-dihydroxybergamottin and 5-geranyloxy-7-methoxycoumarin were lower in fruits stored in MA bags; while no significant difference was observed between control fruits and fruits stored in MI bags. Flavonoids were higher in fruits stored in MA bags; with no significant difference between control and fruits stored MI bags. The examined MAP treatments had no significant effect on limonoids and fruit quality parameters including total soluble solids, acidity, ripening ratio, weight loss, decay, fruit taste and off-flavors. Overall, MAP helped to retain fruit quality and bioactive compounds in 'Star Ruby' grapefruit and can be utilized during prolonged storage. This research was supported by Research Grant Award No. 8056 from the Texas Department of Agriculture, Texas Israel Exchange and the United States–Israel Binational Agricultural Research and Development Fund.

Specified Source(s) of Funding: Texas Department of Agriculture

(010) Mandarin Flavor and Aroma Volatile Composition Are Strongly Influenced by Holding Temperature

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Mandarins are popular with consumers but are prone to the development of off-flavor during storage. Following packing the fruit typically are exposed to periods of both cold and warm temperatures as the fruit move from the packing house to the point of sale and then to the consumer. In order to better understand the impact of warm temperatures on flavor 'W. Murcott' mandarins stored continuously at 5 °C were compared using a sensory panel with fruit that had been stored at 20 °C for either 1 or 2 weeks following 0, 2, or 4 weeks at 5 °C. In addition, the fruit were evaluated for standard quality parameters as well as aroma volatile concentration. The experiment was conducted at two different times during the season. Sensory results indicated that fruit held continuously at 5 °C maintained flavor quality while storage for 1 or more weeks at 20 °C acted to cause considerable flavor loss. The degree of flavor loss at 20 °C increased as prior storage time at 5 °C became greater. Fruit stored at 20 °C had lower acidity than that stored at 5 °C. In addition, much higher concentrations of alcohols, esters, and aldehydes were found to have accumulated in the fruit stored at 20 °C in comparison to that held at 5 °C. The changes in aroma volatile concentration were likely responsible for the off-flavors that were the primary flavor problems noted by the panelists. This study suggests that maintaining mandarins at 5 °C until

purchased by the consumer could be an effective way to lessen or prevent postharvest flavor loss.

(011) Candidate Biomarker Discovery and Selection for 'Granny Smith' Superficial Scald Risk Management and Diagnosis

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Discovery of candidate biomarkers for superficial scald, a peel disorder that develops during storage of susceptible apple cultivars, is part of a larger project aimed at developing biomarker-based risk-management and diagnostic tools for multiple apple postharvest disorders (http://www.tfrec.wsu.edu/pages/posttools/Home). Diphenylamine (DPA) treatment and 1-methylcyclopropene (1-MCP) treatment both reduce or eliminate superficial scald development. Untargeted metabolic and gene expression profiling reveal transcriptomic and metabolomic changes that DPA treatment, 1-MCP treatment, and storage duration all provoke during cold storage that precede and are potentially indicative of post-storage quality, appearance, and treatment effectiveness. Our candidate selection process begins with contrasting metabolomes and transcriptomes of untreated apples with apples treated with DPA or 1-MCP to include biomarkers that may be employed in tools used to assess scald risk and distinguish superficial scald from other peel disorders. Partial Least Square Regression (PLSR) analysis and ranking (Variable Importance in Projection; VIP) of the difference in individual metabolite and transcript levels between control and DPA treated fruit was used for this initial selection. Over 1000 expressed genes and metabolites related to DPA treatment were selected using this protocol. Candidate biomarkers will undergo rigorous experimental validation to select those that best reflect scald risk status in a range of experimental conditions known to affect scald development as well as in a commercial setting.

(012) Optimum Grading Conditions for Identifying Lesions of Citrus Canker (*Xanthomonas citri* subsp. *citri,* Xcc) on Grapefruit

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While current rules allow fresh citrus to be shipped within the U.S. even if they contain minor symptoms of citrus canker (*Xanthomonas citri* subsp. *citri*, Xcc), export markets are governed by the receiving country and many of these (i.e., members of the European Union) still do not allow fruit with canker symptoms. Experiments were conducted over three seasons to determine the best conditions for identifying and removing grapefruit with canker lesions. Washed fruit were first evaluated for the number of canker lesion and minimum and maximum lesion size, which ranged between 1 to 10 lesions per fruit, and 1 to 10 mm in size. Each fruit received a unique bar code for rapid identification during the grading process. The experiments were conducted on a recirculating grading line (1.0 m × 4.6 m) evaluating grading conditions such as lighting, speed of fruit flow, roller color, number of graders, and percentage of fruit infection. Grading personnel from commercial packinghouse were utilized for some of the experiments. As expected, slower line speeds (6.1 m/min) allowed significantly better detection of canker lesions than faster speeds (12.2 m/min), and each additional grader, from 1 to 3, significantly increased the removal percentage of fruit with canker symptoms. Sixty-five percent of the fruit with canker were correctly identified and removed when three graders evaluated the fruit. While this may appear like a relatively low percentage at first glance, keep in mind that an average of 22 graders evaluate the fruit on each Florida packing line. In addition, while canker removal was not significantly different if the overall percentage of symptomatic fruit was 2% or 5%, significantly more fruit with canker were left undetected as the abundance of symptomatic fruit increased to 10% and 20%. Greater lighting intensities between 1,000 and 2,000 lux only occasionally improved canker detection at the

An asterisk (*) following a name indicates the presenting author.

highest value. However, some graders commented of excessive glare at 2,000 lux. The use of gray rollers significantly improved canker detection compared to the use of white rollers. We also found that with each additional canker lesion per fruit, graders were 2.8% more likely to identify the fruit as having canker and removing it. In the same way, increasing canker lesion size by 1 mm resulted in a 6.2% increase in the likelihood of detecting it on the grading line. The relationship between these results and commercial grading practices will be discussed.

Tuesday, July 31, 2012 Grand Ballroom

Teaching Methods

(081) Toward a National Consensus on Learning Outcomes for the Horticulture Curriculum

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Many departments are facing consolidation as universities strive to have a more efficient organizational structure. Undergraduate horticulture programs contained within these consolidated units could soon lose identity or face management and direction from those not familiar with horticulture as a field of study. In May 2012, horticultural leaders from approximately 20 institutions from across the county, including 2-year schools, gathered in Ithaca, NY, for the purpose of identifying core competencies and learning outcomes that should be expected of any horticulture program. If available, learning outcomes were solicited from all institutions prior to the meeting, and these were consolidated into a set of outcomes and ranked according to their commonality or uniqueness. The participants then identified those outcomes that are essential for any horticulture program, those that are desirable, and those that programs should strive to achieve if resources permit. The hope is that this set of learning outcomes will be useful in guiding the maintenance and development of horticulture curricula during this time of change across institutions of higher education.

(082) Academic Cultures: Differences in Evaluating Teaching Excellence

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The works of Boyer (1990) and Glassick et al. (1997) stimulated dialogue about what constitutes scholarly work and scholarship in teaching; influencing how we teach, how we need to evaluated teaching and potentially how we reward the intellectual contributions of teaching. To do this, teaching excellence must be defined so objective methods for evaluating teaching can be constructed. The methodology of this work included the use of semi-structured interviews with chairpersons of Reappointment, Promotion and Tenure Committees for all colleges across Michigan State University. Each Chairperson was asked the following questions: how do you define teaching excellence; how would you measure teaching excellence; and how do you measure teaching excellence (strengths and benefits, as well as challenges and weaknesses of the current methods)? The IRB approved interviews were conducted by individual Co-PIs, audio recorded, and transcribed with numeral identifiers. Transcriptions were open coded to identify themes across academic cultures for how teaching excellence is communicated, measured and evaluated. Results will be presented based on university and unit policy and procedures, with special emphasis on how teaching excellence is evaluated, the importance given to student versus instructor centric evaluations, and the importance given to the scholarship of teaching and learning.

(083) Plants of the Popol Vuh

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The Popol Vuh is an ancient text of stories of the Quiché Indians of Guatemala in Central America. It is considered an important text in the literature of the Americas because it contains fragments of cosmogony, religion, mythology, and cultural traditions that pre-date the Spanish conquest of that region. The Quiché nation was a powerful and civilized people who descended from the Mayans. Plants mentioned in the Popol Vuh include foods such as corn (made into cakes, or tortillas), beans, eaten with corn cakes, pepper seeds, cacao, tomato, tobacco, and tropical fruits. Vines are mentioned, which are presumed to be of varying *Vitis* species. Gourds are mentioned in the context of carrying various items and in a story involving a calabash tree. Other uses for corn were an intoxicating beverage from which "The Four Hundred Youths" became intoxicated, and its use to create the first successful humans (after mud and wood had been unsuccessful). Rubber was used to make a ball, with which a special game was played: elbows, knees, and hips (but not hands), were used to thrust the ball through a solid stone ring high on the opponents' wall. Other fruits mentioned are yellow berries, eaten for sustenance, and tzite bean, a type of red bean, also called Palo de Pito (*Erythrina berteroana* or *E. rubrinervia)* used by soothsayers both then and now. Some plants are represented in hieroglyphs from the Mayan codices. For example, several drawings depict a person planting grains of corn using a stick. The codices predate the written Popol Vuh by at least three centuries, and record Mayan history for hundreds of years prior to the Spanish conquest. The codices themselves were written on the inner bark of fig trees.

(084) Seeking Partners for a Course to Improve Journal Manuscripts Written by Graduate Students

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A popular graduate course at Iowa State University improves students' skills associated with the preparation of manuscripts for refereed journals in horticultural science and related disciplines. The class, *Publishing in Biological Sciences Journals*, has been offered for nearly two decades in a face-to-face, classroom format. The objectives of this poster presentation are to share information on the class and to solicit interest from colleagues at other universities in partnering with us as we offer, for the first time, a version of the class to students at a distance. This poster summarizes keys to the success of the class as it has been taught to date, including the unconventional approach we require students to follow in developing a manuscript. Students whose class manuscripts later were published in refereed journals will be profiled, along with other outcomes data. The textbook for the class, *Getting Published in the Life Sciences* (Wiley-Blackwell, 2011), was written by some instructors of the course and will be displayed. We also will review how the course will be modified to accommodate students at a distance and explain how faculty at partnering universities can participate as peer-reviewers of the manuscripts written by students at their home institution. In an era when few universities invest in courses of this nature, we hope to extend the success we have witnessed, thereby benefitting a larger number of graduate students, as well as ASHS and other organizations that publish journals in the life sciences.

(085) Growing Growers Farmer Education and Mentoring Program

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Like many areas across the United States, Kansas City has a strong need to grow new vegetable and specialty crop farmers as well as provide education for existing ones. The Growing Growers Farmer Education program was established to address this need and to train these new farmers on effective growing practices. As a collaboration between Kansas State University Research and Extension, University of Missouri Research and Extension, Lincoln University Cooperative Extension, the Kansas City Food Circle, Cultivate KC, and the Kansas Rural Center, we set the goal of providing educational opportunities to help new growers get started and established ones get better at what they do. We do this by providing apprenticeships for new growers at established vegetable farms. Many of the host farmers are graduates of the program, and each year new apprenticeships are made available for upcoming growers. Farm apprentices work on a local farm during the growing season to get first-hand, practical experience; they attend monthly workshops; and they get direct one-on-one training from their host farmer. The apprenticeships are both paid and volunteer. We offer a first year apprenticeship that provides a broad overview of farming, proceeded by a second year apprenticeship that emphasizes more advanced farm management skills. The monthly workshops offered address many of the skill sets required to run a local farm, from soil management to production planning to marketing to farm business management. In addition, we've developed an email listserv for area networking, which includes area growers, restaurateurs, grocery stores, and others interested in the local farming industry that has been highly successful at maintaining communication between all of these entities. Finally, we organize special events to help develop the local farming industry and have been able to enroll the apprentices in a business short-course offered through the Kauffman Foundation, a local foundation dedicated to entrepreneurship and business education. As local food networks continue to grow, vegetable grower education and mentoring programs will be instrumental to the development of a stable local food system.

(086) Using Farm Tours to Promote Extension

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The population of Florida gets further from the primary producers and an understanding of their connection to the land with rampant urbanization. The extension service must reach out to these atypical clientele to provide services and to ensure they realize the proximity of agriculture to their communities and the importance of agriculture to their well being. Farm tours have been used by many county extension offices to showcase local agricultural industries to politicians and curious citizens to encourage support and understanding for agriculture. At the same time the agricultural tours can be a useful tool to promote and market extension programs and their importance in education of agricultural producers, urban residents and elected officials making budget decisions affecting operations of the extension service. The experiences of three county extension directors, from a rural, a semi-rural, and a metropolitan county, in promoting agriculture through the use of farm tours indicate similar objectives and impacts. A variety of implementations have been tested, from self-guided tours to tightly scheduled bus tours.

Sponsorship is often required to provide busses and lunches for a cost to participants that will entice them. Extension agents and farm owners provide on-site learning with participants, teaching about their operation, explaining production, marketing, business and other aspects of a successful agricultural enterprise. A variety of evaluation techniques were used from oral questions with raised hands to on-line post tour surveys. A majority of participants in the smaller counties are repeat attendees, retired and curious about what local farms are doing. A smaller segment of participants aspire to a farming lifestyle and come to learn about opportunities. In the large metropolitan county, extension also deals frequently with international visitors including government employees, university faculty and students, business people and farmers from all over the world who want to meet farmers, learn about Florida's agriculture and uniqueness of the U.S. Cooperative Extension and its direct connection with the land-grant university system. The participants of the farm tours come away with a better understanding of agriculture and increased support for the mission of the extension service.

(087) Implementing a Multi-week Inquiry-based Laboratory Module in Plant Tissue Culture in an Undergraduate Botany Course: Effects of Hormones on Plant Organ Development

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Plant tissue culture is an important tool in both basic and applied studies as well as in commercial applications. Plant tissue culture is based upon the theory of totipotency, that is, the genetically based ability of a cell or a nonembryonic organ to form all the cell types in the adult organism. Here we present the methodology and assessment results of the implementation of a multi-week laboratory module conducted in the introductory botany course. In this module, spread throughout the semester, the students used African violet (*Gloxinia* sp., Fam. Gesneriaceae) to gain experience in plant tissue culture techniques. The objective was for the students to learn how to take part of the plant from in vivo to in vitro culture. This required the establishment of aseptic techniques and the use of different media components to multiply plants under in vitro conditions. This lab module was initially pilot tested in one lab section and currently impacts approximately 140 minority students per year, providing hands-on experiences in plant tissue culture. In depth assessment of gain-of content knowledge and gain-of confidence revealed that our novel approach allowed the students to learn while increasing their self-perception of scientific methodology. In three semesters, at the completion of the lab module, the students reported a 2.5-fold overall increase in the post-module assessment for content knowledge compared to pre-module assessment. Similarly, approximately 85% of the students reported that they gained self-confidence in many aspects pertaining to conducting future research such as the use of primary literature, the design and performance of novel scientific experiments, formulation of a testable hypothesis etc. Though this lab module was solely in plant tissue culture, the inquiry-based nature of the exercise develops research skills and 'demystifies research' thus promoting the students to get involved in different research projects available in their home institutions during the academic year or at other institutions during the summer months.

Specified Source(s) of Funding: HHMI

(088) The Development and Implementation of Three Hybrid Units in an Introductory Horticulture Course

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A substantial portion of students enrolled in the Landscape and Horticulture Technology Program at Valencia College are employed either full-time or part time. This results in difficulties in enrolling in face-to-face courses and limits the total number of courses taken per semester. A possible solution to this problem includes the use of fully online and/or hybrid courses. One of the main reasons for students enrolling in these types of courses is the scheduling convenience factor. Lectures and assignments are scheduled around the student's schedule, allowing him/her to continue with employment while enrolling for as many courses as time and/or funds permit. Students in the A.S. degree program for Landscape and Horticulture Technology at Valencia College, as well as potential students spoken to at two trade shows/conferences in Florida, have expressed interest in either fully online or hybrid courses. There are currently several institutions throughout the state and nation offering these types of courses. These institutions offer both the same A.S. degree as Valencia College and one offers a Bachelor's in Science in Horticulture. In most cases, the effectiveness of these types of courses (online or hybrid) on student learning has been shown to be comparable to student learning in face-to-face courses. The purpose of this research was to develop and implement three hybrid course units for HOS 1010C (Introduction to Landscape and Horticulture Technology), then to assess if student learning utilizing the combination of online lectures with face-to-face labs would be comparable with the level of student learning achieved in fully face-to-face courses. This could further lead to the development of complete hybrid courses, where lectures are online and labs are held face-to-face. The data compared was obtained from a combination of summative and formative course-embedded assessments. The summative assessments includes specific questions on tests related to the three hybrid course units, while the formative assessment includes informal surveys (face-to-face) before or during classes as well as a formal survey (online) after course completion. This information allowed the researcher to reflect on the effectiveness of hybrid course units compared to face-to-face course units. By comparing this data, it was demonstrated that the hybrid units were as effective in student learning.

(089) Enhancing Student Learning with Increased Mathematics and Quantitative Analysis in Two Horticulture Courses

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TPSS 601 Crop Modeling is a graduate course on crop models and crop simulations. It requires some calculus background and makes use of regression analysis and computer simulations. Students have used simulation programs such as CSMP (Continuous System Modeling Program, IBM) and STELLA (isee systems). The programs SAS, StatView (Abacus Corporation), and PC SAS have been utilized for statistical analysis. TPSS 300 Tropical Production Systems is a required undergraduate course, and TPSS 674 Plant Growth and Development is an elective graduate course. Concerns over the mathematics and science proficiencies of students have led to using some of the mathematics, quantitative methods, and computer simulations from TPSS 601 in these two TPSS courses. This paper discusses how this was done. Systems analysis was introduced into the courses, looking at the whole plant and crop production from a systems approach. This also included using systems thinking from STELLA. Basic calculus, which is not a prerequisite for these courses, was covered to help students understand modeling, simulation, and crop models. Students performed online computer simulations such as Virtual Plants. They discussed scientific articles on a simulation model of the growth and development of flowering rose shoots, a peach crop yield and tree growth simulation model, and an Easter lily flowering model. Students learned about growth analysis including growth curves, growth equations, simple and compound rates of growth, and yield components. They analyzed allometric equations for tropical tree species. In covering dormancy, chill unit and heat unit models were introduced. In addition, the graphical tracking technique for floriculture crop scheduling was presented. Incorporating these quantitative methods into the TPSS 300 and TPSS 674 courses have helped enhance student learning and increase course rigor.

(090) Student Perceptions of an Online Collaborative Landscape Design Project

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Online environments such as Google's 3D Warehouse allow students to invite collaborators to explore multiple alternatives to meet specific landscape design criteria and to individually edit and track the progression of a digital model as each collaborator contributes. In Fall 2011, class participants in Hort 120, *Introduction to Computer Applications,* repeated a study conducted in 2010 to measure their perceptions of group projects and the value of online collaboration. For the study, students were provided a SketchUp model consisting of an existing residential house and patio and a client design statement. Prior to this course, 50% of class participants had previous experience with CAD applications, while 63% rated their proficiency with Google SketchUp as "very little experience." Students had one week to make a contribution to the evolving model. At the end of the week, 33 revisions were submitted. Course participants were surveyed to measure their perceptions of working as individuals within the virtual group dynamic. While 66% of class participants preferred to work as individuals rather than in groups, 41% agreed that working with others on group projects was more beneficial than working alone. 53% agreed that the collaborative design project completed for the course was a worthwhile experience, and 47% felt that the project completed for the course had value for real-world applications. Student responses in the 2011 study were similar to those received in 2010.

(091) Developing and Expanding Integrated Pest Management Education in Southern Nevada

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From 1999 until 2009, the Las Vegas Valley population grew from 500,000 to nearly 2.5 million. This created a challenge: to meet pest management needs with minimum impact on residents and the environment. As pesticide usage expands, concerns about their environmental effects also expand. This results in a need to increase community educational outreach. Pesticide training has traditionally been conducted as stand-alone programs for specific groups such as pest control operators, farmers and nurserymen. The University of Nevada Cooperative Extension Horticulture team looked at new clientele groups to target, such as Commercial Training Conferences, Master Gardener training, Prison Horticulture training, Invasive Weed management programs, and other community programs whose clientele and staff must also understand IPM principles. Integrating IPM training into other programming reaches users effectively. It has proven successful in Master Gardener training by including a section on IPM and pesticide safety. A CEU training track was added to a large green industry training, which met a stated need from many landscape professionals. One important but overlooked group is those who work in areas other than horticulture. Employees and staff in other areas of organizations such as Las Vegas mega-resorts are now being targeted. This includes those who control funding. Good educational efforts in a community such as Las Vegas encompass many partners and a diverse clientele.

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Temperate Tree Nut Crops

(193) White Delight Peach Series: Medium Chill, Low-acid, White-fleshed Peach Cultivars

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In the early 1990s, the Texas A&M University *Prunus* Breeding and Genetics Program began to develop a series of low-acid, white-fleshed peach cultivars adapted to the medium chill zone of the southern United States. This work has resulted in four new low-acid, white-fleshed peach cultivars that ripen consecutively from early June to mid July in the medium chill zone of Texas. This is the first series of low-acid, white-fleshed peaches released for the medium chill zone of the United States. These all bloom within several days of 'June Gold', have lower acidity, similar size and skin blush color and better fruit shape and firmness than 'June Gold'. These cultivars resulted from crosses done between adapted breeding materials and high chill, low-acid, white-fleshed peaches from California, Japan, and China.

(195) The Kentucky Eastern Filbert Blight Resistant Hazelnut Trial

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The European hazelnut (*Corylus avellana*) has a large nut and has potential as a new crop for small farmers in Kentucky for both in-shell nut sales at farmers' markets and shelled nuts in value-added products. Susceptibility to eastern filbert blight (EFB) has limited the past use of European hazelnut cultivars in this region. Recently released hazelnut varieties from Oregon State University have high resistance to EFB and could serve as potential new cultivars for the region. The objective of this study was to examine regional suitability of five EFB resistant hazelnut cultivars, 'Jefferson', 'Yamhill', 'Gamma', 'Eta', and 'Theta' in Kentucky plantings. 'Jefferson' and 'Yamhill' are main crop cultivars, whereas the other selections are mainly considered pollinizers. The cultivars Jefferson, Eta, and Theta have late blooming characteristics and may avoid late season frost and freeze events in our region. These trees were selected in the Willamette Valley in Oregon and were not specifically selected for winter hardiness in the Kentucky region; therefore, the critical winter temperatures for tree damage are not known. Additionally, it is not known if these varieties will flower early in the spring and be damaged by frost events. In 2010, plants of the five hazelnut cultivars that were produced via tissue culture by a nursery in Oregon and were shipped to Kentucky State University (KSU). Trees were grown in one gallon tree pots in the greenhouse and overwintered outside the greenhouses in a cold frame and straw. In Spring 2011, replicated trials of the five EFB resistant cultivars were established at three locations: 1) University of Kentucky (UK)–Quicksand station at Jackson, in eastern Kentucky; 2) KSU in Frankfort, located in central Kentucky; and 3) Western Kentucky University (WKU) in Bowling Green, located in western Kentucky. The KSU trial was established in a randomized complete-block design with four blocks and two replicates of each cultivar per block, whereas the UK and WKU plantings had three replicate blocks. Smaller grower trials which included all five cultivars were also established at eight grower sites in Kentucky in Apr. 2011. Irrigation was provided as needed and weeds controlled at KSU, UK, and WKU plantings. First year survival rate was excellent, at approximately 90%, and plant vigor was high for all cultivars. Winter survival, pest and disease incidence, as well as any breakdown of EFB resistance by the cultivars in the spring of 2012 will also be reported.

Specified Source(s) of Funding: USDA Evans-Allen funding

(196) 'Zinner' and 'Mcmillan' Pecan Cultivars Perform Well in South Georgia Trials

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'Zinner' and 'McMillan' pecan cultivars have been evaluated for 10 years in a yield trial located in south central Georgia. Trial trees were planted in an irrigated orchard at a 12 m × 12 m spacing and given care according to UGA guidelines for commercial orchards. Actual yields were measured for each tree. A subsample of nuts was taken annually from each tree and nut weight, percent kernel, nut volume, and specific gravity were determined. Cluster size, harvest date, and damage from pecan scab (*Fusicladosporium effusum*) and black pecan aphid (*Melanocallis caryaefoliae)* were also determined for each clone. 'Zinner' had similar nut yield to 'Desirable' and 'Stuart', which were included in the trial as check cultivars. Nut size of 'Zinner' (9.5 g) was slightly smaller than 'Desirable' (10.3 g) and very similar to 'Stuart' (9.7 g). Percent kernel of 'Zinner' (57%) was superior to both 'Desirable' (52%) and 'Stuart' (45%). 'Zinner' was susceptible to damage from black pecan aphids and will need to be monitored for this pest. 'McMillan' had smaller nut size (9.1 g) and a moderate percent kernel (50 %), but much higher yields than 'Desirable' and 'Stuart'. 'McMillan' also had excellent resistance to pecan scab. Both cultivars are now recommended for trial plantings in the state of Georgia, with 'Zinner' recommended for trial in full-spray commercial orchards and 'McMillan' recommended for low-input and organic plantings or in high scab pressure orchards.

Specified Source(s) of Funding: Georgia Commodity Commission for Pecan

(197) Dormancy Weather Conditions on Commercial Nut Yield of Pecans Growing under Subtropical Conditions

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Besides the effect of alternate bearing to decrease yield in off-years, also low nut yield in pecans growing under subtropical regions had occurred in seasons preceded by winters with very low chilling accumulation. Also, alternated periods of warm and cold conditions during dormancy are common and its effect on nut yield is unknown. The objective of this study was to determine the effect of weather during dormancy on commercial pecan nut yield. The effects of temperature, relative humidity and precipitation of November, December, January, and February on commercial nut yield of pecans growing under subtropical conditions were examined by linear regression analysis. The growing area studied has an elevation of 70 m and is located in Northwest México between 28°N and 29°N and 111°W and 112°W. Using a temperature base of 7.2 °C, from 1 Nov. to 28 Feb., chilling hours ranged from 142 in "warm winters" to 232 in "cold winters," in a 10-year span (1999–2009). Independent variables were the average and the standard deviation (SD) of daily chilling hours (base temperature 10 °C, minus hours above 25 °C), daily high temperature, daily low temperature, daily average temperature, daily range temperature, and daily relative humidity. Also cumulative precipitation was included. Period from 1 Nov. to 28 Feb. was divided by month (November, December, January, and February), bimonthly (November + December, December + January, and January + February), and for the whole period (1 Nov.–28 Feb.). The only significant effect was found with the standard deviation of the February Chilling (kg/ha= 105.8 + 439 · SD February daily chilling; r^2 = 0.53*) and the standard deviation of the February daily minimum temperature (kg/ha= –104.8 + 680.8 · SD daily low temperature; r^2 = 0.47*). No significant responses were detected for precipitation and relative humidity. The higher the variation in daily chilling hours and minimum temperature represent the presence of periods of cold and warm days. According to data, dormancy stage during February seems to be more sensitive period to temperature.

Specified Source(s) of Funding: Fundación Produce Sonora

(198) Shoot Fruiting Status, Leaf Nitrogen, and Photosynthesis during Kernel Fill in 'Western' Pecan

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Most leaf nitrogen is found within the photosynthetic apparatus, and, as such, nitrogen availability is closely tied with both photosynthetic function and productivity of fruit trees. Reproductive growth in fruit trees also represents a strong nitrogen sink. When soil nitrogen uptake by roots is low, fruit trees remobilize and translocate nitrogen from leaves to help meet nitrogen demand of developing fruit. Our objective was to describe shoot-level impacts of pecan fruiting on leaf nitrogen and photosynthesis during kernel fill under a range of tree nitrogen status. Our study was conducted in a mature pecan (cv. Western) orchard near Las Cruces, NM. In 2009, fifteen trees exhibiting a range of nitrogen deficiency symptom severity (quantified using a SPAD 502 chlorophyll meter) were grouped into three symptom severity classes each with five trees: 1) 'severe', SPAD 26.4–31.4; 2) 'moderate', SPAD 33.6–37.2; and 3) 'slight', SPAD 39.7–46.7. For the 'slight' class, 2.3 kg and 2.1 kg nitrogen (as urea) were broadcast-applied around each tree in 2009 and 2010, respectively. For the 'moderate' class, 1.2 kg nitrogen was broadcast around each tree in 2009 and 1.0 kg nitrogen in 2010. Light-saturated leaf photosynthesis was measured with a Li-6400XT photosynthesis system on fruiting and non-fruiting shoots during kernel fill (2 Oct. 2009, 1 Oct. 2010, and 5 Nov. 2010). Following photosynthesis measurement, the leaflet measured and its leaflet pair partner were sampled, dried in an oven, and ground. Leaf tissue nitrogen concentration was measured with a ThermoFinnigan DeltaPlus XP Isotopic Ratio Mass Spectrometer. Both leaf nitrogen concentration and leaf nitrogen per area were significantly lower on fruiting shoots than non-fruiting shoots on all three sampling dates. For both variables, the nitrogen status main effect was also significant while the 2-way interaction of shoot fruiting status and tree nitrogen status was not. Photosynthesis of leaves on fruiting shoots was also significantly lower than that of non-fruiting shoots on all sampling dates, especially on 2 Nov. 2010, when fruiting shoot photosynthesis was reduced by 42.8%. Our data suggest that pecan fruit nitrogen demand reduced nitrogen in nearby leaves on the same shoot during kernel fill and that photosynthesis of those leaves was negatively affected as a consequence. The effect of tree nitrogen status and shoot fruiting status might be best summarized with an additive model where there is a larger

relative reduction in leaf nitrogen and photosynthesis for fruiting shoots on low nitrogen status trees.

Specified Source(s) of Funding: SCRI, Hatch, and State Funds

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Vegetable Breeding

(363) Identification of Lettuce Germplasm Lines Resistant to Banded Cucumber Beetle

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Banded cucumber beetle (BCB), (*Diabrotica balteata* LeConte) is among the major pests that cause significant economic damage to the lettuce crop in Florida. Control of the insect mainly relies on pesticide applications, which can pose adverse impact on environment. Host plant resistance is an environmentally sound method for controlling BCB and is compatible with other approaches in lettuce IPM. In this study, we evaluated responses of 67 lettuce germplasm lines and 10 cultivars to BCB in the field experiments in 2010. The BCB attacked lettuce from mid-Nov. 2010 through early Dec. 2010 and were not noted after the first freeze on 7 Dec. Lettuce lines varied for their responses to foliar feeding by BCB and two germplasm lines (60185 and 70096) showed resistance. The resistance in 70096 and 60185 was confirmed in the laboratory tests. The two lines will be useful as sources of resistance for development of resistant cultivars that can reduce foliar feeding damage by BCB as well as for genetic study of the resistance.

(364) Development and Application of a Suite of Non-pungency Markers for the *Pun1* Gene in Pepper (*Capsicum* spp.)

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Pungency in peppers is due to the presence of capsaicinoid molecules, which are only produced in *Capsicum* species. The major gene *Pun1* is required for the production of capsaicinoids. Three distinct mutant alleles of *Pun1* have been found in three cultivated *Capsicum* species, one of which has been widely utilized by breeders. Although these mutations have been previously identified, a robust collection of molecular markers for the set of alleles is not available. This has been hindered by the existence of at least one paralogous locus that tends to amplify with *Pun1*. We have developed a suite of markers that can differentiate the four *Pun1* alleles and have tested them on a diverse panel of pepper lines and in an F_2 population segregating for pungency. These markers will be useful for pepper breeding, germplasm characterization, and seed purity testing.

Specified Source(s) of Funding: AFRI Competitive Grant from the USDA NIFA (2010-8517-20551), Cornell University Presidential Life Sciences Fellowship, and USDA National Needs Graduate Fellowship Competitive Grant No. 2008-38420-04755 from NIFA.

(365) Identification and Mapping of QTL Affecting Antioxidant Compounds in Cherry Tomato

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Antioxidant compounds such as lycopene, beta-carotene, ascorbic acid, and anthocyanin are important fruit quality traits in cherry tomato (*Lycopersicon esculentum* Mill.). Our objectives were to identify RAPD markers associated with QTL affecting three antioxidant compounds including lycopene, beta-carotene, and ascorbic acid in an F_2 population from the cherry tomato cross of CNB106 (low antioxidant compounds) × LA3538 (high antioxidant compounds) grown in a greenhouse, and then, place these markers linked to antioxidant compound QTL in a genetic linkage map constructed using the F_2 population of the cross. Continuous frequency distributions for three antioxidant compounds were observed in the greenhouse population indicating quantitative inheritance for the fruit quality traits. A total of 23 RAPD markers, seven obtained from CNB106 and 16 obtained from LA3538, were identified to be significantly associated with QTL affecting the three antioxidant compounds in the greenhouse population based on simple linear regression and interval mapping. Three CNB106-derived and four LA3538-derived markers, located on four different linkage groups of the linkage map, were significantly associated with QTL for lycopene in this

population. We detected two CNB106-derived and eight LA3538-derived markers associated with QTL for beta-carotene in the population and placed these markers on three linkage groups of the cherry tomato map. One CNB106-derived and three LA3538-derived markers significantly associated with ascorbic acid QTL were mapped on two linkage groups of the map. After validating the associations of markers with QTL for antioxidant compounds in different populations and environments, these validated markers can be used in cherry tomato breeding programs for developing new cultivars having high antioxidant compounds.

Specified Source(s) of Funding: CNARES, RDA (PJ0087 88032012)

(367) Identification of Drought-induced Root Proteome in a Wild Tomato Species (*Solanum chilense*), Using Isobaric Tags for Relative and Absolute Quantitation Proteomics Analysis

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In this project, seedlings of wild tomato (*Solanum chilense*) were grown to 4-leaf-stage in a hydroponic tank filled with ½ Hoagland solution. Drought treatment was applied by letting plants to air-dehydrate in empty tanks overnight. The control plants were maintained in the solution. The next morning when the leaves started to wilt, roots were harvested and frozen immediately in liquid nitrogen. Protein was extracted using TCA/acetone precipitation method. Proteins in the pellets were solubilized in a buffer consisting of 50 mM TEAB (triethylammonium bicarbonate) and 6 M urea. Proteins (100 ug/sample) were digested with trypsin A and the digests were labeled with taqs in the iTRAQ reagent kit (8Plex, AB Sciex). Labeled proteins were subjected to MS/MS analysis. Mascot v 2.3 was used to quantify the level of expression of each protein identified via the iTRAQ reporter ions. The MS/MS spectra were used to interrogate the ITAG2.3_proteins database. Proteins identified from the analysis were searched for orthologous proteins from *Arabidopsis* in STRING database, and a protein interaction map was constructed for the molecular regulation to dehydration stress in wild tomato.

Specified Source(s) of Funding: NIFA–AFRI

(368) Performance of Current Broccoli Varieties under Eastern U.S. Conditions

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Broccoli production on the east coast has been limited because the weather often causes developmental defects in the head that make the crop unsalable. As a result of the small market for seeds, there has been limited effort to develop varieties that have better tolerance of the growing conditions. As the initial step in a large new public–private breeding effort to develop such varieties, we conducted a regional trial across the East Coast in 2011 using existing commercial material. This trial was conduced in five locations representing a broad range of eastern climates (southern Maine, western New York, Piedmont Virginia, Mountain North Carolina, and Coastal South Carolina). At each site, the 32 entries were planted once when the weather was likely to be most favorable (to show potential), and once when the growing conditions are good but the chance of defects is too high for commercial production (to assess adaptation to the east). Evaluators used a common scale, and practiced calibration to evaluate eleven traits that have been quality limitations in eastern broccoli. These traits included bead (i.e., flower bud) uniformity, bead size, plot uniformity, head extension, head uniformity, holding ability, proportion of marketable heads, dome, color, days to maturity, and head firmness. The trials were conducted under confidentiality agreements that preclude revealing the identity of varieties in this context. The entries included standards selected by the public breeders as representing varieties commonly planted in the east. Participating seed companies (Bejo Seed, Seminis Vegetable Seed, and Syngenta Vegetable Seeds) were asked to complement with commercial material they felt might perform well. The commonly planted varieties performed similarly to those selected by the seed companies, indicating that growers are accessing the best currently available material. However, none of these varieties consistently produced marketable-quality product. Thus there is room for improvement. Several entries were in limited marketing as numbered material. These were among the strongest performers, indicating that there is notably better material in the pipeline. Principal component analysis showed that difficult traits, like high bead uniformity, were not negatively associated with essential traits like small bead size and domed head.

(370) Different Expression of Root Aquaporin Genes between Dutch 'Dundee' and Japanese 'Reiyo' Tomato Seedlings

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We have been investigating physiological characteristic of root in Dutch and Japanese tomato varieties, and we found that the root permeability of Japanese variety 'Reiyo' had significantly higher than that of Dutch variety 'Dundee'. In order to research the genetic difference, we analyzed root aquaporin genes in both varieties. Compared to PIP (one group of aquaporin family, existing on cell membrane) expressions of two varieties, we obtained that 'Reiyo' had higher expression than 'Dundee' in PIP2:3 and 2:4. By contrast, in PIP1:2 and 2:5 'Dundee' had higher expression than 'Reiyo'. Additionally, we examined base sequences of cDNA because our primers used for aquaporin gene amplification were based on another tomato variety 'Micro-Tom' sequence data. The sequences of cDNA for the PIPs from 'Dundee' and 'Reiyo' were basically coincident with the 'Micro-Tom' data. Although we need to have more precise investigation of the function for PIP1:2, 2:3, 2:4, 2:5, and other PIP families, we found that aquaporin genes had different expressions at Dutch and Japanese tomato varieties.

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Viticulture and Small Fruits 1

(272) Understanding the Ripening Chemistry of Cold Climate Wine Grape Cultivars to Predict Optimal Harvest Times

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The chemical composition of grape berries has generally been accepted as the most important factor when determining harvest time. The balance between sugar content, acidity, and phenolic ripeness are used to determine harvest times as both sugars and organic acids contribute to sensory quality, stability, and alcohol potential of wine. Developing a dynamic profile of these compounds facilitates harvest at optimal times to produce quality wines. Chemical composition changes during berry ripening have been studied extensively in *Vitis vinifera* cultivars, but little is known of the chemical composition of hybrid cold climate wine grape cultivars. We sampled berries from 11 cold climate wine grape cultivars approximately every 10 days from August to October during the 2010 and 2011 growing season and assayed for soluble solids (°Brix), titratable acidity (TA), pH, and berry weight. Concentrations of organic acids, sugars, and other metabolites were also measured to predict peak maturity time for the selected cultivars. Through the comparison of the concentration of sugars and acids to heat accumulation units such as Growing Degree Days (GDD), it was found that 1330 to 1500 GGDs (Base 10 °C) are needed to fully ripen cold climate wine grapes to peak maturity. Complete knowledge in the range of variation for these measurable components can be used to determine optimal harvest times of cold climate wine grape cultivars.

(273) Effect of Nitrogen Application on Mineral Nutrients, Vigor, and Yield under Crop Forcing in a Warm Region to Produce Cool Climate Quality Fruit

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Our previous research has demonstrated the potential of crop forcing to shift fruit ripening to the cooler portion of the growing season and to improve fruit quality of wine grapes in warm regions. When a large portion of the new growth was removed for forcing, petiole NO_3-N content at full bloom was deficient in forced vines while the contents of other mineral nutrients remained within normal range. Furthermore, lower vine vigor and yield were observed in forced vines, compared to non-forced vines in previous experiments. An experiment was conducted in a mature 'Cabernet Sauvignon' vineyard in the San Joaquin Valley of California to determine if vine N status, vigor, and yield of forced vines can be improved by supplemental N applications. UN-32 liquid fertilizer was applied under drip irrigation emitters at 28 kg N/ha four times at 14 d intervals before or after forcing, starting 4 weeks prior to full bloom of non-forced vines or 3 weeks prior to full bloom of forced vines. Forcing was conducted on 24 June 2011, when growing shoots were hedged to six nodes and all leaves, summer laterals, and primary clusters were removed. N applications did not affect the number of forced shoots and clusters but resulted in

greater vine vigor and higher yield. Petiole NO_3-N content at full bloom was increased markedly by N applications, more so when N was applied after forcing. Petiole total N content was increased by N applications before and after forcing at a similar magnitude. The content of other mineral nutrients at full bloom affected by N applications included lower P and Zn by N applications before and more so after forcing; higher Mn only by N application before forcing; and higher Ca and Mg only by N application after forcing. Analysis conducted at veraison for non-N and N application after forcing revealed higher NO_3-N, total N, Mn, and Ca but lower P, B, and Cu with N application. Only NO_3-N was deficient in forced vines without N application, limiting vine growth and cropping. N application after forcing was more effective, improving vine N status as well as increasing vine vigor and yield.

Specified Source(s) of Funding: California State University - Agricultural Research Institute

(274) Genetic Characterization of *Vitis californica* and *V. girdiana*

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Microsatellite DNA marker analysis was used to characterize 62 *Vitis californica* and 31 *V. girdiana* candidate selections that are currently maintained by the Department of Viticulture and Enology at the University of California, Davis, and 83 vines of "wild" *V. californica* (selected based on phenotype) from diverse geographic areas in Northern California that were not located near current commercial vineyards. Final analysis was based on nine markers from nine different linkage groups that were polymorphic in the study set. From 50 *V. californica* vines collected in Sonoma County, CA, 10 were F_1 hybrids with either 'Cabernet Sauvignon', 'Merlot', or 'Zinfandel;' and several others were the same clone as other wild vines, even if the vines were separated by 20–40 m. The final reference population of 83 wild *V. californica* vines was selected from diverse geographic areas in northern California. Thirty-eight of these vines were chosen because they were growing > 400 m apart to eliminate clonal duplication and were collected from areas removed from commercial grape cultivation. The other 47 candidate selections were also included in the reference population for *V. californica* allele frequencies, since they were collected as *V. californica* based on phenotype in diverse areas of the state. The reference population for *V. girdiana* consisted of 25 candidate selections. Allele frequencies for *V. vinifera* were based on the available profiles of 45 diverse cultivars. Based on likelihood analysis, the populations of *V. californica* and *V. girdiana* contained hybrids with *V. vinifera* as well as pure forms of both wild species. Selections from the wild, non-hybrid populations will be added to the grape collection of the National Clonal Germplasm Repository in Davis, CA.

(275) Effect of Salicylic Acid on Physiological Characteristics Related to Leaf Senescence under Low Temperatures in Kyoho Grapevines

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Vines begin senescence under low temperatures of 4 to 10 °C during the growing season when double cropping is practiced in Guangxi, China, a sub-tropical grape growing region. Sugar accumulation and acid degradation are reduced, resulting in slow or insufficient fruit ripening for commercial production. Field study demonstrated that salicylic acid (SA) application 1–2 d prior to a low temperature event was effective in inhibiting leaf senescence and yellowing, and promoting fruit ripening. In 2010, an experiment was conducted to simulate field temperature conditions to determine physiology changes in relation to leaf senescence in Nanning, Guangxi, China. Leaves of 1-year-old self-rooted Kyoho grapevines grown in greenhouse were sprayed with water or SA at 0.015% until runoff, incubated at 7 °C for 12 h, and then allowed to recover at 25 °C for l d. Activity of superoxide dismutase (SOD), peroxidase (POD), and catalase (CAT) in leaf blades were reduced by exposure at 7 °C, recovered during the exposure at 25 °C, but did not restore to levels prior to exposure at 7 °C. Vines treated with SA had higher activity of SOD and POD at both 7 °C and 25 °C. The ratio of bound to free water as well as the contents of free proline, soluble sugars, and soluble proteins was higher, but the content of Malondialdehyde (MDA) and relative electrical conductivity were lower in SA-treated vines after 12 h exposure at 7 °C. The research demonstrated the potential of SA to inhibit leaf senescence and yellowing by maintaining higher SOD and POD activity, higher contents of free proline, soluble sugars, and soluble proteins, as well as reducing MDA accumulation under low temperatures.

(276) FamO28-22-5: A Potential Red Wine Muscadine Selection for Florida

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Muscadine grapes have been important in southeastern United States for their Pierce's Disease resistance, and muscadine wines have been well recognized for their high nutritional values and unique taste. In addition to the poor color commonly found in warm grape growing regions, the red wines from muscadine grapes in Florida often encountered browning problem due to their unstable pigments. In the efforts to improve the red wine quality of muscadine grapes, the grape breeding program at Florida A&M University selected a new breeding line FamO28-22-5. This selection has perfect flower, is moderate in vigor, very productive, and has produced high quality red wines, as compared the wines from 'Noble', the best commercial muscadine grape for red wine in Florida. The preliminary color data obtained from 0.5- to 3.5-year-old aging wines showed the red color of this selection is rich and stable. It could be a premium red grape for Florida wine industry in the future.

(277) Comparison of Vegetative Growth, Cropping Potential, and Fruit Quality of Selected American and French–American Hybrid Bunch Grape Cultivars and Advanced Selections in Alabama

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Experimental vineyards were established at the Sand Mountain Research and Extension Center (SMREC), Crossville, AL, and the North Alabama Horticulture Research Center (NAHRC), Cullman, AL, in 2008 to evaluate the performance of Pierce's Disease (PD) tolerant American and French-American hybrid bunch grape cultivars and advanced selections developed by the University of Arkansas grape breeding program. PD tolerant cultivars studied at the SMREC include 'Black Spanish', 'Blanc du Bois', 'Champanel', 'Conquistador', 'Cynthiana', 'Favorite', 'Lake Emerald', 'Seyval Blanc', 'Seyval Blanc' grafted on Coudrec 3309, 'Stover', and 'Villard Blanc'. The experimental vineyard planted at the NAHRC includes 'Conquistador', 'Stover', 'Mars', and 'Neptune' as standards for processing and table grape cultivars and 12 advanced selections from the University of Arkansas grape breeding program. The experimental design utilized in both vineyards is a randomized complete-block design with 4 replications. During 2010–11, data were collected to determine vine pruning weight, trunk cross sectional area, leaf area, and leaf chlorophyll rates. Vine early shoot development, percentage of open flowers, and veraison progression were also assessed throughout the growing season. Total yield per vine, mean cluster weight, average berry weight, and soluble solids content were measured. The results suggest 'Champanel' was the most vigorously growing grape among the PD tolerant cultivars in our test. 'Blanc du Bois', 'Seyval Blanc' and 'Seyval Blanc'/3309C had early ripening season, while 'Cynthiana' and 'Lake Emerald' had late ripening season. 'Villard Blanc' produced the largest yield of 16.5 kg/vine and had the greatest mean cluster weight of 238.13 g. 'Champanel' produced the largest berries of 4.2 g on average. Selection 'A2245' was the most vigorously growing vine in the advanced selections trial, and 'A2574' had the highest yield of 15.06 kg/vine. Table grape selection 'A2807' had the largest mean cluster weight of 485.4 g on average and the greatest mean berry weight of 5.8 g. Research will continue and multiple season data is going to provide more complete evaluation on suitability of growing hybrid bunch grape cultivars in Alabama and the Southeast.

(278) Where's the Grape? High Elevation Grape Trials in Northwest New Mexico

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Fifty wineries and tasting rooms operate throughout New Mexico producing > 900,000 gal (>3,406,000 L) of wine per year valued at $60 million annually. Commercial grape production in the Four Corners Region is supported by two wineries. The challenges of growing grapes at our high elevation site (> 1,700 m) are numerous and define the objectives of the studies: 1) Identify *vinifera* and *vinifera* hybrids capable of supplying market demands to produce quality wines that are: a) capable of surviving extreme winter temperatures, killing spring frosts, with huge diurnal temperature fluctuations and; b) growing on elevated soil pH. Viticulture activities at Farmington, NM, involve examination of: 1) 15 table grape varieties; 2) 20 wine grape varieties; 3) a rootstock trial comprised of two *vinifera* scions (Gewurztraminer and Refosco) grafted onto

nine rootstock combinations (of 110 Richter; 775, 779, 1103, and 1045 Paulsen types; SO4, Kober, Couderc, and Teleki); 4) selections from the Cornell grape breeding program; and 5) six surviving selections of Riesling vines taken from cuttings at 1,700 m elevation. Except for the rootstock trial, all table and wine grape studies are grown on their own roots. Table grapes showing promise for high elevation sites are 'Swenson Red', 'Glenora', 'Vanessa', and 'Reliance'. 'Himrod' and 'Interlaken' also have potential from prior year's evaluations but did not yield well in 2011. 'Marquis' remains questionable. Among the red wine grapes, 'Baco Noir', 'Kozma', and 'Leon Millot' continue to yield. 'Malbec' and 'Sangiovese' failed again in 2011 and were removed from the trial along with 'Agria'. Among the white wine varietals, 'Chardonel', 'Seyval Blanc', 'Siegfried', 'Traminette', 'Valvin Muscat', and 'Vidal Blanc' had greater than 71% of their vines in the trial yield grapes in 2011. 'Viognier', 'Muller-Thurgau', and 'Sauvignon Blanc' did not perform in 2011 and were removed from the study. The rootstock trial has performed poorly even after mounding with soil around graft unions were undertaken. Studies 1–3 were replicated in part from other statewide trials located at lower elevations. Many *vinifera* entries that yielded in those locations did not do well in Farmington because of winter kill and spring frosts. French-American and Cornell grapes and *vinifera* cultivars from northern Europe appear to have greater adaptability to high elevation intermountain sites. Riesling selections also have established. Sugar to acid appears well balanced and shows that the region has potential to produce favorable wines. We will be planting additional entries for evaluations in 2012.

Specified Source(s) of Funding: USDA Hatch

(279) Varietal Response of Grapes to Captan with Emulsifiable Concentrate

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Captan is an effective protectant fungicide commonly used on a broad range of crops. When combined with surfactants and under conditions that enhance absorption Captan can cause severe phytotoxicity on grapes. A spray application error, resulting in an off-label application to a cultivar evaluation trial (part of the NE1020 Multi-state project), provided an opportunity to evaluate differences in sensitivity among cultivars to injury from Captan mixed with an emulsifiable concentrate (Danitol). Three- and four-year-old vines were sprayed with a tank mix of Captan (1 lb/A) and Danitol (16 fl. oz/A) on 4 Aug. Environmental conditions were favorable for uptake (warm, high humidity) before and at the time of this application. Injury to leaves, stems, and fruit was evaluated by three raters 2 weeks and 3 weeks after application. Damage ratings for all cultivars increased similarly across rating dates for all cultivars. Cultivars had significantly different injury ratings on leaves ($P = 0.0124$), stems ($P < 0.0001$), and fruit ($P = 0.0002$). The most severely affected cultivars were hybrids (NY 81, and 'Chambourcin') while the least affected was a *V. vinifera* ('Carmenere'), but overall severity ratings overlapped substantially between hybrids and *V. vinifera* cultivars. All cultivars were severely affected and ultimately many vines died. Leaf chlorosis was apparent within one week of application. Leaf necrosis, longitudinal stem splitting and necrosis, adventitious root formation, fruit shriveling, and death all occurred later. The effect was lethal and systemic, affecting the trunk below the graft union and the root system. Captan should not be applied with or near in time to oils, emulsifiable concentrates, oil-based adjuvants, or any chemical that enhances uptake.

(280) Effect of Oxygen on Growth and Biofilm Formation of *Xylella fastidiosa* in Defined Media

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Xylella fastidiosa is a xylem-limited bacterial plant pathogen, and is the causal agent of Pierce's disease of grapevine, phony peach disease, plums leaf scald and scorch diseases of almond and many other fruit crop, ornamental and forest tree species. The disease symptoms are putatively due to blocking of the transpiration stream by the formation of biofilms (bacteria and exopolysaccharides) and the formation of plant-generated tylosis. The dissolved oxygen concentration in the xylem environment during the growing season can reach hypoxic levels (20 to 60 $\mu mol \cdot L^{-1}$). Wells et al., reported that *X. fastidiosa* was an obligate aerobe, and did not grow in an anoxic environment. *Xanthomonas campestris*, the closest genetic relative to *X. fastidiosa*, has been reported to be an obligate aerobe. The growth and biofilm formation of three strains of *X. fastidiosa*, *X. campestris* pv. *campestris* and *Erwinia* sp. (facultative anaerobe) was compared in vitro in the presence of 0%, 0.21%, 2.1%, and 21% of O_2. The pattern of growth for *X. fastidiosa* closely resembled that of the facultative anaerobe (*Erwinia* sp.), and not the obligate anaerobe (*X. campestris*). *X. fastidiosa* was capable of growing in an anoxic environment in nutrient broth, and in two chemically-defined media, CHARDS and XDM2-PR. Planktonic growth and biofilm formation increased more in the anoxic treatment in the XDM2-PR medium. *X. fastidiosa* also produced a different organic acid profile under low oxygen conditions indicative of anaerobic fermentation.

Specified Source(s) of Funding: California Department of Food and Agriculture

An asterisk (*) following a name indicates the presenting author.

Tuesday, July 31, 2012 Grand Ballroom

Waste Utilization in Horticulture

(114) The Effects of Composted Insect Rearing Waste on Radish, Squash, and Green Bean

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A study was initiated to determine the potential for composted solid and semi-solid insect rearing waste as a growth substrate for plants. Semi-solid larval diet was washed through the vermiculite pupation substrate and resulting material composted for 6 weeks. Radish (*Raphanus sativus* L.) was grown in either a commercial potting mixture or in blends of colony waste (CW) and equal parts compost plus peat (CP). Squash was grown in different CW:sand (S) mixtures. Mixes of 80:20 and 100:0 CW:CP had radish germination rates equal to the commercial mix. Radish shoot dry weight from 80%, 60%, and 40% CW, respectively, were higher than the commercial mix. Squash (*Cucurbita pepo* L.) grown in 20% CW had the highest shoot and root dry weights. No substance in the CW appeared to be detrimental to plant growth. As a potting substrate there were no differences in plant performance among the CW, the commercial mix or the CP.

(115) An Economic Analysis of a University Educational Vermicomposting System—Bobcat Blend

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Vermicomposting is a process in which worms break down organic material and transform it into vermicompost, a valuable horticultural product. Additionally, research has found that vermicomposting can divert a significant amount of organic waste from the waste stream. The purpose of this study was to implement a pilot project vermicomposting system at Texas State University using red wiggler worms (*Eisenia fetida*) and cafeteria food waste as a primary feedstock to determine the potential economic value of the system. Approximently 50 lb of food waste was collected weekly from one cafeteria on campus and combined with shredded university paper waste. Vermicomposting bins and systems were reviewed and a layered bin system was constructed using recycled 5-gal. food service buckets. The system was constructed in an 8 ft. × 10 ft. shed to reduce input costs in maintaining temperatures necessary for the worms to thrive. Worms were checked 2–3 times weekly and rotated through the system in approximately 3–4 months. Vermicompost was harvested at the end of each semester and then weighed and packaged for sale using a food scale. Worm castings were also integrated into the university gardens and greenhouse. Economic analysis results demonstrated the value of the operation to the university in terms of the product generated for use for sale as a fertilizer and the diverted cost of waste disposal versus the cost of operation. Results of the economic analysis will be presented and will be valuable in adding to the literature the potential value of vermicompost as a substitute for synthetic fertilizers or as an ingredient in compost-based potting mixes.

Specified Source(s) of Funding: Texas State University Environmental Service Committee

(116) 454 Pyrosequencing Analysis of Bacterial Communities in Dairy Manure after 10 Days, 3 Months, 6 Months, and 9 Months of Composting

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Composted dairy manure has good potential for use as a potting mix amendment. However, some prospective consumers have concerns that harmful fecal microorganisms might survive the composting process. The changing bacterial communities in dairy manure over 9 months of composting were analyzed using 454 pyrosequencing. DNA was extracted from 10-day, 3-, 6-, and 9-month-old compost and the V1 through V3 region amplified by PCR using mixture of the 27F primer composed of equal concentrations of seven degenerative primers and unique tagged reverse primers targeting the 534 region. The DNA analysis technique resulted in 83,555 quality sequence reads that could be classified. Representatives of 18 different bacterial phyla were identified. The dominant phyla were the Firmicutes, Proteobacteria, Actinobacteria, Bacteroidetes, Deinococcus-Thermus, and Chloroflexi. The relative abundances of the different phyla changed over time, with microbial composition changing the most between the 10-day and 3-month-old compost. In the 10-day-old compost, the Firmicutes were the dominant phyla, comprising 68% of the bacterial community. The relative abundance of this group decreased significantly during the other months, but it remained the dominant phyla averaging around 30% of the population. The second or third most prevalent groups were either the Actinobacteria or the Proteobacteria depending on the compost's age. Analysis of the sequencing results at the genus level revealed that bacterial diversity was high, comprising of 472 different genera, although the relative abundance of the majority of genera was low (comprising less than 1%). Sixty-two

genera were present at more than 0.5% of the population, and were considered the dominant genera. Sequences with strong homology to *E. coli* or other enteric bacteria were absent, whereas halotolerant or halophilic bacteria were prevalent. These findings indicated that composting reduced the levels of fecal coliforms to below the 454 pyrosequencing detection limit (~10^4 cfu/mL), and that temperature and salt concentration were the primary factors impacting the microbial community in the aging compost.

Specified Source(s) of Funding: Hatch funds and United Dairymen of Idaho

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Undergraduate Poster Competition

(187) Evaluation of Sapodilla Cultivars

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Sapodilla [*Manilkara zapota* (L.) P. Royen] has been long cultivated for its high quality fruit and latex which is used to make chicle (chewing gum). Tasting similarly to a pear doused in brown sugar, it is a highly esteemed fruit in tropical areas. With origins in Central America and Mexico's Yucatan Peninsula, the sapodilla is also cultivated in tropical and subtropical parts of the world; particularly in southern and southeast Asia, Venezuela and Florida. Fairchild Tropical Botanic Gardens, University of Florida–Tropical Research and Education Center, and USDA–ARS–SHRS, all located in southern Florida, have 42 clones of cultivars collectively in their ex situ collections with origins in Central and South America, Mexico, Florida, Hawaii, and Thailand. These cultivars are not well characterized and there is much confusion of their proper identities. The purpose of this study is to clarify confusion of the identity of the sapodilla cultivars in the aforementioned collections, evaluate these clones in the collections under local conditions, and determine their potential for both commercial and home growers. Data will include morphological, horticultural, phenological and fruit characteristics. Preliminary data has shown distinct differences in morphology and fruit characteristics as well as provided a framework for determining what characteristics are valuable for differentiating cultivars in the field.

Specified Source(s) of Funding: USDA–NIFA–MSP Grant Agreement Number 2011-38413-30118

(189) Computer Aided Evaluation of *Rhododendron calendulaceum* Early Seedling Growth Parameters in Relation to Soilless Media

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Rhododendron calendulaceum (Flame Azaleas) have many desirable horticultural traits but are often challenging to grow. In this study, we investigated Flame Azalea seedling growth in response to growing media. Seeds collected from Hooper Bald, Graham County, NC, were germinated in 96 cell flats and grown for a period of 12 weeks in varying media. Varying ratios of peat, perlite, coir, and sand were used to formulate the media used in the experiment. A total of four separate media mixtures with three replications of each, were used to evaluate early seedling growth to better inform existing propagation protocols. Seedling emergence timing and percentage was recorded. Shoot length, root length, shoot/root ratio, and true leaf area were also evaluated using computer-aided analysis of 30x digital images of randomly sampled seedlings. Significant differences in seedling growth parameters were detected in response to the different media treatments. Emergence of seedlings ranged from 57% to 69% across the treatments, in line with prior work showing a germination rate of 61% for this seed lot. Treatment 1, consisting of a media mixture of 4:2:1 peat, sand, and perlite, had the lowest emergence percentage but exhibited significantly larger root growth, total plant growth, and leaf area when compared to the other three treatments. Our results provide useful information for nurserymen and propagators interested in the Flame Azalea.

(190) Comparison of Parents with F_1 and F_2 Generations of Sorrel (*Hibiscus sabdariffa*)

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Hibiscus sabdariffa or sorrel is grown throughout the world for its fresh juice made from the calyxes of the plant. Plant height can reach up to 7 ft and branches between varieties vary. The objective of this study was to compare the height, branches and floral induction of two parent Caribbean sorrel varieties with F_1 and F_2 generations. The parental varieties were St Kitts dark

(SKD) and Trinidad black (TTB). Data was collected on height, branching and floral induction at 2-week intervals. Parent SKD had the greatest amount of fruit-bearing branches than TTB, F_1 or F_2 populations. The TTB × SKD F_1 resulted in taller plants than either parent or the SKD × TTB F_1 plants. However, all F_2 generation plants were shorter than either parent. All F_1 plants initiated flowers when SKD did, which was 2 weeks before TTB; however, all the F_2 initiated flowers with TTB. Sorrel is self-pollinating, causing inbred varieties, but hybrid vigor can be obtained by crossing varieties that can improve production.

Specified Source(s) of Funding: VI Dept. of Agriculture Specialty Crops Block Grant and USDA–NIFA–Resident Instruction in Insular Areas (Grant #2008-34816-20016)

(191) Nitrogen Level Influences Shoot Tissue Pigmentation in Two Cultitypes of Purslane (*Portulace oleracea*)

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Purslane (*Portulace oleracea)* is a succulent weedy annual in much of the United States. In other parts of the world, purslane is grown as a specialty vegetable crop and valued for its nutritional quality and high levels of omega-3 fatty acids. Nitrogen (N) will influence plant growth and alter pigment composition and accumulation. As a leafy vegetable crop, purslane contributes carotenoid phytochemicals in the typical "Mediterranean Diet." However, little is known about the impact N fertility levels will have on pigment concentrations in purslane shoot tissues. The objective of this study was to evaluate the influence of N fertility levels on the concentration of nutritionally important carotenoid and chlorophyll pigments in purslane. Two cultitypes ("green leaf" and "yellow leaf") of purslane were grown in nutrient solution culture under 13, 26, 52, or 105 $mg \cdot L^{-1}$ of N. Plants were harvested at 45 days after seeding, and tissue was freeze-dried for pigment analysis. Carotenoid and chlorophyll pigments were extracted from shoot tissues and measured using HPLC methods. Nitrogen level influenced shoot tissue beta-carotene ($P = 0.02$), lutein ($P = 0.003$), neoxanthin ($P = 0.002$), total carotenoids ($P = 0.006$), chlorophyll *a* ($P = 0.001$), chlorophyll *b* ($P = 0.001$), and total chlorophyll ($P = 0.001$) in purslane shoot tissues. Purslane cultitypes influenced concentrations of lutein ($P = 0.001$), neoxanthin ($P = 0.001$), violaxanthin ($P = 0.002$), chlorophyll *b* ($P = 0.001$), and total xanthophyll cycle pigments ($P = 0.003$). Increases in N fertility levels acted to increase concentrations of nutritionally important shoot tissue pigments in purslane. Therefore, N fertility management should be considered when using purslane as a specialty vegetable crop.

(192) Going Full Circle; Developing a Campus Community Garden Linked to a Campus Food Pantry

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Campus community gardens are established and operated to bring a diverse group of individuals from within the community together to work towards a common goal. Using the best management practices as determined by a qualitative assessment of North American campus community gardens in a previous project, University of Arkansas (UA) students created a community garden as a co-curricular student activity. The garden was initiated, planned, and developed as a component of an individual capstone project requirement for the Minor in Sustainability degree program. The UA community garden is accessible for students, staff, and faculty to learn and grow a variety of plants and is also intended to provide fresh produce and flowers to the UA Campus Full Circle Food Pantry. The availability of fresh produce and flowers gives a unique aspect to the food pantry and their customers of the university community who might not otherwise have access to these items. Soil amendments for the garden are partially derived from composted food waste from the dormitory complex where the garden is located closing a loop from food consumption to production. The campus community garden provides an educational service learning opportunity allowing classes and students from many fields of study to use the garden for direct or indirect education, and become involved within the campus community. It will provide a venue for students obtaining the new Sustainability Minor to actively participate in continued operation of the project. The UA campus community garden has potential to increase engagement in the educational and social community of campus and to provide healthy fresh produce to those in need at the food pantry and volunteers in the garden.

(194) Physical Characteristics of Pyrenes as a Means to Identify Blackberry and Raspberry Cultivars

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The objective of this study was to document and measure the pyrenes of North Carolina blackberry and raspberry selections relative to standard varieties previously documented. Additionally, we explored how simple measurements of pyrenes could be utilized to identify the possible source of blackberry or

raspberry cultivar. The fruit of 12 blackberry cultivars (APF-45, Arapaho, Chester, Natchez, Navaho, NC 430, NC 537, ORUS 1350-2, ORUS 1939-4, Ouachita, Triple Crown, and Tupy) and 10 raspberry cultivars (Autumn Britten, Caroline, Himbo Top, Mandarin, Moutere, Nantahala, Nantahala × Abliss, Nantahala × Cherokee, Octavia, and Redeva 96-3) were harvested from research plots in Salisbury, Laurel Springs, and Mills River, NC in 2010 and 2011 and their pyrenes extracted. These cultivars include primocane fruiting or thornless blackberries and floricane or primocane fruiting raspberries. Measurements of length, width, and depth were taken with an electronic digital caliper and weights per pyrene were measured in milligrams with an analytical balance. Qualitative observations of the shape of the raphe (lower edge) of the pyrene and pyrene shape were also recorded to assign cultivars to groups based on specifications such as concave, straight, or convex raphae and oval, half-circle, and/or triangular pyrenes. Using SAS software, the physical characteristics of blackberry and raspberry pyrenes were analyzed to identify if there was adequate variance among cultivars to warrant the use of these characteristics as a means of identification of an unknown cultivar. This study showed that weight, length, width, depth, shape (length/width), and flatness (length/depth) were significant indicators of cultivar for both blackberries and raspberries. Variations of weight per unit measurement were also significantly related to cultivar; however, this is likely due to the strong relationship between these ratios and weight itself. The pyrene of an unknown cultivar may be characterized by raphe shape and pyrene shape and then further differentiated from other cultivars by its weight, length, width, depth, shape (length/width), and flatness (length/depth).

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Citrus Crops

(353) Response of Government and the Citrus Industry to the Discovery of Asian Citrus Psyllid in Arizona

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In Oct. 2009, about 3 months after the first find of Asian Citrus Psyllid (ACP) in San Luis Rio Colorado Sonora, a colony of ACP was found just across the border in San Luis, AZ. Since then, 12 additional sites have been found in Arizona, all except two in Yuma County. Less than 50 individual ACP have been found since 2009 and all have been eradicated. No ACP found in Arizona has yet tested positive for HLB. As of now, much of southwestern and southern Arizona is under federal quarantine for ACP and trees and fruit that move out of the quarantine area require special treatment to eradicate ACP. The response of the Arizona Department of Agriculture to the discovery of ACP has been to increase trapping and eradication activities using funds received from the Federal Government. The University of Arizona and the citrus industry have responded by establishing screenhouses to produce trees. The industry has also developed a plan to establish an area-wide spray program. Extension and outreach efforts have been directed toward the industry and the homeowner. The location of ACP finds in Arizona suggests that both Mexican ACP populations near the border and the transport of citrus fruit from the interior of Mexico may lead to the establishment of the insect in Arizona. The small numbers of ACP found in Arizona, in contrast with large populations found in California, suggest that ACP populations may be adversely affected by the arid climate of the region, and that timely detection and eradication efforts are the keys to controlling spread of the ACP in arid regions.

(354) Quantitative Real Time PCR Analysis to Estimate Gene Expression Levels and Transgene Copy Number of Transgenic Citrus Plants Containing Putative Disease Resistance or Insecticidal Genes

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Numerous 2-to 4-year-old transgenic scion grapefruit and sweet orange and rootstock carrizo transgenic lines obtained via *Agrobacterium*-mediated transformation were evaluated by a Taqman based real-time polymerase chain reaction (qPCR) assay. We evaluated the expression levels of the inserted transgene (putative disease resistance or insecticidal gene) by quantifying messenger RNA (mRNA) levels and also estimated the copy number in each on these lines. The transcript levels from both the gene of interest and *egfp* reporter gene was determined. Expression levels varied in the individual lines and could be grouped into high, medium, and low levels of mRNA expression. There was no variation in mRNA expression levels from numerous clones of several selected transgenic lines. The copy number was calculated by comparing threshold cycle (CT) values of the gene of interest and *egfp* genes with those of the endogenous reference genes (18S rRNA or cytochrome oxidase (COX)). In most cases the copy number of the gene of interest was identical to that of *egfp*. A majority of the lines contained 1–4 copies of the transgene. No direct relationship between copy number and expression level of transgenes was obvious in a majority of the transgenic lines evaluated, suggesting that differential expression could be due to factors like rearrangements of the T-DNA in the genome, DNA methylation or position effects. Results obtained from qPCR were in agreement with that observed via Southern blotting indicating its potential for the rapid estimation of copy numbers from a large number of putative transgenic lines. Our results

indicated that the transgenes were stable even after 4 years in the greenhouse.

(356) Influence of Production Practices and Storage on Grapefruit Carotenoids, Limonoids, and Fruit Quality Attributes

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The impacts of the production system (organic or conventional) and post-harvest handling practices (storage duration and temperature) on bioactive compounds in grapefruit (*Citrus paradisi* Macf. 'Rio Red') were investigated. Grapefruits were harvested in Nov. 2008, and stored at 23 °C (room temperature) and 9 °C for 4 weeks. Stored fruits were analyzed for carotenoids, limonoids, and fruit quality attributes such as TSS and total acidity (TA) at 0, 7, 14, 21, and 28 days after storage. Grapefruits grown under a conventional production system had more than double the amount (26.26 μg/g) of lycopene compared to organic grapefruits (12.83 μg/g) at 0 days after harvest. The antioxidant levels of organic and conventional grapefruit were also not significantly different except second week after harvest. The organic grapefruits had 77 % higher ($P \leq 0.05$) nomilin than conventional grapefruits, but limonin was not significantly different in both production systems at the time of harvest. The sensory evaluation results were consistent with TSS and TA levels in the organic and conventional grapefruits. The overall appearance of organic and conventional grapefruits was not significantly different ($P \leq 0.05$), except for fruit interior color, which is brighter in conventional grapefruit. Overall, the grapefruits stored at room temperature and 9 °C had severely degraded both carotenoids and limonoids. Additionally, the production system had a differential effect on carotenoids and limonoids.

Specified Source(s) of Funding: USDA–NIFA # 2010-34402-20875 "Designing Foods for Health" through the Vegetable & Fruit Improvement Center.

(357) Quantification of *Candidatus* Liberibacter Asiaticus in Fruit Tissues of *Citrus aurantifolia* Christ. (Swingle)

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In order to begin the study of in planta distribution of *Candidatus* Liberibacter asiaticus (Las) in Mexican lime [*Citrus aurantifolia* Christ. (Swingle)], quantitative real-time PCR analyses were carried out in total DNA purified from different fruit tissues [seed, peduncle, flavedo (exocarp), albedo (mesocarp) and endocarp (juice vesicles plus lamella)] of six PCR (A2/J5)-positive huanglongbing-infected trees from Colima, México. The qPCR protocol was developed in a LightCycler® 1.5 thermal cycler using a Taqman probe labeled with 6-FAM and BHQ-1 as reporter and quencher dyes, respectively, Las-specific primers previously published, and reaction conditions of 10 μL (final volume), 100 ng of total DNA, 50 cycles and ramp rates of 3 °C/s. For quantification of Las, a standard curve (error: 0.0209, efficiency: 1.868) constructed by serial dilutions (3.08×10^3 to 3.08×10^7 copies/μL, four replicates per dilution) of Las-16S rRNA gene cloned in pCR®2.1-TOPO® (analyzed by sequencing), was used to calculate the samples' Ct values and bacterial titers. Results indicate that seeds, followed by fruit peduncle and flavedo contain the higher bacterial titers, which ranged from 9.16×10^4 (Ct 37.75) to 3.60×10^6 (Ct 33.50) bacterial cells/g of fruit tissue. This experiment supports previous ideas that Las distributes unevenly throughout the plant and specifically in fruit tissues, and reinforces current research in Mexico to understand huanglongbing pathology in this economically important crop. Fund FORDECyT-CONACyT agreement No. 139259.

(358) Interaction of Soil-applied Fertilizer on Huanglongbing Development in New Growth Flushes of Sweet Orange

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The following study was conducted to determine if soil applied fertilizer can affect movement of *Candidatus* Liberibacter asiaticus, the putative causal agent of citrus greening, into new growth flushes of citrus in the absence of its primary vector, Asian psyllid. A 2 cultivar × 2 Liberibacter × 2 fertilizer experiment was conducted in an enclosed greenhouse. Liberibacter was

introduced by grafting two infected buds on each tree in Aug. 2010. In Oct. 2010, the fertilizer was terminated on one-half of the trees. Two growth flushes occurred in March/April and May/June and leaves from each flush were removed for sampling. Plants with Ct values between 32 and 36 were removed from the study since in this range it is unclear if they are infected. Of the remaining plants, infected trees had infection rates ranging from 64% to 100%. Uninfected trees had a 0% infection rate. The infection rate tended to be higher for 'Valencia' than 'Hamlin' and was not affected by fertilizer treatment. Incidence of the disease symptoms leaf mottling, Zn island greening, veinal chlorosis, and vein corking were much higher on trees that did not receive fertilizer. There was a significant interaction between fertilizer treatment and Ct value for P and Mn with unfertilized trees having low levels of both nutrients across Ct values and fertilized trees having declining Ct values. Ca and Mg did not exhibit the same pattern as P and Mn perhaps because of the high concentrations of these nutrients in the well water used to water the trees. Zn declined with Ct value with fertilization having little effect. The fertilization treatments in this study were extreme and yet had little effect on the incidence of Liberibacter in the two growth flushes that occurred after infection.

(359) Regulating Citrus Tree Growth with Salicylic Acid

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A severely debilitating and currently incurable disease called Huanglongbing (HLB) (a.k.a. "Citrus Greening") is a serious threat to the Florida citrus industry. All commercial citrus cultivars are to some extent susceptible to the causal agent, a type of phloem-limited bacterium designated *Candidatus* Liberibacter asiaticus (*C*-Las). The classic symptom of the disease is blotchy mottling or variegated chlorosis of leaves and tree decline. Recent microarray analysis studies have revealed genes involved in sieve pore plugging are up-regulated in HLB-symptomatic trees. HLB-related phloem plugging interrupts the communication between sources and sink organs, and nutrient transport. Since there is not cure, current management strategies have focused on preventing infection by eliminating the inoculum (infected trees), vector control, production of pathogen-free nursery plants, and nutritional programs to treat symptoms. The goal of this project was to understand the effects of salicylic acid (SA), a common nutritional program ingredient, on the growth of citrus plants. In other plant species, SA is known to induce systemic acquired resistance (SAR); however, based on field observations, SA appears to be acting as a plant growth regulator (PGR) in HLB-affected trees. In light of this knowledge, the central hypothesis of this project was that the application of SA induces budbreak and the development of new shoots in citrus. New growth apparently helps to alleviate HLB symptoms by generating new, functional phloem that helps restore plant function until it is populated by *C*-Las. Young healthy citrus trees of 'Hamlin' and 'Midsweet' sweet orange were maintained in a growth chamber for 6 weeks. Different trials consisted of different sources of SA applied as foliar sprays. Growth measurements were taken weekly, photosynthesis and respiration rates, chlorophyll content, electrolyte leakage percentage and leaf sap pH were assessed at different points in time, including at the end of the experiment. Plants were destructively harvested and leaf, shoot and root dry mass determined. Total non-structural carbohydrate content and nutrient content were analyzed. These experiments, using healthy citrus trees, did not show a significant effect of SA on budbreak or shoot growth. This indicates that SA may only be effective at inducing budbreak and shoot growth in stressed trees (e.g., HLB-affected). More detailed experiments are planned using HLB-affected trees.

(360) Phloem Anatomy of Citrus Trees: Healthy versus Greening

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Phloem cells from HLB-affected trees become obstructed with callose and P-protein plugs. The presence of these plugs is believed to hinder the transport of photoassimilates (nitrogenous and reduced carbon compounds) to the root system. However, even with a seemingly collapsed phloem tissue, citrus trees remain viable and produce fruit for some time, suggesting either incomplete plugging of phloem elements or the existence of alternative routes for photoassimilate transport. In this study, we examined the basic structure of phloem tissue from HLB-unaffected and HLB-affected trees under light and scanning electron microscopy. To avoid any possible interference with callose induced by injury during sampling, we employed freeze substitution technique. Sieve elements from HLB-unaffected trees show sizable lateral pores to phloem and ray parenchyma. The cells have very angular sieve plates and appear relatively clean from cellular components. HLB-affected phloem cells contain massive amounts of amorphous material clearly traversing sieve plates and lateral pores. Eventually, these cells totally collapse into almost a solid cell wall barrier. Occasionally, wound phloem appeared along the petiole cortex in HLB-affected trees. Most notably is the large number of wall perforation all along the cortex parenchyma with abundant pit fields. These anatomical features will be discussed in terms of alternate routes for photoassimilates.

(361) Callose Predominates over Phloem Protein2 in Citrus Phloem Plugging from Huanglongbing

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Phloem plugging of citrus trees affected with Huanglongbing

(HLB) was shown previously to result from two types of materials in sieve elements, callose and a lectin of phloem protein2 (PP2) (Achor et al., 2010). An associated study (Etxeberria et al., 2009) found that diversion of sugars to starch accumulation left the root system of affected trees lacking carbohydrate reserves as starch. It was proposed that this plugging and sugar diversion might be responsible for the decline of HLB infected trees. This study evaluated plugging in 4 cultivars ('Flame', 'Valencia', 'Hamlin', and 'Murcott') in field sites and 2 cultivars ('Duncan' and 'Valencia') in a greenhouse to determine if one plugging type predominated and was a better candidate for deletion transformation or some other type of blocking of its production. Field and greenhouse plants affected by HLB were sampled and leaf tissue prepared for transmission electron microscopy. A total of 22 field and 7 greenhouse trees were sampled to observe leaf phloem plugging types. Callose plugging predominated in all samples with a range of callose to PP2 of 1.8 to 13. The average ratio was 2.7 for all field samples and 2.4 for greenhouse samples. This data suggests that callose plugging is more likely to cause phloem dysfunction, but PP2 plugging accounts for over 25 % of the phloem plugs. A rapid procedure to evaluate callose plugging in scaffold limbs is also described.

Specified Source(s) of Funding: Citrus Research and Development Foundation

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Consumer Horticulture and Master Gardeners

(049) Characteristics and Volunteering Behaviors of Purdue Master Gardener Interns and Master Gardeners

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Relationships of variables of volunteering behaviors and characteristics of Purdue Master Gardener Interns and Master Gardeners were measured through a retrospective questionnaire in Indiana. Variables measured were demographics of the respondents, attributes of the program, respondents' attitudes about volunteering, respondents' self-efficacy to volunteer, operationalization of participation, and prior volunteering experience. A goal of this study was to measure relationships among variables and between variables and total volunteering hours across all volunteering sectors. This one-time, online Qualtrics questionnaire was administered to Interns and Master Gardeners through the Purdue Master Gardener county coordinators. Of the 754 responses received, 194 are Interns and 560 are Master Gardeners of which most are in the Advanced Master Gardener level of the program. The median age of respondents was 55 to 64 years of age with most respondents having been in the program from 1 to 5 years. Respondents reported volunteering a median of 6–14 hours per month. Additionally, the study sought to identify if some variables measured can predict total volunteer commitment. Identifying predictive variables of Interns and Master Gardeners and describing the participants and attributes of the program may lead to program changes, which in turn, may lead to an increase in participation and possibly an increase in volunteering. Increase in volunteerism is important during economically challenging times to meet community needs.

(050) Changing the Vegetable Garden Paradigm

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Many homeowners are concerned about the economy and have an increased interest in starting home-based vegetable gardens. In a series of workshops held in 2009, it was learned that half of the attendees had never gardened before. Those living in urban areas suffer from the misconception that they lack the required space to have a successful vegetable garden. Another obstacle facing new gardening homeowners is the perception that vegetable gardening is very labor intensive, especially for those with full time employment. Changing the vegetable garden paradigm is an opportunity to introduce non-conventional growing strategies and ideas to these home gardeners. Coastal Research and Extension Center has been actively involved in promoting small scale home vegetable gardens with the emphasis on reducing the perception of labor required. The goal is to help foster a pattern for successful growing and harvesting for the home gardener.

(052) Changing Attitudes in Home Landscaping and Gardening as a Result of Master Gardener Sponsored Garden Tours

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Since 2001, the University of Arizona Cooperative Extension Maricopa County Master Gardener program has sponsored a day-long public driving tour consisting of six gardens owned and maintained by Master Gardener volunteers and a school or

community garden that receives Master Gardener volunteer support. The garden tour helps educate the public in support of the Maricopa County Master Gardener mission statement "to teach people to select, place and care for plants in an environmentally-friendly manner with research specific to the low desert." This event, which over 1,000 people attended, is the major fundraiser for the Master Gardener program and over 3,500 volunteer hours go into making the event a success. In 2011, the 10th Annual Real Gardens for Real People Garden tour featured a 6.7-acre community garden with 287 individual plots and six residential gardens. Eighteen Master Gardener garden experts were placed at different gardens based on specific features of each garden. These experts provided additional information on such topics as growing vegetables and flowers, container gardening, correct landscaping watering techniques, Xeriscape landscaping, growing roses in the desert, cacti and succulents, citriculture, composting, integrated pest management, and attracting wildlife. The day of the tour, a paper survey was distributed to every attendee. The survey asked attendees the likelihood that their behavior would change in the following area: adjust irrigation system frequency or duration; adjust the location of drip emitters; select and plant desert adapted plants; and plant a vegetable garden. Surveys were returned by 178 attendees the day of the tour. Per the survey, 64.3% of respondents stated they would probably or definately adjust the frequency or duration of their irrigation timer, 51.4% would adjust the location of irrigation drip emmiters, 77.8% would select and plant desert-adapted plants, and 53.7% would plant a vegetable garden. Forty-three electronic surveys were collected nine months post-event. As a result of attending the garden tour, the respondees advised that 59.5% adjusted the irrigation schedule in the landscape, 35.0% planted a vegetable garden, 73.8% chose desert adapted plants for their landscape, and 76.7% considered the mature size when choosing and placing plants in their landscape.

(053) Fruit Quality Preference and Availability of Quality Fruit: A Case Study with 'Honeycrisp' Apple

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In a previous study with untrained consumer panels we pointed out that 'Honeycrisp' is a highly favored apple cultivar because of its quality features. Fruit quality of the same cultivar, however, can vary widely by growing site, production technology, etc. Therefore, fruit quality does not always meet consumer expectations. The aim of this study was to investigate fluctuations in fruit quality on shelves of supermarkets/grocery stores. Fruit quality of 'Honeycrisp' apple was determined after random purchase occasions (once a month) from four supermarkets/grocery stores (Buehler's, Giant Eagle, Heinen's, Walmart) in the Cleveland, OH area. 'Honeycrisp' apples were available from two seasons; between Dec. 2010 and Apr. 2011, and between Sept. 2011 and Apr. 2012. The following fruit quality parameters were measured: fruit size, color, soluble solids concentration, and titratable acidity. An untrained consumer panel of 110 participants evaluated 'Honeycrisp' fruit samples after a random purchase from the four different supermarkets/grocery stores for appearance, texture, and taste. Fruit quality and consumer preference of 'Honeycrisp' apples varied widely among grocery stores at a given purchasing occasion, and also over time within the same supermarket/grocery store.

Tuesday, July 31, 2012 Grand Ballroom

Environmental Stress Physiology

(205) Irreversible Commitment to Flowering in Two Mango Cultivars

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In recent years, the state of Nayarit, Mexico, has experienced variations in rainfall distribution and warmer temperatures during the autumn–winter season which have caused erratic flowering of mango. The early-flowering cultivars, such as 'Ataulfo', have been less affected than tardy ones such as 'Tommy Atkins'. To understand this problem and develop management practices to minimize it, it is essential to learn when irreversible commitment to flowering (ICF) occurs in shoots of these two cultivars. This research was conducted during 2006–07, 2008–09 and 2009–10 in three commercial orchards of each cultivar in northern, central, and southern Nayarit. The orchards had no irrigation and the climate is classified as warm-subhumid (mean annual temp. > 22 °C; mean temperature of the coldest month > 18 °C; summer rainfall ~ 1,225 mm). The date in which ICF occurred was determined by quantifying the type of growth (vegetative or floral) produced by the apical buds throughout the various vegetative flushes ('Ataulfo': spring and summer; 'Tommy Atkins': spring and fall) in response to monthly girdling and defoliation treatments. Shoots not receiving treatments were used as control. 'Ataulfo' flowered every year during the 3-year study. Spring shoots emerged from April to May. Shoots treated between June and August did not flower; flowering occurred in shoots treated from October on (53.2%). Summer shoots emerged in July–August and flowering occurred in treated shoots from November on (32.4%). 'Tommy Atkins' did not flower in 2008–09. During

2006–07 and 2009–10 spring shoots emerged in from April to May and flowering occurred in treated shoots from November on (23% to 56%). Fall shoots emerged in October–November and flowering in treated shoots occurred from February on (20% to 61%). Control trees of 'Ataulfo' showed flowering in 41 to 43% of the shoots whereas in 'Tommy Atkins' it was 47% to 52%. Irreversibly committed to flowering apical buds arising from vegetative flushes were always characterized by having a conical shape with a slight separation of the vestigial leaf primordia (bud scales). Microscopic examination of these buds showed elongation of the primary axis and initial development of secondary axes as well as presence of tertiary axes meristems.

Specified Source(s) of Funding: INIFAP, CONACYT–FORDECYT, and Gobierno de Nayarit–SEDER

(206) Modeling Carbon Gain and Plant Growth of Lettuce (*Lactuca sativa*) under Ethylene and Hypobaric Environments for NASA Advanced Life Support (ALS) Systems

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Hypobaria (low total atmospheric pressure) is essential in sustainable, energy-efficient plant production systems for long-term space exploration and human habitation on the Moon and Mars. There are also important engineering, safety and materials handling advantages of growing plants under hypobaric conditions, including reduced atmospheric leakage from extraterrestrial base environments. It is important to predict or model plant growth and edible biomass production for human consumption during space exploration. Net daily carbon gain (CDG) was used to model plant growth rate and mass balance in our low pressure plant growth system (LPPG) designed for a NASA life support system. There was a linear correlation between accumulated CDG and measured total plant, leaf and root dry mass. Edible fresh mass can also be predicted from the model. The model could fit hypobaric and hypoxic environments with ethylene scrubbed or allowed to accumulate. We evaluated the model via analysis between direct measurements and modeled data. There was a highly significant linear relationship between modeled and measured data indicating that errors can be predicted from the LPPG system.

Specified Source(s) of Funding: NASA–NAJ04HF31G

(207) Using an Apple Microarray to Characterize the CBF-Regulon in Transgenic 'M.26' Apple Trees Overexpressing a Peach CBF Gene

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CBF proteins belong to the CBF/DRE binding sub-family of the Apetala2-ethylene responsive factor (AP2/ERF) super family of transcription factors that bind to a *cis*-element containing a conserved CCGA core sequence. CBF genes have been shown to regulate a large number of cold-regulated genes that are associated with cold acclimation in both herbaceous and woody plants. In *Arabidopsis*, cold temperatures initiate a global change in gene expression (at least 306 genes), 12% of which are members of the CBF regulon. In the present study, we utilized a 40,000 feature oligonucleotide-based microarray (Soria-Guerra et al., 2011. Plant Mol Biol Rep.) to analyze the CBF-regulon in transgenic apple overexpressing a peach CBF gene. Levels of gene expression were compared in leaves of three sets of samples: a) Non-acclimated trees overexpressing a peach CBF gene (T166) vs. Non-Acclimated Untransformed 'M.26' (wt) trees; b) Non-Acclimated wt vs. Cold Acclimated wt trees; and c) Cold-Acclimated wt vs. T166 trees. The acclimation regime consisted of placing trees at 4 °C and a short photoperiod (8/16) for 2 weeks. Three biological replicates were included in the analysis where one of the replicates consisted of a dye-swap. Wolfinger and JMP Genomics were utilized to determine the number of significantly up- and down-regulated genes at the 0.01 and 0.05 probability level. Wolfinger analysis indicated that there were 514 genes that were significantly up or down regulated in the T166 line compared to the non-acclimated 'M.26' trees while over 1,400 genes were significantly up or down regulated in the cold acclimated vs. the non-acclimated 'M.26 trees. There were 113 genes common to both cold acclimated and non-acclimated T166 trees. This suggests that CBF regulon consists of about 8.5% of all cold-regulated genes. Interestingly, there was a group of genes regulated by CBF that were not strictly regulated by low temperature. Additional statistical analyses are in progress as is the grouping of differentially regulated genes into specific functional categories. This work represents the first attempt to define the CBF-regulon in fruit trees.

(208) CBF Gene Expression in Peach Leaf and Bark Tissues Is Gated by a Circadian Clock

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CBF transcription factors regulate a host of genes (CBF-regulon) that respond to low temperature and play a role in

freezing tolerance. In peach, (*Prunus persica*) there are at least 4 CBF genes situated in tandem on scaffold 5 of the peach genome. This is in contrast to apple (*Malus ×domestica*) where there are 5 complete CBF genes that are not in tandem and are distributed on different linkage groups. CBF gene expression, induced by low temperature, has been shown to be gated by a circadian clock in Arabidopsis (Fowler et al., 2005. Plant Physiol 137:961–968). In contrast to herbaceous plants, CBF gene expression patterns in woody plants are more complex. The present study was conducted to determine if CBF gene expression in peach leaf and bark tissues was also influenced by a circadian clock. One-year-old 'Loring' peach trees grafted on 'Bailey' rootstocks were moved to a Conviron PGV36 growth chamber for 2 weeks with 12 h day/12 h night photoperiod. The light level during the day period was approximately 300 mmoles photons·m^{-2}·s^{-1}. A constant temperature of 25 °C was maintained. After 2 weeks of entrainment, a subset of trees was exposed to 4 °C under ≤100 mmoles photons·m^{-2}·s^{-1} continuous light for up to 48 h. Low temperature exposure was initiated at a Zeitgeber Time (ZT) of either ZT 4 or ZT 16 h (ZT 0 = subjective dawn) and leaf and bark tissues were harvested at various time points during the 48 h exposure. RNA was extracted from leaf and tissue samples and expression levels of 3 of the peach CBF genes were determined using RT-qPCR. Results indicated a distinct gating of CBF gene expression by a circadian clock for all 3 CBF genes and in both leaf and bark tissues. The CBF expression in ZT 4 samples showed a clear induction after being placed at 4 °C with expression peaking in leaf samples at 6–12 hours depending on the specific CBF gene, while the CBF expression peaked at 12–24 h in bark tissues. In contrast to ZT 4 samples, the CBF gene expression in ZT 16 samples was highly attenuated. These results are in agreement with similar studies in Arabidopsis. Analysis of expression patterns of two CBF-regulated genes (*PpDhn1 and PpDhn3*) in ZT 4 and ZT 16 samples is currently being conducted to determine the impact of CBF circadian gating on the expression CBF-regulon genes.

(209) High Temperature Induced Morphological and Oxidative Changes in Different Citrus Genotypes

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Atmospheric greenhouse gases are predicted to increase global temperature, which can affect the growth and development of plants. In the present investigation, grapefruit and sweet orange were exposed to high temperature to understand the mechanism and variation in high temperature tolerances among of these two genotypes. Plants were grown in 15 × 8 cm plastic pots containing Fafard Mix 4P. Mineral nutrition was provided periodically using Peters' professional fertilizer. Plants were kept at 700 μmol·m^{-2}·s^{-1} *PAR* with a 12-h light and 12-h dark photoperiod in environmental growth chambers and acclimatized for 90 days before applying treatments. Plants were exposed to 38 °C for 10 days and then recover at 27 °C for 5 days. Among the genotypes, sweet orange appeared to be more susceptible for high temperature stress. The first visible sign of heat injury was observed at 4 days after treatment at the abaxial side of leaves in the form of numerous small circular brown necrotic areas in sweet orange. These necrotic lesions become very large by 8 days after heat treatment and accelerated the rate of leaf abscission. However no such injury was observed in grapefruit. The rate of lipid peroxidation and H_2O_2 production were higher in sweet orange than grapefruit. Higher activities of antioxidant enzymes were observed in grapefruit than sweet orange. These results showed that grapefruit is well equipped to tolerate high temperature stress. It seems Sweet orange will be most affected by rising global temperatures.

(210) Silicon Drenches Improve Drought Stress Tolerance in Poplar

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Aridity due to depletion of water resources and climate change poses a problem for agriculture worldwide. Increasing evidence demonstrates that silicon (Si), the second most abundant element in the soil, can improve plant response to various abiotic stresses. In this work, we examined whether drought tolerance of poplar (*Populus tremuludes* × *P. Alba*) could be improved following Si application. Poplar, which has substantial water needs, is an important tree source for the paper industry and for potential bio-fuel production. Poplar plants were transplanted into 1.75-L containers with a peat-based potting mix and grown in a greenhouse at 25 °C and with 50 μmol·m^{-2}·s^{-1} supplemental light for 16 hours daily. Plants were regularly irrigated with a commercial complete fertilizer. Silicon treated plants received twice weekly drenches (500 mL per plant) with 4 mM potassium silicate; control counterpart received corresponding drenches with potassium chloride to equal the potassium of the Si treatment. After 6 weeks, irrigation was withheld to impose drought stress and plants were transferred to growth chambers (16 hours of light at 100 μmol·m^{-2}·s^{-1} supplemental and 22 °C). Observations were conducted immediately upon transferring of plants to chambers and for three subsequent days (2, 3, and 4 days post water withholding). Leaf angle measurements from 8 leaves per plant were taken with a digital protractor to quantify the degree to which leaves had wilted; and the daily leaf angle change was calculated. A visual wilt index of whole plants on the scale of 1 (no wilted leaves) to 9 (whole plant wilted) was also determined. Leaf angle change was significantly lower in Si-treated poplar plants as compared to their control counterparts at days 2, 3, and 4 into drought stress. At day 2 leaf angle was 23 ± 3° for Si plants and 32 ± 3° for control plants. The greatest difference in leaf angle was found 3 days after drought stress (44 ± 4° for Si treatment versus 61 ± 4° for control). Visual wilt index results

corresponded to leaf angle measurements; at day 2 and 3, wilt index was significantly lower for silicon treated plants. On day 4 post water withholding, wilt index did not significantly differ among treatments, indicating that the Si effect was exhausted at this point. Overall, we have demonstrated the applicability of Si drenches for delaying drought stress response in poplar plants.

Specified Source(s) of Funding: Hatch funds

(211) Impact of Kaolin Particle Film and Water Deficit on Water Use Efficiency, Morphological Leaves Characteristics and Growth in Cape Gooseberry Plants

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Cape gooseberry (*Physalis peruviana* L.) is a native plant of tropical America, principally of Colombia, Peru and Ecuador. It is common to find episodes of water stress in cape gooseberry, since it is mainly grown under rain-fed conditions in Colombia. Kaolin particle film applications has been used to improve water use efficiency (WUE) under water stress conditions. Water use efficiency, anatomical and morphological leaves characteristics, and growth response of cape gooseberry plants to a particle film treatment under varying levels of water stress during 16 weeks were evaluated. Cape gooseberry plants that received foliar applications of kaolin had the highest WUE and plant total dry weight. Kaolin applications also enhanced stomatal density. Leaf transpiration and leaf thickness were reduced by particle film treatments in well-irrigated and water-stressed cape gooseberry plants. In conclusion, kaolin sprays could be an useful tool to help cape gooseberry under limiting soil moisture conditions, since particle film treatments can improve WUE.

Specified Source(s) of Funding: Universidad Nacional de Colombia

(213) Detecting Physiological Water Stress in Southern New Mexico Pecan Orchards using Remote Sensing

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While leaf-level plant physiological parameters can provide useful information to better understand drought stress in pecans, extraordinary cost and long collection times, along with the necessity of leaf destruction, limit their use. Remote sensing applications are considered a promising technique in detecting and up-scaling leaf-level physiological responses to large areas. The objective of this study was to detect physiological changes in pecan trees exposed to soil moisture deficits using remotely sensed surface reflectance derived from Landsat-7 Enhanced Thematic Mapper (ETM) and Terra Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER). The study was conducted simultaneously on two southern New Mexico mature pecan orchards in 2011. Two treatments were applied to both orchards; well-watered and water deficit. The beginning of each irrigation cycle was considered the well-watered level, while water deficit was assumed at the end of the irrigation cycle. Irrigation cycle varied from 14 to 20 days. Irrigation cycles were synchronized with satellite overpasses. Several reflectance indices were computed from the remotely sensed data including reflectance in individual bands, Band Ratios (BR), the Normalized Difference Vegetation Index (NDVI), the Soil Adjusted Vegetation Index (SAVI), and shortwave infrared (SWIR) moisture indices of Landsat-7 ETM+. The empirical relationships between reflectance indices and in situ measurements of pecan foliar midday water potential were compared. Green reflectance was related to water deficit and showed significant relationships ($P = 0.049$) from May to June ($r^2 = 0.65$). $SWIR_{(2.08–2.35\ \mu m)}$ and BR $SWIR_{(1.55–1.75\ \mu m)}/SWIR_{(2.08–2.35\ \mu m)}$ were also significantly related ($P = 0.036$ and 0.035, respectively) to foliar water deficit from June to September ($r^2 = 0.67$ and $r^2 = 0.65$, respectively). On the other hand, SWIR moisture indices show significant relationships ($P = 0.016$) with foliar midday water potential from mid of September to mid of November ($r^2 = 0.75$). NDVI and SAVI were not significantly related to foliar midday water potential of pecans. Although ASTER data are still being analyzed, results illustrated that reflectance indices such as BR and SWIR moisture indices have potential as nondestructive proxies for detecting water deficit in pecan trees.

(214) Electrical Responses of Walnuts Trees to Periods of Light and Darkness

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Recent studies have shown that electrodes inserted into the stem of some fruit tree species can be used to measure internal electrical signals in response to changes in environmental variables such as soil water content. However, the relative effects of internal or external factors, such as placement of electrodes, light intensity or air temperature, on electrical responses to environmental stimuli have not been quantified. We measured the effects of short periods of darkness and light, placement of electrodes along the stem, and air temperature on electrical potential (EP) in young walnut (*Juglans regia*) trees. Six trees were subjected to 10 minutes of absolute darkness [photosynthetically active radiation (*PAR*): 0 μmol·m^{-2}·s^{-1}] followed by 20 minutes of artificial light (*PAR*: 21 μmol·m^{-2}·s^{-1}), followed again by 10 minutes of darkness (*PAR*: 0 μmol·m^{-2}·s^{-1}). Electrical potential (EP) was measured with three electrodes inserted into the trunk of each tree at 8.5, 32.5, and 37.5 cm above the soil surface. Electrical potential differences (ΔEP) between each set of electrodes and air temperature were also continuously monitored during the experimental period. Data were analyzed by principal component analysis to determine the main factors associated with changes in EP and ΔEP. The factor that explained the most variation in EP and ΔEP was light intensity (explaining 57.6% of the variance). Position of the electrode along the trunk accounted for the second greatest amount of variability (15.1% of the variance) in EP and ΔEP, whereas temperature had no significant effect on EP and ΔEP. The results suggest a clear relationship between electrical signals in walnut trees with respect to light/dark cycles, and that the electrode placement along the stem should be taken into account when relating electrical signaling to environmental variables such as light/dark cycles.

Specified Source(s) of Funding: PROGRAMA FONDECYT, Chile

(215) Gene Expression Analysis in Garlic Sprouts from Seed Cloves Stored at Different Temperatures

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A good development of garlic bulbs and cloves differentiation require cold weather and short photoperiod at early development phases, followed by high temperatures and long photoperiods until the harvest. If cold requirements are not met, a high incidence of defects bulbs is observed. The mechanism by which the low environmental temperatures start molecular expressions of genes that lead to the bulb formation is not known. The objectives of this work were differentially to describe the transcriptome profile of garlic sprouts of cloves stored at 5 °C during 5 weeks and room temperature (RT) as well as to observe the plant developing and quality bulbs in both storage conditions. Two storage conditions were studied; i) garlic bulbs (cv. Coreano) stored at RT for two consecutive seasons (2009–10 and 2010–11) (RT × RT) and ii) garlic bulbs stored for 5 weeks at 5 °C in both seasons (5 × 5). One cloves set of each condition storage were planted at Cosio Aguascalientes, Mexico to study their development in field. The DNAc 5 × 5 sprouts created a library of 85 clones whose bio informatics analysis showed 28 unigenes; 64.28% were stress response proteins, 14.28% were metabolism proteins, 10.71% structural proteins, 7.14% transcription factors and 3.57 % without homology. Differential hybridization of 5 × 5 and RT × RT libraries and its Southern analysis identified 48 constituent genes, 20 over expressed genes (eleven were phenyl alanine ammonium lyase isozymes and two related to fructans metabolism) and 17 repressed genes. Plants from cloves stored at 5 °C ahead the harvest time 42 days in comparison with RT plants, but they had lower height, yield and leaves number but also low incidence of undifferentiated bulbs.

Specified Source(s) of Funding: CONACyT

Tuesday, July 31, 2012 Grand Ballroom

Genetics and Germplasm 1

(402) Selection of Muskmelon with Resistance to *Monosporascus cannonballus* In Vitro

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Monosporascus root rot or vine decline caused by *Monosporascus cannonballus* is widely distributed in the major cucurbit crop growing areas in Korea. Most watermelon, muskmelon and Oriental melon crops are grown in plastic greenhouses in the southern part of the country where the spread of the disease is severe. First isolated in 1993 from the diseased roots of the bottle gourd-grafted watermelon plants, *M. cannonballus* has been found in wilted plants of muskmelon grown in greenhouses with temperatures often higher than 30 °C. The high temperature greenhouse growing conditions favor disease development on muskmelon plants especially during the fruit ripening stage. Because of this disease, the stable and sustainable production of muskmelon crops has been a challenge to many growers. As an effort to develop new cultivars resistant to *M. cannonballus*, various germplasm materials of *Cucumis melo* (muskmelon) including commercial lines and hybrids were evaluated in this study. Seeds were surface sterilized in 3% Clorox® for 20 minutes and rinsed in sterile water under a laminar flow transfer hood. After seed coat removal, the naked seeds were cultured on agar medium with the pathogen (*M. cannonballus*) inoculums. Among the 42 genetic materials (28 commercial varieties, 9 accessions, 8 germplasms including domestic lines) tested, the seedlings of 'Rio Gold' and 'Tokyo Early' showed resistance to the pathogen, while seedlings of 'Busan 914' and 'Busan 920' showing only a partial resistance. The rest of the genetic materials were susceptible to the disease. Findings of this study may well be used for further selection and breeding of new muskmelon cultivars resistant to *M. cannonballus*.

(403) Assessment of Genetic Diversity and Cyanogenic Glucoside Content among Lima Bean Landraces from the Dominican Republic, Haiti, and Puerto Rico

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Protection of crop genetic resources is a key approach for securing food sources for the future generations. Crop diversity in part is maintained by farmers who share plant material, introduce new varieties and even select improved genotypes. Also the farmers keep and, in some cases without knowing, protect the wild relatives of many different species. The establishment of genetic relations within a crop is an important component in crop improvement programs. Correct assessment of genetic diversity is invaluable in any crops' conservation and for diverse applications including the identification of new combinations with maximum genetic variability for further selection and introgression of desirable genes from diverse germplasm into the available genetic base. In this study, we report the first genetic diversity assessment of lima beans (*Phaseolus lunatus* L.) in the Caribbean. Lima bean, known as "pois souche" in Haiti and "haba" in Puerto Rico (PR) and the Dominican Republic (DR), is a drought and heat tolerant grain legume crop that is produced and consumed throughout the Caribbean. Most landrace varieties in the Caribbean are photoperiod sensitive (short-day) indeterminate plants that produce pods during the dry season. Fifty-five landraces collected from the PR, Haiti and DR were subjected to fluorescence-based Simple Sequence Repeat marker analysis on polyacrylamide gels. The number of alleles per loci ranged between 1 and 8 with the percentage of polymorphic loci being 74.17 ± 12.64. A high number of alleles were found per locus, at an average of 2.67 ± 1.46. The percentage of polymorphic loci was highest in accessions from PR (75%) followed by DR (70.8%) and Haiti (62.5%). The average proportion of observed heterozygous individuals (H_o) was higher than expected in all three countries. The overall heterozygosity (H_t) in all accessions was 0.4110 ± 0.1964 with approximately 40% of the diversity due to within country variation (H_s = 0.3969 ± 0.1916) and only 3.65% (G_{st} = 0.0365 ± 0.0512) due to differentiation among samples. The results reveal a low level of differentiation between country samples. The UPGMA analysis showed that all samples clustered with the known-check variety (Sieva) of Middle-American descent. Interestingly, all samples from Haiti grouped in a cluster that did not contain any samples from PR. Since lima bean is one of the few agronomical important crops that contain toxic cyanogenic glucosides, we also assessed all accessions for the presence of linamarin (the cyanogenic glucoside in lima beans) in leaves and seeds using a UPLC–TOF system.

(404) Agricultural Characteristics and SSR Profiling of Kidney Bean Landraces from Korea and Bulgaria

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The agricultural characteristics and the genetic diversity of kidney bean landraces from Korea and Bulgaria were evaluated. Days from planting to flowering were ranged from 50 to 79 days with an average of 57.2 days. Days from flowering to maturity were ranged from 25 to 64 days with an average of 38 days, and days from planting to maturity were ranged from 83 to 123 days with an average of 95.2 days. Kidney beans originated from Korea tend to bloom and mature earlier than those from Bulgaria. In growth habitat, 71% of being originated from Korea are erect type, but 60% from Bulgaria are climbing type. Also quantitative characteristics were different from Korea and Bulgaria. 71% of the colors of flower are white with purple stripe in korea, but 71% of those are white in Bulgaria. On the average, landraces seems more or less early maturing. One hundred fifty-five kidney beans from Korea and Bulgaria were analyzed using 10 SSR markers. Ninety-seven alleles were detected with a lowest five at the BM161, BM181, and BM211 and a highest 18 at BM156. The average polymorphism information content(PIC) was 0.61. Gene diversity was higher in the Bulgarian population than that of Korea.

(407) New Sources of Resistance to Cucurbit Powdery Mildew in Melon

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Many physiological races of the cucurbit powdery mildew pathogen (CPM) *Podosphaera xanthii* (Castagne) Braun & Shishkoff have been reported on melon (*Cucumis melo* L.). Melon accession PI 313970 is the only reported source of host plant resistance to race S, which first appeared in Imperial Valley, CA in Spring 2003. Race SD, which overcomes resistance in PI 313970, occurred in single spore isolates from collections of CPM from Imperial Valley and on melons in a greenhouse at Salinas, CA following many years of growing PI 313970 year-round in the greenhouse. Variants of races S and SD, designated SW and SDW, infect watermelon [*Citrullus lanatus* (Thunb.) Matsum & Nakai]. Four hundred thirty melon accessions were evaluated for new host plant resistance to races 1, S, SW, SD and SDW in controlled-inoculation greenhouse tests at Riverside, CA in 2008 and 2009. Twelve of the accessions, which were collected from five sites in Madhya Pradesh, India, exhibited high-level resistance to one or more races. All 12 accessions were identified as members of *C. melo* ssp. *agrestis*. Two accessions were further classified as *C. melo* ssp. *agrestis* var. *flexuosus* (PI 614543, PI 614576); seven were further classified as *C. melo* ssp. *agrestis* var. *momordica* (PI 614524, PI 614527, PI 614528, PI 614544, PI 614545, PI 614546, PI 614577); and the varietas classifications of three accessions were not designated (PI 614525, PI 614526, PI 614529). In subsequent open field tests at Holtville they were all resistant to a CPM population that could have been race 2 in 2010 ('PMR 45' failed to germinate), and only PI 614543 was susceptible to race 1 in 2011. Four accessions (PI 614525, PI 614543, PI 614544, PI 614576) were susceptible to a Salinas isolate of race S in a growth chamber. Only three accessions (PI 614524, PI 614527, PI 614545) were resistant to a Salinas isolate of race SD in a greenhouse. The discrepant reactions of these 12 accessions among the respective tests of CPM isolates may have resulted from three potential sources of variability: (1) heterogeneity within the accessions (they are open-pollinated), (2) genetic variation among identical CPM isolates based on phenotype characterization by the melon CPM race differentials, and (3) environmental variation. Regardless of the source of variation, these 12 *C. melo* ssp. *agrestis* accessions are potentially useful sources of genes for host plant resistance to several races of CPM.

(408) Assessing Skinning Resistance in Sweetpotato

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Sweetpotato consumption and acreage is increasing, but production costs now exceed $4,000 per acre and the high use of hand labor erodes profitability. Strides to mechanize and reduce labor input are difficult because many of the popular varieties are highly susceptible to skinning damage. A preponderance of damage is unsightly for marketing and accentuates rots and weight loss in storage. Our interest is to assess the differences in skinning resistance in varieties of sweetpotato, including those with a putatively tougher skin. Although the objective is straightforward, quantitative measurements are difficult. Results suggest that a water jet skinning meter developed at North Carolina State University, has the capacity to discriminate between varieties which skin easily in contrast to those with more durable skin. Furthermore, our technique also includes an assessment of desiccation at the wound site and underscores the importance wound healing as an equally important goal. The techniques developed in this study will be useful in developing selection protocols in breeding programs.

Specified Source(s) of Funding: Specialty Crop Research Initiative; award #2009-51181-06071

(409) Evaluation of Lettuce Collections for Heat Tolerance

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Global warming and climate change pose serious challenges to the horticulture industry and place unprecedented pressures on the sustainability of the U.S. agriculture. In order to meet the needs of a growing population and increasing demands for fruits and vegetables, it is critical to adapt the leafy greens industry to future environments. There is a pressing need to develop crops that can survive and perform well at high temperatures. Plant growth and development may be drastically affected by heat stress that could lead to a reduction in economic yield of leafy crops. Depending on lettuce (*Lactuca sativa*) cultivars, seed germination may be inhibited when temperatures exceed 28 °C. The delay or inhibition of seed germination at high temperatures may reduce seedling emergence and stand establishment of lettuce in the field. In order to identify heat tolerant lettuce genotypes, more than 3,500 lettuce varieties and germplasm accessions were screened in growth chambers. Seeds were placed in petri dishes to test their ability to germinate at high temperature (34 °C) as compared to controls at 24 °C. Three-week-old seedlings were exposed to heat stress (43 °C day/35 °C night) for a week before being assessed for leaf and plant damages as well as growth reduction. By using these methods we were able to identify different types (crisphead, butterhead, green leaf, red leaf, romaine, wild, or primitive forms) of lettuce genotypes that can tolerate heat stress and/or germinate under high temperature conditions.

(410) Lettuce Yields and Metabolites Found in 45 Cultivars Grown under Best Management Practices

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Lettuce is an important leafy vegetable crop grown in worldwide food systems with the United States ranking second behind China in total production. In 2009 the USDA Food Economic Research Service reported 1,057,715 ha of lettuce grown in the world. Metabolites such as nitrate and polyphenolics accumulate in lettuce and their potential effect on human health should be considered. Nitrate accumulation in leafy vegetables may have detrimental effects on human health including methaemoglobinaemia and carcinogenesis. Many polyphenolic compounds are considered antioxidants and present positive health benefits when included in human diets. There are four main types of lettuce and numerous cultivars within each type. Because these metabolites may vary significantly between lettuce types and/or cultivars, 45 cultivars of lettuce, representing the four types, were grown in the field under best management practices at the LSU AgCenter's Burden Center in Baton Rouge, LA, during Fall 2011. The top two highest yielding cultivars of head, butterhead, and romaine types and the top three highest yielding leaf types were analyzed for nitrate concentration and total phenolic compounds. Two classes of polyphenolic compounds, caffeic acid derivatives and flavonols were identified in all types. Results suggest there are considerable differences in these metabolites between types and varieties and this information should be considered by producers and consumers.

(411) Topset Diversity in the USDA National Plant Germplasm System's *Allium sativum* Collection

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Allium sativum L., garlic, has been cultivated for thousands of years and has primarily been propagated vegetatively using cloves and topsets/bulbols. There are two basic types of garlic, those that produce flower stalks and an inflorescence with topsets (hardneck varieties) and those that do not(softneck varieties). Much variation exists in the size, color, and number of bulbols per umbel in hardneck varieties. The USDA–ARS National Plant Germplasm System *Allium sativum* collection contains approximately 280 accessions. Of these accessions 59.6% are hardneck varieties that produce bulbols. In 2010, topsets were harvested from regeneration plots of the *Allium sativum* collection and characterized for size, color, and number of bulbols per umbel. Images were also taken of samples for each accession. Topset colors ranged from cream to dark purple among accessions and occasionally within an accession. The majority of accessions have cream colored topsets. Four size classes were used to characterize the collection [small (< 0.5 cm diameter), medium, large and extra large (1.5- to 2-cm diameter)], with the majority in the small size class. As with color, bulbol size varied among umbels within an accession; 31% of the accessions produced topsets in two size classes. The average number of bulbols per umbel ranged from two (W6-10731) to over 200 (5 accessions). The collected topset characterization data will allow the garlic collection user community to more efficiently select accessions to use for specialty crop production such as green garlic or dried products utilizing bulbols.

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Organic Horticulture 1

(066) A Comparative Analysis of Organic Retail Market Trends in Gainesville, Florida

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Organic food production is a fast growing industry in the United States. Research on local retail market trends is important to understand the growth of the organic industry. Interest in organically produced foods is increasing in Gainesville, FL, whose population represents a younger progressive demographic. Studying the uphill trend of organic foods in Gainesville can offer an insight into the growth of organic foods for this new generation. In this study, three markets including Ward's Supermarket (local), Publix (supermarket chain), and Walmart Supercenter were compare on prices, availability, and selection of organic foods over a 2-year period, 2011–12. The study also included a comparison of alternative labeling to the USDA Certified Organic label. Data on major categories of foods including fresh fruits and vegetables, coffee, dairy, eggs, and meats were collected in one visit of each market at random dates and times between Jan. and Feb. of 2011 and 2012. Similarly to the 2009 USDA national report on marketing U.S. organic foods, this study found that price premiums were higher on average for organic foods in all three markets, with few exceptions. Moreover, price premiums (in percentage) were highest with organic produce such as fresh fruits and vegetables. Compared with the data in 2011, on average organic and conventional food prices increased in 2012 for all three markets. However, Publix's organic milk prices decreased and their conventional milk prices increased from 2011–12. All of the markets studied offered greater selection and availability of organic produce over organic animal products (dairy and meats). In general, Ward's Supermarket offered the most variety and selection of organic foods compared to the other markets. Walmart Supercenter offered the least variety and selection of organic foods. Ward's Supermarket had the widest array of alternative labels while Walmart had the least selection of alternative labels. In 2012, Publix and Walmart demonstrated an increase in availability and selection of organic foods as compared with the observations in 2011. According to the results of this study the organic food market in Gainesville is growing. Further research is recommended to include other markets such as farmers' markets, co-ops, and local health food stores for a more comprehensive study of organic market trends.

(067) Influence of Mychorrhizae and Poultry Compost on Tatsoi Growth, Development, and Microbial Food Safety

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Tatsoi, *Brassica rapa (*Narinosa group), also called rosette bok choy, is an Asian leafy vegetable, and is currently gaining popularity in organic production. Tatsoi can be grown at low temperatures, but performs best in the raised temperatures of a protected growing environment like a high tunnel during winter and early spring months. The incorporation of organic amendments, such as poultry compost, into soil may pose food safety risks if pathogenic microorganisms are present. A high tunnel study was conducted in early Spring 2011 on the Eastern Shore of Maryland to determine the effect of two commercially available products: arbuscular mycorrhizal fungi (AMF) and poultry compost, on the development and microbial food safety of tatsoi. The experimental design was a randomized complete block (RCB, n = 4) for each of the following treatments: Pelletized organic chicken compost, AMF, Poultry compost, and AMF + Poultry compost. Treatments were applied to tatsoi seeds at planting, and baby leaves were sampled over three harvests. Treatment rates were 12.4 g/m^2 for poultry compost and 16.0 g/m^2 for AMF. When used separately, AMF or poultry compost increased baby tatsoi leaf fresh weight, dry weight, length and width in comparison to the control plants. However, when these treatments were combined they significantly decreased fresh weight, but did not influence leaf area. All leaf samples were negative for *E. coli* O157:H7 and *Salmonella*, while one sample was positive for generic *E. coli*. This study indicates that AMF + compost may not have a synergistic effect on tatsoi growth and development, and that these soil amendments, at the levels used, may not pose a food safety risk factor to baby tatsoi grown in the protection of a high tunnel.

Specified Source(s) of Funding: USDA–NIFA and UMES Agricultural Experimental Station

(068) Fish Emulsion: A Liquid Organic Fertilizer for Healthy Seedling Establishment

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Most of today's seedling production uses limited nonrenewable resources and mineral fertilizers that are not approved for use in organic production. Coir, a bio-product of the coconut industry, and fish emulsion (water soluble fertilizer) are both renewable and approved for use in organic production. Therefore, this study was conducted to investigate the effect of varying concentrations (based on EC values) of fish emulsion fertilizer on the establishment of sunflower seedlings in coir substrate. Sunflower seeds were sown in 36 cell trays (3.8 × 2.6 × 5.7 cm) containing coir. They were fertigated with three concentrations of fish emulsion with target EC values of 0.5, 1.0, and 1.5 dS/cm, and conventional fertilizer 20–8.7–16.6 (N–P–K) as a control at 50 mg/L of N. The nutrient solutions were supplied after the emergence of first set of true leaves. Fish emulsion concentrations with EC values of 1.0 and 1.5 dS/cm resulted in increasing pH and EC values. There were no differences in the shoot height and root length among the treatments. The shoot fresh and dry weights of control plants were greater than that of the plants supplied with fish emulsion. Fish emulsion concentration with the EC value of 1.5 dS/cm produced the lowest root fresh weight. Based on visual index, the control plants appeared robust compared to the fish emulsion supplied seedlings. However, the root volume of seedlings supplied with 0.5 dS/cm of fish emulsion appeared greater than the control.

Specified Source(s) of Funding: USDA

(071) Antioxidant Activity and Whitening Effect of Various Tomato Plant Parts

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Tomato is an annual plant, cultivated mostly in greenhouse. Most of the tomato plant has been discarded as a waste after fruit harvesting although tomato plants, not fruit have many physiological functions like antioxidant activity and whitening effects. Therefore, in this study, various parts of tomato plants (leave, stem, root, or fruit) were evaluated for their antioxidant and whitening effect for cosmetic purposes. Tomato samples were freeze-dried, extracted with 80% methanol. Antioxidant activities of tomato plants were determined by DPPH radical scavenging and ABTS radical scavenging. Whitening effect of tomato samples was studied by tyrosinase inhibition or melanin synthesis extent on B16 melanoma cell line. Tomato leaf extracts showed the strongest antioxidant activity with 31% DPPH scavenging, 88.7% ABTS scavenging among samples. For whitening effect of tomato extracts, leaf extracts showed a 1.5–2 times higher tyrosinase inhibition than those of stem or fruit. Leave and root extracts showed above 70% inhibition of melanin synthesis on B16 melanoma cell. In conclusion, tomato leaves showed the highest antioxidant activity and whitening effect among samples. Therefore, these results indicated that tomato leaves could be applicable for functional cosmetic material in industry field instead of being thrown away.

(072) Physiochemical Properties of *Lycium chinense* Treated Seawater

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Seawater has been applied to cultivate several crops like rice and wheat as an eco-friendly material, due to its enriched nutrients and minerals or induction of disease resistance. *Lycium chinense* was harvested after one or two times treatments of 15%, or 30% seawater in mid-August or September. *Lycium chinense* was analyzed for its physical and physiological functions. Compared to those of conventional *Lycium chinense,* 30% seawater treated plant showed significantly higher ash content, mineral content such as K, P, Mg, Na, Fe, Zn, but lower reducing sugar content. In addition, seawater treated plant had higher amount of total phenol, flavonoid, carotenoid, and antioxidant than those of conventional one. Among treatments, 30% seawater resulted in higher quality plant than 15% seawater. Plant quality was the excellent by 2 times with 15% seawater in September or 1 time with 30% seawater in November. These result indicated that seawater of 15~30% concentration was applicable as an eco-friendly material to cultivate *Lycium chinense*.

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Pomology

(298) Assessing the Role of the Pistil in Sweet Cherry Fruit Set

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Several sweet cherry (*Prunus avium* L.) cultivars have compelling quality attributes but are beset with poor productivity (e.g., 'Benton', 'Tieton', and 'Regina'). The causes of this poor performance are being investigated so that remedial programs may be developed. Previous work in our lab has implicated maternal factors in poor fruit set. Our current research is investigating therefore the role of stigma receptivity and ovule viability on fertilization in sweet cherry. In addition, the role of temperature on these key elements of crop fertility was investigated. We studied four cultivars, 'Sweetheart' (self-fertile, high productivity), 'Benton' (self-fertile, low productivity), 'Rainier' (self-sterile, high productivity), and 'Tieton' (self-sterile, low productivity) in field and growth chamber studies. Sections of 2-year-old branches were collected prior to anthesis and distributed randomly among growth chambers set to either a high, moderate, or low temperature profile. Flowers were emasculated at full white (i.e., within 12–24 h of anthesis) to avoid self-pollination. Hand pollinations were made in the chambers to replicate sets of flower using previously collected compatible pollen. Single applications of pollen were made manually to stigmatic surfaces at 24-h intervals up to 6 days after anthesis. Pistils were collected at 3 intervals (8 h, 24 h, 48 h) post pollination for microscopic assessment of stigma receptivity and ovule activity. To assess stigmatic receptivity we evaluated the rate of pollen hydration and germination. Pollen hydration rate was affected by cultivar more than temperature. Pollen germination on the stigmatic surface was related positively with temperature. The highest recorded rate of pollen germination was ≈35%, and 'Rainier' and 'Sweetheart' had higher germination rates than 'Benton' and 'Tieton' under cold temperature. The rate of pollen tube growth increased with pollination timing, peaking on 4 days after anthesis. By the same time we observed significant senescence of the primary ovule. We also observed a positive relation between temperature and ovule senescence, irrespective of cultivar. Primary ovule viability of 'Rainier' was greater than other cultivars though this difference among varieties was negligible for the second ovule. With further analyses, and integrating all results, we will revisit models for effective pollination period in sweet cherry.

Specified Source(s) of Funding: Washington Tree Fruit Research Commission, WSU Agriculture Research Center

(300) Restricting Basipetal Transport of Auxin in the Rootstock Stem of Composite 'Royal Gala' Apple Trees Reduces Root Growth and Cytokinins in the Xylem Sap

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It has been hypothesized that the stem of dwarfing apple rootstocks reduces basipetal transport of indole-3-acetic acid (IAA) to the root, thereby limiting root growth, biosynthesis of root-produced hormones (cytokinins and gibberellins), and their consequent transport in the xylem vasculature to the scion for growth. This hypothesis still remains largely untested experimentally; therefore, we applied the auxin transport inhibitor "1-N-naphthylphthalamic acid" (NPA) to the graft union of composite 'Royal Gala' apple trees to elucidate whether restricting shoot-root IAA transport reduced root growth (experiment 1) or cytokinin concentration in scion xylem sap (experiment 2). In experiment 1, 'Royal Gala' scions were grafted in early spring onto 'M.9' (dwarf), 'MM.106' (semi-vigorous), 'M.793' (vigorous), and 'Royal Gala' ('R.G'; very vigorous, self-rooted

control) rootstocks. NPA in lanolin was applied to the graft union (5 mg·mL^{-1} per tree) of half the experimental trees in early, mid, and late summer; the remaining trees were untreated. Root dry weights were measured in winter. In experiment 2, 'Royal Gala' scions were grafted onto 'MM.106' in late winter. In the second spring following tree grafting, half the trees were either untreated or treated with NPA applied to the graft union as previously described. Zeatin (Z), zeatin riboside (ZR), isopentenyladenosine (IPA), and isopentenyladenine (2iP) concentrations were quantified in the scion xylem sap 96 hours after treatment. Rootstock and NPA interacted ($P < 0.001$, LSD = 12) to modify final root dry weights. Without NPA, root dry weight of 'M.9' was less than 'MM.106', 'M.793', and 'R.G' (41, 98, 114, and 85 g, respectively). With NPA, root dry weights were 20, 35, 35, and 22 g, representing a 52%, 64%, 69%, and 74% reduction in root growth for 'M9', 'MM.106', 'M.793', and 'R.G', respectively. Root dry weights of 'M.9' and 'R.G' were similar only when NPA was applied. NPA lowered ZR in scion xylem sap from 0.49 to 0.32 ng·mL^{-1} ($P < 0.01$) and 2iP from 0.43 to 0.17 ng·mL^{-1} ($P < 0.05$), but did not affect Z or IPA. We conclude that the smaller root system of M.9 could result from limited shoot-root transport of IAA within the rootstock stem. Lowering shoot-root transport of IAA also appeared to down-regulate the biosynthesis of some root-produced cytokinins.

(301) Enzymatic Solubilization of Asian Pear Flesh and Its Functional Characterization

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Pear fruits are popular among consumers due to their sweetness, crispness, characteristic fragrance and slight aroma. However, 25% to 30% of total fruit yields are practically applied to produce pear juice and pear flesh is thrown away as a waste although it is consists of nutritious dietary fiber, accounting for 35% to 40% of whole fruit weight. In this study, we analyzed the pear dietary fiber content of five major Asian pear cultivars and determined optimal enzymatic hydrolysis condition of pear flesh. Furthermore, we functionally characterized enzyme treated pear flesh with respect to antioxidant activity, anti-lipid peroxidation, and anti-diabetic effect. Five pear cultivars showed the 11.63% to 30.15% amount of total fiber, occupied for 0.85% to 2.23% of soluble dietary fiber contents. Their dietary fibers were consisted of cellulose (15–113 mg/g), hemicellulose(93–171 mg/g), pectin (0.43–6.33 mg/g), and lignin (4.4–10.0mg/g). Fruit flesh from five varieties of pears was prepared by grinding, removing juice out and frozen-drying. Pear flesh powder (1% to 50%) was enzymatically hydrolyzed for 3–12 h at 28–60 °C using four commercial enzymes, including pectinase, cellulase, hemicelluase, or/and b-glucanse. Flesh powder showed above 50% solubilization efficiency by the combination of pectinase (0.1 unit/mL) and cellulose (0.1–1 unit/mL) with a 10% flesh powder at 37 °C for 3–6 h. Solubilized flesh showed higher antioxidant activity (62 mM vit C eq.) and anti-diabetic effect (23%), compared to those of pear juice with 2.9 mM vit C eq. and 22%, respectively. Those results indicated that it could be applicable to increase the yield of pear juice and produce nutritional and functional pear juice in food industry. This study was financially supported by Rural Development Administration (Project No. PJ 907072)

Specified Source(s) of Funding: This study was financially supported by Rural Development Administration (Project No. PJ 907072)

(302) Fruit and Shoot Growth in Exposed and Shaded 'Red Sensation' Pear Branches

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The pear cultivar 'Red Sensation' is showing popularity in the industry because of the highly-colored, sweet and juicy fruit. The effects of shading on fruit and leaf characteristics of 'Red Sensation' pear trees were evaluated at the Experimental Farm of the Universidad Nacional del Comahue, in the High Valley region, Río Negro, Argentina (38°56'S, 67°59'W). A crop of pear trees grafted on *Pyrus communis* L. rootstock, planted in 1993 at 4.0 × 2.3 m spacing, trained to palmette leader and grown in sandy loam were studied. Row orientation was north–south. The orchard was kept weed-free, fertilized, thinned, pruned and sprayed for pest and disease control according to the local standard program for pears. The experimental site was located in an arid region; trees were surface irrigated at weekly intervals to match the crop evapotranspiration requirements throughout the season. An automated meteorological station collected air temperature, relative humidity and sunshine duration data. Two comparable branches on each of six uniform trees were selected for good exposure and one branch of each pair was shaded. Treatments were: a) control and b) application of shade, by covering branches with a 20% transmission (i.e. 80% reduction in irradiance) black saran neutral density shade net, from 30 to 50 days after full

bloom (DFB). Full bloom occurred on 29 September 2011. Fruit diameter (FD), shoot length (SL), leaf area (LA), specific leaf weight (SLW) and SPAD value were determined at 50 DFB. LA was measured with a Cid-202 leaf area meter. SPAD value was assessed with a Minolta SPAD-502 portable apparatus. Discs were excised between the midrib and leaf margin, using a cork borer of 11 mm diameter. They were subsequently dried at 80 °C for 48 h and weighed to obtain SLW. FD was the maximum width perpendicular to the main axis and it was recorded with a Vernier caliper. Means were compared using Student's *t*-test to determine significant differences ($P \leq 0.05$). Low light level significantly reduced FD and SL and compared to the controls: 28.1 vs. 26.6 mm and 42.7 vs. 32.4 cm for treatments a) and b), respectively. LA, SLW and SPAD values were not affected: 18.8 cm^2, 4.23 $mg \cdot cm^{-2}$ and 42.2 SPAD value for the control samples, respectively. Further studies are needed to study the relative effects of reductions in light levels during different periods on 'Red Sensation' fruit and shoot growth.

(303) Reflective Fabric Improves 'Bartlett' and 'D'Anjou' Pear Yield

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We applied reflective fabric (Extenday™) to alleyways of pear orchards to investigate the influence of fabric on canopy light interception and distribution, fruit set, fruit growth rate, average fruit size, yield, fruit firmness, and postharvest quality. Sites included a multi-leader 'd'Anjou' orchard planted at 269 trees/ha (2009–11; Oregon) and a hedgerow 'Bartlett' orchard at a density of 633 trees/ha (2011; California). We evaluated two treatments at both sites: No Fabric [NF], and Fabric applied prior to full bloom (FB) through harvest [FS]. For 'd'Anjou' we included two additional treatments: Fabric applied prior to (FB) and removed 75 days after full bloom (DAFB) [F-75], and Shade, 60% shade-cloth applied 60 DAFB through harvest in 2009 and 2010 only. Weekly 'd'Anjou' fruit growth rate was not affected by the fabric treatments relative to NF in any year, but significantly reduced for shaded fruit. Final fruit size of 'Bartlett' and 'd'Anjou' was similar among treatments, with the exception of shade-treated fruit which were smaller. Total 'd'Anjou' tree yield in year one was significantly greater for fabric treatments compared to NF (c.a., 27% and 21% for FS and F-75, respectively), but not significantly different between fabric treatments, indicating that increased tree yields were a function of greater fruit number. 2011 'Bartlett' yield ($P = 0.19$) and fruit number ($P = 0.16$) were higher for FS than NF, but not significantly; however, yield efficiency was significantly higher (~30) with Fabric. In year 2, a significant yield increase relative to NF was observed for FS (11%), but not F-75 (3%) in 'd'Anjou'. Severe freeze and wind events limited d'Anjou' production in 2011 (i.e., ~40% of 2009 and 2010 yields), irrespective of treatments. For 'd'Anjou', we observed higher yields and light interception for Fabric treatments in the lower exterior, mid and interior canopy. Relative to NF, 'Bartlett' FS had significantly more fruit in the upper canopy on both the north and south sides the tree. At harvest, fruit maturity was advanced by several days for both 'd'Anjou' and 'Bartlett' FS treatments relative to NF. Slightly greater levels of soluble solids were observed in FS 'd'Anjou' fruit, but not 'Bartlett'. Shaded 'd'Anjou' fruit had lower sugar content than other treatments. Postharvest quality of 'd'Anjou' fruit was not affected by treatments in all three years. Relative to NF, total 3-year projected per acre 'd'Anjou' returns were increased by $2,600 and $4,800 for FS and F-75, respectively.

(304) Cropload Management and Appropriate Harvest Timing Improves Final Fruit Size and Fruit Quality of US 71655-014, a New Fire Blight Resistant European Pear Selection

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US 71655-014 ('Gem') is a fire blight resistant pear selection developed at the USDA Appalachian Fruit Research Station. Despite possessing several positive attributes [precocity, high annual production, attractive fruit appearance, fire blight resistance, good storability and consumer acceptance], 'Gem' is a small-fruited genotype. The Pacific Northwest pear industry prefers large-fruited cultivars (exceeding 200 g). We, therefore, examined two strategies to improve fruit size of 'Gem'. First, a 2-year cropload study was initiated on sixth leaf trees. Croploads were established by thinning at 50 days after full bloom to four cropload levels based on the number of fruit per cm^2 of trunk cross-sectional area (TCA): T1) 8–10 fruit per cm^2 TCA, T2) 6–8 fruit per cm^2 TCA, T3) 2–4 fruit per cm^2 TCA, and T4) commercially thinned to 'Bartlett' standards (3–5 fruit per cm^2 TCA, determined after thinning). Fruit weight at harvest was 150 g, 171 g, 208 g and 203 g for T1, T2, T3, and T4, respectively. Frequency distribution of larger fruit size classes was markedly improved for T3 and T4. Individual tree yields averaged 30 kg for T3 and T4; roughly half of T1. However, canopy volume and TCA of T3 and T4 indicated that trees could be planted at higher densities to attain adequate yields of high-quality fruit. Return bloom and fruit load was not significantly affected by cropload, in either year. Cropload level strongly predicted fruit weight at harvest and could serve as a production manage-

ment tool to target fruit weight for a given market. In 2011, we examined the role of harvest maturity on fruit size and quality following cold storage and ripening. Fruit were harvested weekly for 4 weeks. The initial harvest occurred when fruit attained a previously identified fruit firmness (FF) value coinciding with maximum storability (~7 months). At each harvest, fruit was weighed, placed in regular atmosphere storage (–1 °C), and evaluated monthly for 7 months. Fruit quality attributes [FF, soluble solids, total acids, extractable juice, and fruit weight] were assessed upon removal from cold storage. An additional sample per replication was ripened for 7 days at 20 °C and evaluated for quality attributes. Fruit size was markedly improved with delayed harvest dates. Although 'Gem' is not a melting pear, ripened fruit softened and extractable juice decreased as duration in storage increased, irrespective of harvest timing. Changes in fruit quality attributes relative to harvest maturity and storage duration will be presented.

(305) On-tree Bagging as a Production Technique for Peach Orchards in the Humid Eastern United States

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On-tree bagging is an ancient technique used for pest exclusion and quality enhancement of many fruits. Peach fruit tend to have among the highest amount of residual pesticide at harvest of any fruit. The bagging of peach fruit provides a unique opportunity to greatly reduce the amount of pesticide exposure on fruit and exclude pests, as well as potentially improve fruit quality. Different types of paper bags specially manufactured for fruit bagging (from two manufacturers in Japan and one in Spain) were tested on 'Encore' peaches in two years. Peach size and mass were unaffected by bagging treatments. Fruit skin color was markedly different with hue angle and chroma both significantly different among treatments ($P < 0.0001$ and $P < 0.0001$). Fruit in darker colored bags had less red color and lighter colored bags were similar in appearance to non-bagged fruit. In experiments with 'Fantasia' nectarine no significant differences among bagging treatments were detected in total soluble solids ($P = 0.4721$) and total titratable acids ($P = 0.7885$). Bagging is labor intensive, but appears to provide significant pest protection with no adverse effects on fruit quality. More importantly this technique could allow growers in the east to market new, unique, high value produce to consumers.

(306) Effect of Nitrogen Rates on Bud Distribution in Subtropical Peaches

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Subtropical peach production in Florida is increasing as growers seek to diversify their farms to spread financial risk. Growers in Florida have taken advantage of an unique marketing window (April–May) to be the first domestic supplier of peaches to consumers. Many growers have had to adapt nitrogen fertilizer recommendations from temperate or Mediterranean climates to that of a subtropical climate and may be over- or under-fertilizing trees. An initial grower survey indicated that annual nitrogen application rates range from 112 to 224 kg/ha. At least two commonly grown commercial peach varieties produce large numbers of blind nodes, often exacerbated by high nitrogen applications and warm temperatures. In addition, high nitrogen rates have previously been shown to increase vegetative growth, leading to increased shading and decreased fruit quality. The narrow marketing window requires that subtropical peach producers optimize production methods to ensure high quality fruit. This research was initiated to examine four different rates of nitrogen (44.8, 89.6, 179.3, and 269 kg/ha) in addition to a control (0 kg/ha) to examine the impact on vegetative growth, leaf nitrogen content, and bud distribution in mature 'TropicBeauty' peach trees. Phosphorus and potassium were applied separately to all trees at an annual rate of 33.6 kg/ha, in addition to foliar micronutrient sprays throughout the season. The experiment was set up using a completely randomized design with single tree replicates (N=6). Vegetative growth was collected using annual pruning weights, while bud distribution (live/dead flower, live/dead vegetative buds, and blind nodes) was collected from one-year-old branches. Imposition of nitrogen rate treatments resulted in significant alterations in bud distribution, with an overall reduction in blind nodes (44 nodes/branch to 19 nodes/branch). Flower buds were greatest (9.9 buds/branch) in the highest nitrogen rate treatment (269 kg/ha), while vegetative buds were the greatest in the control (4.3 buds/branch) and in the highest nitrogen rate. Increased vegetative buds did not translate to significantly higher pruning weights; however an increasing trend was observed with the highest N rate. Despite increased numbers of flower and vegetative buds in the control (0 kg/ha), leaf nitrogen rates reflected excessive concentrations (4.3%), leading to the possibility that growers in subtropical climates may be over fertilizing.

Specified Source(s) of Funding: USDA Specialty Crop Block Grant- Florida

(307) Effects of Nitrogen Control by Soil Injection of Ethyl Alcohol on Freezing Injury and Starch Content in Peach Tree

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The objective of this study was to find out increase of starch with nitrogen control for reducing freezing injury by soil injection of ethyl alcohol as a carbon source. The tested variety was 'Kawanakajima Hakuto', which was a one-year-old tree. Twenty-fold diluted solution 1 μ¤ of ethyl alcohol (95%) per a

tree was injected into rooting zone at 7 Aug. 2011. Fertilizer was applied with the recommended application of fertilizer based on soil testing and 25% added amount that of fertilizer N. Nitrate content of soil and leaf severly got lower than non-treatment no later than 5 days after injecting ethyl alcohol. Lower nitrate contents of soil and leaf lasted for 20 days with the recommended application of fertilizer based on soil testing and for 15 days with the 25% added amount that of fertilizer N. Similarly, foliar nitrogen content was lower soil injection of ethyl alcohol than non-treatment for 10 to 30 days after injecting of ethyl alcohol regardless of nitrogen fertilization level. On the contrary, foliar starch content was higher soil injection of ethyl alcohol than non-treatment for 10 to 30 days after injecting of ethyl alcohol. The average freezing injury level of flower bud was 11.0% with the soil injection of ethyl alcohol, but that was 26.0% in case of non-treatment, where the minimum air temperature of early February was below –23 °C for 2 days. In conclusion, it was possible that the soil injection of ethyl alcohol reduced freezing injury according to increasing starch as a result of reducing nitrogen.

Specified Source(s) of Funding: Cooperative research program for agriculture science and technology development(Project No. PJ907104032012) of Rural Development Administration, Republic of Korea

(308) Occurrence of *Phyllosticta* Fungal Fruit Spot and Fruit Cracking in Pawpaw (*Asimina triloba*)

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A leaf and fruit fungal spot has been observed in pawpaw consisting of a complex of *Mycocentrospora asiminae*, *Rhopaloconidium asiminae* Ellis and Morg., and *Phyllosticta asiminae* Ellis and Kellerm. Symptoms include tan spots with dark brown borders on leaves, and dark brown to black superficial spots on the fruit epidermis. Leaves displaying these symptoms were collected from plantings at the Kentucky State University Research Farm and positively identified as *Phyllosticta* leaf spot by the University of Kentucky Plant Diagnostic Lab. Cracking is occasionally observed on pawpaw fruit. It was hypothesized that there may be a correlation between incidence of *Phyllosticta* fruit spot on pawpaw and fruit cracking, due to epidermal damage by the fungus. The objective of this study was to determine if *Phyllosticta* fruit spot and cracking incidence varied by cultivar, and if there was any correlation between fruit spot occurrence and fruit cracking. Ripe fruit were harvested three times per week from a mature pawpaw planting consisting of two pawpaw cultivars ('Sunflower' and 'Susquehanna') grafted onto seedling rootstock. Percent coverage by *Phyllosticta* fruit spot was visually estimated, and fruit cracking was evaluated for each fruit harvested. In 2010, a positive correlation was found between cracking and *Phyllosticta* coverage. However, in 2011, no correlation was seen. 'Susquehanna' fruit exhibited more cracking than 'Sunflower' in 2010. 'Susquehanna' also had a larger fruit size than 'Sunflower', which could lead to greater tendency to crack. Other factors could also be related to fruit cracking, such as firmness and thickness of the epidermis. 'Sunflower' was found to have greater *Phyllosticta* fruit spot damage in 2010, but not 2011. Future studies are needed to determine the relationship between *Phyllosticta* fungal fruit spot and fruit cracking in pawpaw, and to determine varietal resistance to this fungus and possible control measures.

Specified Source(s) of Funding: Capacity Building Grant

(309) Processed Pulp Recovery Rate in Three North American Pawpaw Cultivars after Periods of Drought or High Rainfall during the Growing Season

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The North American pawpaw (*Asimina triloba*) is the largest tree fruit native to the United States and is in the early stages of commercial production. The pawpaw fruit has a creamy yellow-orange flesh and a flavor resembling a blend of mango, banana, and pineapple. The fruit has a short shelf-life and difficulty with postharvest handling and storage presents an impediment to further commercial development. Production of frozen pawpaw fruit pulp as a value-added product would be one solution to this problem of fruit perishability. However, pawpaw fruit pulp extraction is labor intensive and rows of large inedible seeds contained in the fruit impede processing, and valuable pulp may be lost through ineffective extraction methods. The objective of this study was to determine 1) the processed pulp recovery rate of three pawpaw cultivars, and 2) if year to year climatic conditions influence pulp recovery rate. Three sets of five ripe fruit each of three commonly available pawpaw cultivars ('Mitchell', 'Sunflower', and 'Susquehanna') were selected. These cultivars were selected based on varietal fruit size, with 'Mitchell' being a small fruited cultivar, and texture differences that were previously observed; 'Susquehanna' tends to have a firm flesh. The fruit were cut in half and pulp and seed were scooped out with a spoon and placed in a modified Roma Sauce Maker and Food Strainer with a shortened grape spiral and a squash/pumpkin screen. This device separates seeds from pulp and macerates the pulp. The pulp/seed mixture was run through the strainer 3 times to obtain as much processed pulp as possible. In 2010, when the total rainfall was 4 inches below normal, processed pulp recovery rate varied significantly among cultivars, with 'Susquehanna' (44%) and 'Sunflower' (41%) having a greater percentage of pulp recovered from fruit compared to 'Mitchell'

(24%). In 2011, when the total rainfall was 22 inches above normal, processed pulp recovery rate also varied significantly among cultivars, with 'Susquehanna' (49%) and 'Sunflower' (44%) having a greater percentage of pulp recovered from fruit compared to 'Mitchell' (28%). 'Mitchell' fruit also had over twice the percent seed compared to the other cultivars. There was a trend for fruit grown under high rainfall conditions in 2011 to have a higher pulp recovery rate. With large fruit weights and a high rate of processed pulp recovery, which enables more efficient processing, the cultivars 'Susquehanna' and 'Sunflower' are good choices for pawpaw growers and processors.

Specified Source(s) of Funding: 1890s USDA Capacity Building Grant

(310) Jujube Flowering and Pollen Germination

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Jujubes, also called Chinese dates, are native to China and have been cultivated in China for more than 4000 years. Jujubes have small, fragrant, and greenish-yellow colored flowers. As the deciduous fruiting branches (branchlets) grow, single flower or flower clusters start to initiate at the leaf axils. Unlike other tree fruit species, jujube completes its flower bud initiation, blooming, fruit setting, and fruit maturation all within one growing season. Fifty-two jujube cultivars were observed for their blooming type at the NMSU Alcalde Center; in addition, several cultivars were also examined for their pollen release and pollen germination. Among the 52 observed cultivars, 21 cultivars are morning-blooming type with flower buds slitting around 9:00–10:00 AM. The remaining 31 cultivars are afternoon-blooming type with flower buds slitting around 2:00–4:00 PM. The pollen release period for the morning-blooming type is 10:00 AM–2:00 PM, while for the afternoon blooming type it is from 3:00–4:00 PM of the same day to 10:00 AM of the next day. There were very limited pollens left in the anther after 4:00 PM of the same day for the morning type and after 12:00 PM of the next day for the afternoon type. The pollen germination rates ranged from 0% to 68% depending on the cultivar and sampling time. In general, the afternoon-blooming cultivars had higher pollen germination rate in the morning, while the morning-blooming cultivars had higher pollen germination rate from 11:00 AM–4:00 PM. 'Fitzgerald' (morning-blooming) and 'Sihong' (afternoon-blooming) had the highest pollen germination rates among the 24 cultivars examined. The cultivar 'Sugarcane' had very low pollen germination rate and high aborted pollen rate, which partially contributed to its low fruit set at Alcalde. 'Sherwood' was another cultivar with very low fruit set and its high aborted pollen rate could be one of the reasons for its low fruit set.

(311) Effect of Long Term LED Lighting on the Photosynthesis, Structure of Mesophyll Tissue, and Fruit Quality of 'Fuji'/M.26 Apple Cultivar

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This study was carried out to determine the effects of long term light-emitting diode (LED) lighting on the growth, structure of mesophyll tissue and photosynthesis of 10-year-old 'Fuji'/M.26 apple. LED lighting was provided during the night after sunset for 20 weeks from 10 June to Oct. 2011. Experimental treatments consisted of the control, far-red LEDs (730 nm, 2 and 4 hours) and red LEDs (620 nm, 2 and 4 hours) using 20 LEDs/Printed Circuit Board/tree. Results showed that there was no difference among the treatments on the photosynthesis of the leaf at the 12 July growth stage. However, leaf photosynthesis under the far-red LED treatment was significantly higher than the other treatments at harvest stage on 19 Oct. Also, the mesophyll tissues under the far-red LED lighting appeared loosened compared to the control at the 12 Oct. stage. Regarding fruit quality, soluble solid and acid contents of fruits under the red and far-red LEDs (4 h exposure) were lower than the control.

(312) Pollen Tube Growth Model Improves Apple Bloom Thinning

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In apple (*Malus* ×*domestica* Borkh.) production, crop thinning during bloom produces the largest fruit, the greatest return bloom in the following year, and reduces biennial bearing. The application timing for this spray has been subjective, and, in the past, was usually based upon the percent of full bloom open (e.g., an application at 20% and 80% full bloom). While this approach became a standard practice in some growing regions, more precise application timing can be achieved through modeling the fertilization of the desired percent of king bloom needed to achieve a full crop at the desired fruit size. When this target is achieved, a bloom thinner can be applied so that later blooming flowers are prevented from setting fruit. By measuring pollen tube growth rates under controlled atmospheric conditions using growth chambers, we have developed a model that calculates the time required to fertilize the king bloom after pollination. We have found that cultivar differences and temperatures affect

pollen tube growth and the time required for fertilization, and can offer explanations for inconsistent bloom thinning results. Additionally, we believe that this model has the potential to improve crop load management when using liquid lime sulfur and fish oil for bloom thinning in organic apple orchards. There are a limited number of fruit thinning chemicals approved for use under USDA organic standards, and many organic apple growers rely on a combination of liquid lime sulfur with either fish or stylet oil applied during the bloom period. We are also evaluating these materials for their disease control potential when used for flower thinning. The pollen tube growth model is now being tested for flower thinning on a limited basis in commercial orchards with the goal to assemble specific modeling data for each commercially important apple cultivar.

Specified Source(s) of Funding: Washington State Tree Fruit Research Commission, JMS Flower Farms, Inc., Marrone Bio Innovations, Inc., Miller Chemical and Fertilizer Corp.

(314) Sweet Cherry Floral Organ Size Varies with Genotype and Temperature

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The size of floral organs is important for pollinator attraction in many plants. Filament length in particular plays a role in the efficacy of self-pollination, and style length is a key element of effective pollination period (EPP). As part of a broader effort investigating causes for variable fruit set among sweet cherry genotypes, we studied the role of temperature on floral organs in cultivars exhibiting high fruit set ('Sweetheart' and 'Rainier') and low fruit set ('Benton' and 'Tieton'). Two-year-old limbs were collected at 'tight cluster' flower stage and distributed randomly among three controlled environment chambers programmed to mimic high, moderate and low field temperatures according to climate data from the past 20 years. Entire flowers were sampled and dissected at "tight cluster", "first white," "half white', "first open," and "full open" stages. The areas of individual sepals and petals was determined by scanning and image analysis using MATLAB. The dimensions of filaments, styles, pedicels and ovaries, were assessed by digital calipers. We found no relation between perianth organ size and cultivar productivity. 'Tieton' floral organs were significantly larger than other cultivars with the exception of the length of the filament, style, and pedicel. Interestingly, stylar length was not significantly different among cultivars nor influenced by temperature. This indicates that pollen tube growth and/or ovule viability may be more important in determining EPP. Across all cultivars, style length increased linearly from "tight cluster" to "full open" by ≈90%. Only filament and pedicel length were influenced by temperature – both being shorter under cold conditions. Pedicel length was about 15% shorter comparing high and low temperature regimes and increased by 71% between "tight cluster" and "full open." Filament length increased linearly throughout sampling stages, increasing by ≈3.5-fold between the earliest and latest stages.

Specified Source(s) of Funding: Washington Tree Fruit Research Commission and WSU Agricultural Research Center

Tuesday, July 31, 2012 Grand Ballroom

Tropical Horticultural Crops

(345) Chlorophyll *a*+*b* Content and Chlorophyll Fluorescence in Avocado

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One 'Tonnage' (T) and one 'Simmonds' (S) avocado (*Persea americana* Mill.) tree and four T × S crosses were evaluated for differences in chlorophyll content and maximal quantum yield of photosystem II in sun and shade-type leaves. Total chlorophyll content by area (Chl $a+b_{ar}$) ranged from 984 mg·m^{-2} in T×S240 to 4320 mg·m^{-2} in 'Simmonds'. Chlorophyll *a*/*b* ratio (Chl *a*/*b*) ranged from 9.8 to 5.5 in T×S238 and T×S243, respectively. 'Tonnage' and 'Simmonds' had similar Chl *a*/*b* with a wide range in values found among the avocado trees tested. Shade leaves contained more Chl *a*, Chl *b* and Chl $a+b_{wt}$ than sun leaves. Differences in Chl *a*/*b* were insignificant or greater in shade adapted leaves for all trees except T×S238; this did not follow the expected sun/shade pattern. A low chlorophyll *a*/*b* ratio indicates more light harvesting proteins and higher stacking of thylakoids. Chl $a+b_{ar}$ indicates 'Simmonds', 'Tonnage', and to a lesser extent T×S238 had dense packing of chloroplasts in both sun and shade adapted leaves. Shade leaves had more efficient Fv/Fm values than those adapted to sun for all varieties except T×S240. 'Tonnage' had the largest range of total chlorophyll content between shade and sun adapted leaves and likely has the largest genetic variation in its ability to acclimate to changing light intensities. The range in efficiency of photosystem 11 found between the avocado trees tested indicates a potential for improvements through selective breeding. More research is needed to evaluate the entire USDA avocado germplasm collection for traits associ-

ated with photosynthetic efficiency and to determine their heritability.

(346) Fruit Quality Traits and Yield of Six Lychee Cultivars Grown at Two Locations in Puerto Rico

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Six lychee (*Litchee chinensis*) cultivars grown on an Inceptisol soil were evaluated for 4 and 7 years under intensive management in separate experiments at two locations (La Balear farm and UPR–Adjuntas) in Adjuntas, PR, respectively. There were significant differences in number of marketable fruits per hectare among cultivars at both locations but weight of marketable fruit per hectare was significant at La Balear farm only. At La Balear farm, cultivars Kaimana, Bosworth-3, and Groff had significantly higher number of marketable fruits per hectare, averaging 303,084 fruits per hectare whereas in UPR–Adjuntas, 'Groff' had higher number of fruit per hectare (173,105 fruits/ha) although it was not significantly different than most of the other cultivars which averaged 123,998 fruits per hectare. There were no significant differences among cultivars in weight of marketable fruits per hectare at UPR–Adjuntas, averaging 1,930 kg/ha, whereas 'Kaimana' had significantly higher marketable fruit weight (6,910 kg/ha) at La Balear farm. At both locations, 'Salathiel' showed lower number and weight of marketable fruits per hectare. Higher °Brix (sweetness) values were obtained from fruits of 'Kaimana', 'Bosworth-3', and 'Groff' at both locations whereas lower °Brix values were obtained in 'Mauritius', 'Brewster', and 'Salathiel'.

(347) Growth and Yield Response of Eight Hot Pepper Varieties in the U.S. Virgin Islands

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Hot peppers (*Capsicum chinense* L.) are important cash crop for small scale producers in the United States Virgin Islands and are grown mainly for fresh market. Challenges in hot pepper productions in the U.S. Virgin Islands are, high cost of labor and management, limited water resources, weeds, diseases and pests, limited land and natural disasters. This study was conducted at the horticultural field plots of the University of the Virgin Islands Agricultural Experiment Station. The objective of the research was to conduct field evaluations of hot pepper varieties that are suitable to grow in the local soil and climatic conditions of the islands. Eight varieties, 'Ring of Fire', 'White King', 'Compadre', 'Camino Real', 'Jalapeno M', 'Caribbean Red', 'Hungarian Yellow Hot Wax', and 'Aguila Real' were tested in the field. Varieties selected with the cayenne (long and thin) type, bell shape fruits as well as round and wrinkled used as seasoning peppers. Transplants of all eight varieties were planted on 10 Oct. 2011 into rows 120 cm apart. Spacing was 60 cm within row. The trial was laid out by using a randomized complete block design with three replications and fields were irrigated with drip irrigation. Six harvests were conducted during the crop cycle. Data were collected on plant growth, tolerance to insect pests and diseases, marketable fruits, fruit weight, and marketable yield. Fruits were graded by size and condition as per U.S. Department of Agriculture's grading system. Results of Scoville heat unit test (pungency) showed that 'Caribbean Red' is the hottest pepper among all the eight varieties tested. 'White King' was mildest pepper. No serious pests and diseases were observed in the crop. All eight varieties did set fruits during the season and were rated good or excellent in disease tolerance, yield, taste, and adaptability. Frequent rainfall during the late growing and harvest period affected quality production at some extent. Results of variety trials conducted on eight pepper varieties are discussed.

Specified Source(s) of Funding: USDA–NIFA (Hatch)

(348) Using an Organic Biostimulant to Accelerate Growth of Breadfruit Plants for Rootstock

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Biostimulant based on alga extracts have been reported to accelerate in-nursery growth of citrus, avocado, and other fruit crop species grown for transplants. There are no reports of the effect of biostimulants based on marine alga extracts on breadfruit (*Artocarpus altilis*) seedlings. The objective of this research was to determine the effects of rates of an extract of the marine alga *Ascophyllum nodosum* on breadfruit seedlings grown for rootstock. The experiments were conducted in Mayaguez, Puerto Rico, in 2011 and 2012. The biostimulant used was a formulation of an *Ascophyllum nodosum* extract approved for organic systems (Stimplex™). Seedlings 12-cm tall, growing in 2-L polyethylene bags in a substrate of alluvial soil and compost, were sprayed to run-off every 2 weeks with aqueous solutions of the biostimulant at rates 0 (check), 1.0, 2.5, 5.0, and 10.0 mL/L. A completely randomized design with 10 replications was used. The plants were managed organically. During 3 months, seedling height and stem diameter at 10 cm above the ground were measured every 15 days. Chlorophyll concentration in the most recent fully-expanded leaves was measured monthly using a SPAD meter. Results were submitted to regression analysis. Plant growth and chlorophyll concentration in expanded leaves were affected by biostimulant rate. The highest values for seedling height and stem diameter were found when using the biostimulant rates of 2.5 to 5.0 mL/L, whereas chlorophyll concentration in expanded leaves was highest at the biostimulant rates of 5.0 to 10.0 mL/L. The results of this research indicate that growth of breadfruit plants for rootstock may be accelerated using *Ascophyllum nodosum* extracts.

(349) Characteristics of Sorrel Parents, F_1 and F_2 Generations

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Sorrel, *Hibiscus sabdariffa* also known as Jamaican sorrel or roselle, develops a bright calyx of petals with an acidic flavor. Sorrel is used to make juice, punch, wines, or a variety of delicacies such as jams and chutney. It is harvested mostly during the Christmas season and is part of most of the islands' traditions. The purpose of this experiment is to evaluate characteristics of parental, F_1 and F_2 generations of sorrel from selected crosses. The developmental characteristics of F_1 and F_2 generations of sorrel were compared to their parents in regard to plant height, number of branches, and floral induction on a bimonthly basis. Three sorrel varieties were used in this experiment included a day neutral variety from St. Kitts (KDN), 268100 from Nigeria (100) and a local white variety from St. Croix (W). Three hybrids were used in this experiment were KDN × 100, 100 × KDN and W × 100. A 100 × KDN also had an F_2 generation. This experiment has far-reaching agricultural implications because it was found that all hybrids with the parental 100 and KDN grew faster. It was also found that the white variety took the longest to initiate floral buds. The F_1 generations kept the characteristics of the parents with regard to height, leaf shape and flowering time. However, the F_2 generation had characteristics of both parents.

Specified Source(s) of Funding: VI Dept. of Agriculture Specialty Crops Block Grant and USDA–NIFA–Resident Instruction in Insular Areas

(350) A Sorrel Wilt Disease Affecting the U.S. Virgin Islands

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Sorrel (*Hibiscus sabdariffa* var. *sabdariffa* L.), also known as "roselle," "Jamaican sorrel," or "Florida cranberry," is an annual plant belonging to the family Malvaceae. It is cultivated in tropical and subtropical regions for stem fibers, paper pulp or edible calyces, leaves and seeds. Sorrel is an important crop in the Caribbean and South Florida, where traditionally the fleshy calyces are used for the preparation of a drink during the Christmas season. Dried calyces are exported from the Caribbean to West Indian communities in the U.K. and North America. Sorrel is grown as a fall and winter season crop because most lines are photoperiodic and induce flowers in October. Over the past couple of years, several sorrel producers on the island of St. Croix have reported a high mortality of plants in their fields. Plants wilted at any point during growth and production. Internally, conspicuous vascular discoloration was evident in these plants from the roots into the canopy. Surface-disinfested 5-mm^2 infected sorrel pieces of vascular tissue plated on one-half-strength potato dextrose agar (PDA), produced salmon-colored fungal colonies. On banana leaf agar, single-spored strains produced the following microscopic characters of *Fusarium oxysporum*: copious microconidia on monophialides, infrequent falcate macroconidia and terminal and intercalary chlamydospores. Sorrel seedlings were inoculated with isolates recovered from diseased plants by placing a mycelial plug (5 mm^2, PDA) over a small incision 5 cm above the soil line and then covering the site with Parafilm. Parafilm was removed after 1 week and plants were incubated under ambient temperatures (20 to 32 °C) in full sun for an additional 5 weeks (experiment 1) or 7 weeks (experiment 2). Compared with mock-inoculated (wound + Parafilm) control plants. In addition, the DNA of *Fusarium oxysporum* isolates collected from diseased sorrel samples in St. Croix is currently in storage. The next step will be to generate partial, elongation factor 1-α (EF1-α) sequences and compare with those previously reported for this gene.

Specified Source(s) of Funding: USDA–TSTAR

(351) Early Detection and Suppression of Laurel Wilt, Caused by *Raffaelea lauricola*, in the Primary Commercial Avocado Production Area in Florida

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Native and non-native trees in the Lauracae, including the commercially important avocado (*Persea americana* Mill.) are threatened by laurel wilt (LW), caused by the fungus *Raffaelea lauricola*. The redbay ambrosia beetle, *Xyloborus glabratus* (RAB) is the primary vector of *R. lauricola*. During 2002 this exotic beetle was introduced into Port Wentworth, GA, perhaps via infested solid wood packing material. Since then, LW has spread by the natural dissemination of the vector and anthropogenic movement of infested wood throughout the southeastern U.S. (Georgia, South and North Carolina, Florida, and Mississippi), eliminating redbay (*P. borbonia*), swampbay (*P. palustris*) and other native members of this family. Research has shown that avocado trees are susceptible to attack by the RAB and susceptible to LW. In Jan. 2010, the RAB was detected approximately 16 km from the edge of Florida's primary commercial avocado production area in southeastern Miami–Dade County, and in Feb. 2011, LW was confirmed in dying swampbay trees in the same area. Swampbay trees continue to die in the area, recently within 7 km of the closest commercial avocado orchard. Despite intensive research since 2006, no economically viable chemical control measures have been found to combat LW. Thus, detection and immediate suppression of outbreaks of LW within the

avocado production area is viewed as the most appropriate LW management strategy. Populations of RAB decrease dramatically as populations of host trees are eliminated by LW; therefore, as swampbay is eliminated in Miami–Dade County, disease pressure and vector density would be reduced. To assess the distribution and spread of LW in Miami–Dade County, helicopter surveys are currently conducted in a 389 km^2 area that includes 2,914 ha of commercial avocado production. During these surveys, a hand-held GPS unit is used to locate with long and latitude coordinates of avocado trees with LW symptoms (i.e., wilting, desiccation, and dieback). With locations that are plotted on Google Earth® suspect trees are ground-truthed with subsequent diagnostic assays for *R. lauricola*; positive trees or parts thereof are then removed, chipped or otherwise destroyed. To date, one complete aerial survey of the industry has identified 65 suspect trees, none of which have tested positive for *R. lauricola*.

Specified Source(s) of Funding: USDA–SCRI

(352) Nitrogen Fertilization Guidelines for Non-bearing 'Medjool' Date Palms

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The 60-year-old date palm industry in the Southwest Arizona region has been established with the 'Medjool' cultivar rather than the traditional 'Deglet Noor' cultivar. Palms are increasingly irrigated using low-volume irrigation rather than border flood method, and many new trees are planted in sandy soil rather than in silty loam soil. There are no recommended nitrogen fertilization guidelines for non-bearing 'Medjool' dates. In a 30-month study, we fertilized 1- to 3-year-old palms with annual N rates ranging from 0.1 to 1.6 kg/tree for the first year, increasing to 0.3 to 2.94 kg/tree for the third year. We also provided 4- to 6-year-old non-bearing palms with constant annual N rates ranging from 0.4 to 3.6 kg/tree. For the 1- to 3-year-old palms on drip irrigation on sandy soil, initial rates of 0.4 kg increasing to 1.46 kg led to a final growth rate of about 6 cm/month, while the trees provided with 0.1 kg N in year one and increasing to 0.3 kg N in the third year grew had a final growth rate of only 5 cm/month. For 4- to 6-year-old trees on the same soil and irrigation regime, an annual N rate of 1.2 kg/tree led to a final growth rate of at least 5.5 cm/month, and application of 3.6 kg N led to a 6.6 cm/month growth rate, compared with only 5.25 cm/month growth rate for the palms supplied with 0.4 kg N annually. For 1- to 3-year-old palms irrigated using border flood and planted in silty loam soil, initial N rates of 0.8 kg increasing to 2.13 kg in the third year led to an final growth rate of about 7.5 cm/month, while the trees provided with 0.1 kg N in year one and increasing to 0.3 kg N in year three had a final growth rate of only 6.5 cm/month. For 4- to 6-year-old trees on the same silty loam soil and flood irrigation regime, an annual N rate of 1.2 kg N led to a growth rate of as much as 10.2 cm/month, compared with only 8.6 cm growth per month for the palms supplied with 0.4 kg N annually. Leaf N concentrations generally reflected growth rates. This work will help to provide 'Medjool' date palm growers with accurate guidelines for N fertilization of non-bearing date palms.

Specified Source(s) of Funding: Specialty Crop Block Grant through the Arizona Department of Agriculture

Tuesday, July 31, 2012 Grand Ballroom

Vegetable Crops Management 1

(323) Pennsylvania Statewide Cultivar Evaluation Program

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Cultivar selection influences all other production practices. Numerous options are available and it is not uncommon for a cultivar to perform well in one region or state and poorly in another. This can make selection time-consuming and leave growers unsure about how new cultivars will perform on their farms. A team of seven Penn State Extension educators and specialists developed a statewide coordinated cultivar program to help commercial vegetable growers make informed managerial decisions on cultivar choice. We successfully applied for 10 years of funding, with annual renewal, from the Pennsylvania Vegetable Research and Marketing Board to conduct simultaneous evaluations in three locations across the state to capture its environmental diversity. The program was grower driven, using surveys to first identify the need and now to determine the crop evaluated. We also consulted with industry personnel to gauge emerging cultivars with potential for success in Pennsylvania environmental conditions. The decision was made to conduct the evaluation on each individual crop for 2 years to account for year-to-year environmental conditions. Sixteen cultivars of green bell peppers (*Capsicum annuum*) were evaluated on the basis of yield in three locations across Pennsylvania during the growing seasons of 2008–09. This was followed by the evaluation of 26 cultivars of acorn, butternut and buttercup/kabocha winter squash (*Cucurbita* spp.) in 2010–11. Beginning in 2012, 24 cultivars of sweet corn (*Zea mays*) will be evaluated. Results from individual locations were used in establishing regionally appropriate recommendations. This approach also allowed development of statewide recommendations by determining which cultivars performed well across the evaluation sites. Recommendations were disseminated through various extension channels including publications and presentations at local and regional meetings and through webinars. Manuscripts based on our efforts have been submitted to refereed journals and to date one has been published and another is in development.

Specified Source(s) of Funding: Pennsylvania Vegetable Growers Association

(324) Eastern Broccoli Supply Chain Model

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Broccoli is a major specialty crop in the United States with a farm-gate value of over $700,000,000. Rise of transportation costs and interest in local and regional food has led to efforts in the eastern U.S. aiming at insuring a reliable, year-round supply of eastern-grown broccoli that will be welcomed in East Coast markets. We collected data on fresh broccoli acreage, yields, production, and transportation costs from emerging broccoli-producing region in the East Coast (Maine, New York, Pennsylvania, Virginia, North Carolina, South Carolina, Georgia, and Florida) and the mainstream producing regions of California and Arizona. Wherever data were not available, we visited growers and packer/shippers to complement it. We develop a mathematical programming model of the Eastern broccoli distribution system to examine optimal production sites and flows for broccoli grown in the East. The optimization model inputs are: seasonal supply in the aforementioned producing regions, demand in Eastern metropolitan areas and production and transportation costs. Given these inputs, the model minimizes the total costs of producing and transporting broccoli from supply sites to markets and solves for cost-effective seasonal product flows. We use the model to simulate the impact of increased localization on relative total costs. Preliminary analyses suggest that reducing the total miles travelled by broccoli (localization) by 20% increase supply chain costs by a modest 0.11%, with the highest increase occurring in the winter and the lowest in the summer. Localizing any further is feasible only if current Eastern production levels double. These relatively small increases in total costs contrast with large changes in the marginal values that are significant and varying by season and space. The increases in the value of a box of broccoli due to 20% localization vary from $0.18 to $4.77 (which is often more than 15% of the retail price). The largest increases in broccoli marginal values are found during off-production seasons in states that are farthest from the regions that are in production (e.g., Maine in the winter and spring seasons). Our results do not suggest that the retail prices of fresh broccoli would increase by those exact amounts. Instead, they serve to identify the broccoli-producing regions and the seasons where the marginal values are the most sensitive to increased localization.

(325) Impact of Legume Cover Crop, Tillage, and Inorganic Nitrogen Across Two Years on Leaf Area Index and Above Ground Biomass Yields of Two Sweet Corn Cultivars

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The purpose of this 2-year study was to evaluate how a legume cover crop and inorganic nitrogen rates influence above ground biomass (AGB) yields and leaf area index (LAI) of sweet corn cultivars Silver Queen (C1) and Silver King (C2). The cover crop (crimson clover=CC), nitrogen rates (no=0N, and half=HN) and cultivar treatments were applied using randomized complete-block design with three replications as follows: 1) CC-0N-C1, 2) CC-0N-C2, 3) CC-HN-C1, and 4) CC-HN-C2. In Spring of 2010 and 2011, sweet corn seeds were strip till field planted. In both years, AGB was collected approximately 3 weeks prior to harvest while LAI was recorded during vegetative stage (4 June 10 and 6 June 2011), and 4 to 7 days from sweet corn harvest (21 June 2010 and 27 June 2011). Treatment CC-0N-C1produced highest LAI the week of harvest (3.67), while lowest LAI (1.45) was produced by CC-0N-C2 at the vegetative stage in 2010. Maximum AGB fresh (42.3 Mg/ha) and dry weight (5.2 Mg/ha) yields were produced by CC-HN-C1 and CC-0N-C1in 2011, respectively. Minimum AGB fresh (27.6 Mg/ha) and dry weight (3.4 Mg/ha) yields were produced by CC-HN-C2 in 2011. These results indicate that plant biomass and LAI of cv. Silver Queen performed similarly under zero nitrogen or half nitrogen when planted on land where crimson clover is grown and then strip tilled. In general, results from this 2-year study showed differences between the sweet corn cultivars for LAI and AGB fresh and dry yields with Silver Queen performing better.

(326) The Effects of Tillage, Legume Cover Crop, and Synthetic Nitrogen on Yield Response and Water Use of Two Sweet Corn Cultivars over Two Years

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In 2010 and 2011, a study was conducted to compare how a legume cover crop and nitrogen fertilization rates would impact sweet corn cultivars (Silver Queen = C1 and Silver King = C2) marketable fresh yield and water use (WU). The following cover crop (crimson clover, CC), nitrogen rates (no = 0N and half = HN), and cultivar treatments were applied using randomized complete-block design with the following replications: 1) CC-0N-C1; 2) CC-0N-C2; 3) CC-HN-C1; and 4) CC-HN-C2. In spring of both years, the crimson clover was strip tilled and seeds of C1 and C2 cultivars were field planted. Cultivars Silver Queen and Silver King were harvested approximately 74 days after planting. Each year three bi-weekly (vegetative = 3 June 2010 and 24 May 2011, tasseling = 16 June 2010 and 14 June 2011, and mature ear = 30 June 2010 and 2011) volumetric soil water percentages were measured at a depth of 0–30 cm. Treatment CC-HN-C2 produced maximum fresh market yield (15.4 Mg/ha) in 2011, but not statistically greater than CC-0N-C2 (14.5 Mg/ha) in 2010. Minimum yield (10.3 Mg/ha) was produced by CC-0N-C1 in 2010. Between both cultivars over all dates and years, WU was highest and lowest in 2011 for 'Silver Queen' grown in CC-0N and CC-HN, respectively. Results over both years demonstrated that 'Silver

King' grown in strip till crimson clover at half nitrogen had highest yield and fourth lowest water use while 'Silver Queen' in CC-0N had lowest yield and second highest WU. These 2 years of results indicate that 'Silver King' generally performed similarly at HN or 0Nwhen grown in strip till crimson clover compared to other treatments.

(327) Estimation of Chinese Cabbage Yield as Affected by Planting Date and Nitrogen Fertilization for Spring Production

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The average annual and winter ambient air temperatures in Korea have risen by 0.7 °C and 1.4 °C, respectively, during the last 30 years. The continuous rise in temperature presents a challenge in growing certain horticultural crops. Chinese cabbage and radish, two important cool season crops, may well be used as a model to study the influence of climate change on plant growth, because they are more adversely affected by elevated temperatures than warm season crops. This study examined the influence of transplanting time, nitrogen fertilizer level, and climate parameters [including air temperature, radiation intensity, and growing degree days (GDD)] on the performance of a Chinese cabbage cultivar (Chunkwang) during the spring growing season to estimate crop yield under unfavorable environmental conditions. In our study, plant dry weight was higher when the seedlings were transplanted on 15 Apr. (168 g) than on 22 Apr. (139 g). There was no significant difference in the yield when plants were grown with different levels of nitrogen fertilizer. The values of correlation coefficient (R^2) between GDD and leaf number and between GDD and dry weight of the above-ground plant parts were 0.9818 and 0.9818, respectively. Nitrogen fertilizer did not provide a good correlation with the plant growth. Results of this study suggest that the GDD values can be used as a good indicator in predicting the above-ground biomass yield of Chinese cabbage.

(328) The Organic Liquid Manure with Agricultural By-products for Tomato in Fertigated Cultivation and Manufacturing Method of the Same

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This study was carried out to investigate the effects of different organic liquid fertilizer(OLF) for fertigation on growth and fruit quality of tomato in Korea. OLF fermented from 22 Jan. to 16 Apr. at plastic house in 2009. Treatments was given with soybean meal+poultry manure (1:1, w/w), poultry manure+rice bran (1:1, w/w), soybean meal+rice bran (SM+RB, 1:1, w/w), and chemicals (control). We fertigated low concentration about 5% of OLF every week from 2 weeks after planting in 2010. The obtained results from this study were summarized as follows; The redness of hunter's color value was high in OLF treatments. The soluble solids content was in chemicals as 6.3 °Brix and in OLF treatments as 5.9 to 6.4 °Brix. The appearance rate of fruit blossom-end rot was high in control as 20% and that of OLF treatments was low as 4.7% to 7.0%. The fruit yield increased in OLF treatments 13% to 38% compare to control. The portion of over 150 g per fruit was high in OLFs as 70.5% to 72.3% but that of control was 66.7%.

(329) Cover Cropping Strategies for Year-round Weed Control on Mixed Vegetable Farms in Southern New England

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Fall planted winter rye is a common cover crop for southern New England vegetable farmers. In spring the winter rye is plowed under and conventional tillage is used to control weeds. These practices can lead to increased labor and fuel costs and can also degrade soil quality. In an ongoing 3-year experiment, we are investigating how a conventional rye cover crop affects vegetable yield, nutrient cycling, and weed density in mixed vegetable systems. We are comparing three alternate cover crop and tillage treatments to the conventional method. One treatment uses beds of fall planted winter rye that are rolled and crimped in the spring; the rolled and crimped rye formed a mulch layer intended to suppress weeds. A second treatment uses perennial rye and dwarf white clover as living mulch between raised beds. The last treatment, crimson clover, is tilled only in the spring and

the clover is seeded after vegetables are established. The four treatments were assigned to 10 × 50 m plots, and each treatment is replicated three times. Tomatoes, cucumbers/melons, salad/carrots, and cabbage are planted in each treatment. Marketable and nonmarketable yield is recorded for each crop. Soil quality is evaluated biweekly through the growing season using Solvita soil respiration kit. Each spring, samples are also collected for Cornell's soil health assessment test. Weed densities were recorded four times during the season. A 0.5-m grid transect was used to tally presence and absence of seven agriculture weeds in each plot. No herbicides were used in our study. We hypothesized these three treatments could maintain vegetable yield while increasing soil quality and decreasing weed density. The roller crimper winter rye treatment was ineffective at preventing weeds and failed to produce a marketable yield for any crop. Other treatment effects on yield are crop specific. While the crimson clover/no till treatment showed increased tomato yield, cabbage yield was higher in the conventional treatment. Melon and cucumber yields showed no difference between the crimson clover, conventional, and perennial rye and dwarf white clover treatments. Weed densities were lower in the conventional treatments. Weeds had a large effect on cabbage, leading to small heads and low yields. Repeated measures analysis of the Solvita soil test shows no difference between the treatments.

Specified Source(s) of Funding: Northeast SARE

(330) Using Compost to Feed the Soil Community and Meet the Nutrient Requirements of Sweet Corn; Is It Realistic?

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This study evaluated two composts, leaf and yard waste (LY) and biosolids (BS) as soil amendments at three application rates on sweet corn production in an Agawam fine sandy loam during the 2010 and 2011 growing seasons. In 2010, 80 lb of P_2O_5 was broadcasted as recommended by soil tests. No additional fertilizer was added in either year. BC 0805 sweet corn (82 days), was planted on 34-inch rows with a plant population of approximately 28,000 plants per acre. Composts were hand applied at the rates of 0, 10, 20, and 40 tons per acre and incorporated with a Perfecta harrow in three replicated plots. A cover crop of oats was planted in Aug. 2010 after harvest over the entire research area. In 2011, each plot was split in half. One-half received the same treatment as in 2010. The second half did not receive any additional compost or fertilizer. Conventional herbicide weed control was implemented each year. Preside-dress Soil Nitrate Test (PSNT) values were used to evaluate the potential soil mineralization rate in both years. In 2010, marketable yields were greater in plots receiving compost compared to the control. BS application rates of 20 and 40 tons/acre produced acceptable yields, 1069 and 1263 dozen per acre, respectively. LY yields were consistently lower then acceptable yield levels of 1000 dozen per acre. All BS treatment yields were significantly higher in 2011 than in 2010. LY compost yields were at or above acceptable yields. The yield increase was greater with multiple compost applications indicating an accumulative effect of compost in soils. Plots with no additional compost applications in 2011 had similar yield and PSNT values as 2010. This indicates that the effects of compost last for at least 2 years and supports the idea that compost has a residual effect on the soil and crop productivity. Compost has a wide diversity of organic matter, from unstable to very stable; therefore mineralization happens over a longer period of time. Compost continued to feed the soil microbial population through year 2. Both types of compost had a positive effect on the yield over a 2-year period and provided some plant available nitrogen in both application years. Yields indicate both a cumulative and residual effect of compost.

(331) Evaluation of Yield and Quality of Cucumber Grown in Low-tech Greenhouse

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In Mexico greenhouse cucumber in low-tech greenhouses is an alternative for small producers whom do not need large investments for crop management. However, temperature and relative humidity must be maintained from 22 °C to 25 °C and 80% to 85%, respectively. Controlling these parameters is the main problem regarding the internal climate of low tech greenhouses. This problem is reflected in the homogeneity of the quality and yield of the cucumber fruits, especially in months with low temperatures. The objective of this work was to evaluate the effect of harvest dates on the homogeneity of quality, and the yield of cucumbers grown in a low-tech greenhouse during the autumn–winter 2010 cycle. Plants of cucumber (*Cucumis sativus* L) cv. Paraiso, were grown in a low-tech greenhouse at the Universidad Politecnica de Guanajuato. The internal relative humidity and temperature were recorded weekly during the cycle of production using thermohigrometers. Cucumber fruits were harvested in 5 different dates from Nov. 2010 to Jan. 2011. The monthly average temperature and relative humidity were lower than the recommended in a range from 2 °C to 5 °C and up to 20%, respectively. The uniformity of fruit quality was assessed by the following parameters: appearance, weight,

length, diameter, color, °Brix, and titratable acidity. The aspect of fruit was acceptable, with no defects caused by pests, stress or mechanical damage. No significative effects were detected from harvest dates on the quality parameters studied, which ensure the crop homogeneity during all production cycle. Yield was 3.5 $kg \cdot m^{-2}$, which is within the range recommended for this crop in Mexico although it is low when compared to 6 $kg \cdot m^{-2}$ recommended worldwide. It was concluded that despite the constraints about controlling the temperature and relative humidity during the management of the greenhouse cucumber in low-tech greenhouses, it is possible to obtain products with quality and yields comparable to those from the fruits obtained in high-tech greenhouses. This provides a crop alternative for small producers, as no high investment or operation costs for the greenhouse cucumber production are required.

Specified Source(s) of Funding: Universidad Politecnica de Guanajuato

(332) Deficit Irrigation Effects on Gas Exchange, Root Growth, and Fruit Yield of Melons

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Cultivar evaluations for drought tolerance and irrigation management are very important in water-limited, arid regions of the United States. This study was conducted to investigate the effect of deficit irrigation (50% vs. 100% crop evapotranspiration, ETc) on three melon (*Cucumis melo* L.) cultivars ('Mission' and 'Da Vinci', *reticulatus* type and 'Super Nectar', *inodorus* type). Overall, deficit irrigation significantly reduced photosynthetic rate (Pn) by 30% and stomatal conductance (gs) by 21%. The highest average Pn (20.53 $\mu mol \cdot m^{-2} \cdot s^{-1}$ of CO_2) and gs (0.31 $mol \cdot m^{-2} \cdot s^{-1}$ of H_2O) were recorded in 'Mission' and 'Super Nectar', respectively. Transpiration rate and leaf water use efficiency were not significantly affected by either irrigation or cultivar. Throughout the development period, physiological traits were affected by cultivar and irrigation regimes. At fruit set Pn and gs were reduced with deficit irrigation in all cultivars but recovered only in 'Da Vinci'. Deficit irrigation significantly enhanced root length density (RLD; $cm \cdot cm^{-3}$) in 'Mission' (120%), decreased RLD in 'Da Vinci' (19%) and did not affect in 'Super Nectar'. Deficit irrigation significantly reduced marketable yield (43%) in 'Super Nectar' but not in 'Mission' and 'Da Vinci'. Thus, 'Super Nectar' (*inodorous* type) appeared to be more sensitive to drought stress, likely through reduction in Pn. 'Da Vinci' and 'Mission' (*reticulatus* type) exhibited some drought tolerance, showing no yield reductions along with improved Pn and RLD, and thus are better choices in water-limited regions.

Specified Source(s) of Funding: TDA–SCBP

(334) Managing Nutrients in Outdoor Floating Hydroponic Systems for Lettuce Production

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The low cost and simple design floating hydroponic systems makes it an attractive and productive system for small farmers who lack greenhouses or other protective structures. However, nutrient management strategies for outdoor floating systems affected by rain events is uncertain. The objectives of this study were to determine optimum nutrient solution concentration and impact of dilution on lettuce production. Nutrient solution treatments were installed in 15-L plastic tanks under greenhouse conditions at two locations in north Florida for production of lettuce (*Lactuca sativa* L. var. 'Green Wave') from transplants. For the first experiment, increasing amounts of NO_3-N (0, 22, 56, 91, 125, 159, 193 $mg \cdot L^{-1}$ of NO_3-N) were supplied by adjusting the amount of fertilizer solution added to a finale solution volume of 12 L. For the second experiment, nutrients were dissolved in equal amounts of water (8 L) to supply 91 $mg \cdot L^{-1}$ of NO_3-N for all treatments. At 14 days after planting, increasing amounts of water (0, 0.96, 1.93, 2.89, 3.86, 4.82, 5.78 L) were added to simulate dilution of hydroponic solution by rainfall (0 to 7.62 cm depth). At 5 weeks after planting, lettuce was harvested, fresh and dry weights determined, and nutrient content measured. Maximum lettuce yield was obtained with NO_3-N concentrations from 91 to 159 $mg \cdot L^{-1}$. Nitrate concentration in lettuce tissue increased and uptake efficiency decreased with increasing N rates. The results suggest 91 $mg \cdot L^{-1}$ of N (726 mg per plant) was optimum for lettuce production. Dilution of nutrient solution with up to 5.78 L (equivalent to a 7.62-cm depth rainfall) did not impact yield, quality, or N uptake efficiency of lettuce. This indicates the amount of N and nutrients in the hydroponic solution could be more useful for management than concentration. Large rain events that dilute nutrient solution without compromising the amount of nutrients available do not require adjustment of hydroponic solution for lettuce production.

Wednesday, August 1, 2012 Grand Ballroom

Crop Physiology

(140) Skin Lignification Is Associated with Resistance to Skinning in Sweetpotato Storage Roots

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Skinning, or surface abrasion in storage roots of sweetpotato [*Ipomoea batatas* (L.) Lam.] at harvest causes substantial losses of marketable products in storage. Since skin lignification is thought to improve skinning resistance, a greenhouse experiment was conducted to test this hypothesis and to investigate how pre-harvest chemical treatments would enhance the phenyl-propanoid pathway to improve skin toughness in sweetpotato. 'Beauregard' (B-14) was grown in pots in the greenhouse for 4 months. Five days before harvest, plants were treated with foliar applications of ethephon, KOH and Diquat, and compared with two controls: devined and untreated. Higher skinning force and skin lignin content were observed in roots from ethephon treated plants. In contrast, skin phenolic content was lower in roots from ethephon treated plants. No difference was shown in cortex and stele phenolics contents among all treatments. No difference was observed in phenylalanine ammonia-lyase (PAL) activity among treatments. In contrast, polyphenol oxidase (PPO) activity in skin and cortex was higher in ethephon treated plants compared to control plants. In addition, the force required to peel the skin was correlated with skin lignin content ($r = 0.55$) and skin PPO activity ($r = 0.52$). Therefore, skin-lignin production appears to contribute to skin set and skinning resistance in sweetpotato. These treatments, however, have little or no effect on the phenyl-propanoid pathway, but ethephon increases skin lignin production and enhances skinning resistance.

(141) Three Plant Growth Regulators Modify Growth and Flowering Responses of *Borrichia frutescens* (L.) DC. Produced in Containers

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Liners of sea marigold, *Borrichia frutescens* (L) DC, were potted into 2.3-L containers filled with pine bark based media and grown in greenhouse conditions. Plants were drenched with five levels of paclobutrazol (0, 5, 10, 20, or 40 mg/pot a.i.) {(±)-(R*,R*)-β-[(4-Chlorophenyl)methyl]-α-(1,1-dimethylethyl)-I*H*-1,2,4-triazole-1-ethanol} or uniconazole (0, 0.5, 1,2, or 4 mg/pot a.i.) [(E)-(p-chlorophenyl)-4,4-dimethyl-2-(1,2,4-triazol-1-yl)-1-penten-3-ol]. In a separate experiment, plants in 2.3-L containers were treated with paclobutrazol (0, 50, 100, 200, or 400 mg·L^{-1} a.i.) , uniconazole (0, 25, 50, 100, or 200 mg·L^{-1} a.i.) or daminozide (0, 2500, 5000, 10000, or 20000 mg·L^{-1} a.i.) {[butanedioic acid mono (2,2-dimethylhydrazide)]} as spray applications. Both experiments were a completely randomized orthogonal contrast design. Growth measures included height, width, internode length, flower count, leaf dry mass, stem dry mass, root dry mass, leaf number, leaf area, and ornamental rating for both experiments. Compared to controls, drench applied paclobutrazol (40 mg/pot a.i.), drench applied uniconazole (4 mg/pot a.i.), and spray uniconazole (200 mg·L^{-1} a.i.) decreased shoot mass 53%, 27%, and 43%, respectively. Daminozide and spray applied paclobutrazol did not reduce shoot dry mass compared to controls. Only spray applied uniconazole affected specific leaf area (SLA = leaf area / leaf mass), increasing SLA 21% at 200 mg·L^{-1} a.i. Paclobutrazol applied as a drench (40 mg/pot a.i.) reduced height 55% and uniconazole applied as a drench (4 mg/pot a.i.) reduced height 36%. Drench applied paclobutrazol had greater discrimination amongst treatment levels and greater height control than uniconazole. Spray applications at tested levels of plant growth regulators (PGR) did not result in height control. In general, drench application of PGRs resulted in height control of *B. frutescens* and spray applied PGRs had minimal effect.

(143) Abscisic Acid Positively Effects Greenhouse Tomato Fruit Quality and Decreases Incidences of Blossom End Rot

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Calcium (Ca) transport into leaves and fruit via xylem water movement is determined by transpiration rates and plant growth. Phloem sap accounts for most of the water used for fruit expansion; however, Ca required for proper fruit development comes from xylem sap. High leaf transpiration and vigorous vegetative growth is thought to restrict Ca movement into low-transpiring tomato fruit, a causal factor for the physiological disorder blossom end rot (BER). ABA is known to regulate stomatal closure, leaf transpiration, and plant water potential. Our objective was to analyze the effect of foliar ABA application on Ca partitioning, fruit quality, and incidences of BER in greenhouse-grown tomato (*Lycopersicon esculentum* var. Mountain Fresh Plus). The experimental design was a randomized complete block in a split plot factorial arrangement consisting of main plots of Ca treatments at 60, 90 180 mg/L, and sub plots of ABA at 0 and 500 mg/L with 6 replications. Calcium treatments were applied continuously through the irrigation system, while ABA treatments were applied foliarly once per week from anthesis to final harvest. Marketable tomato fruit numbers were not influenced by Ca, ABA, or their treatment interactions. Fruit size significantly ($P \leq 0.05$) increased with increasing Ca treatments. Fruit size was also positively affected by ABA application ($P \leq 0.05$). There

were significant ($P \leq 0.005$) decreases in BER among Ca treatments, ranging from 1.58 fruit/cluster at 60 mg/L Ca treatment to 0.44 fruit/cluster at 180 mg/L Ca treatment. ABA significantly ($P \leq 0.001$) reduced BER from 1.63 to 0.48 fruit/cluster. Fruit tissue Ca was positively influenced by Ca treatments ($P \leq 0.001$), ABA application ($P \leq 0.001$), and their interaction ($P \leq 0.05$). Fruit Ca concentration ranged from 26.62 to 63.67 μg/g dry weight (DW). Tomato leaf Ca concentrations were significantly ($P \leq 0.001$) different among Ca treatments and ranged from 2.1% to 4.1% DW and were positively correlated to Ca concentrations and consequently, incidence of BER in the fruit tissue. Fructose and glucose increased significantly ($P \leq 0.05$) with increasing Ca treatments ranging from 19.66 to 21.76 mg/g and 17.06 to 19.07 mg/g DW, respectively. Fructose and glucose were also significantly ($P \leq 0.01$) increased by ABA treated. These data suggest that foliar application of the plant growth regulator ABA improved tomato fruit quality and increased Ca partitioning into tomato fruit tissue, thereby decreasing the incidence of BER.

Specified Source(s) of Funding: Valent BioSciences

(144) Abscisic Acid-induced Chlorosis Is Leaf Age Dependent and Can Occur Independently of Ethylene in Arabidopsis

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Exogenous abscisic acid (ABA) induces leaf chlorosis in various vegetable and ornamental crops, causing a potential problem for its commercial use. In muskmelon seedlings, we have shown that chlorophyll loss increased linearly with increasing ABA concentration by up to 33% (7.57 mM-ABA). One mechanism generally proposed for ABA-induced chlorosis is senescence by stimulated ethylene production. We examined the effect of exogenous ABA (0, 0.1, and 1 mM) on chlorosis and ethylene production in intact Arabidopsis (*Arabidopsis thaliana*) leaves. Chlorosis occurred only in the oldest leaf treated with 1 mM-ABA; leaf chlorosis index (SPAD reading) decreased by 39% within 24 hours of treatment and by up to 69% thereafter. As opposed to our assumption, ethylene production was suppressed by ABA in the youngest (6–7th) and oldest leaves. The magnitude of reduction was similar in the two leaves at both ABA concentrations (up to 62% to 81%), while the ethylene level in the largest (4–5th) leaf was maintained relatively low and unaffected by ABA. These results suggest that ABA-induced chlorosis is leaf age-dependent, and that it can occur independently of ethylene.

(145) Methyl Jasmonate Treatment Enhances Glucosinolate Content of Cauliflower Heads without Influencing Postharvest Quality

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Previous reports indicate that spray treatments of methyl jasmonate (MeJA) can significantly increase glucosinolate concentrations in brassica vegetables and putatively enhance anticancer bioactivity. However, there is little information about the effect of MeJA treatments on the postharvest quality of cauliflower. To address this, cauliflower heads in replicated field plots were sprayed with either 0.1% Triton-X (controls) or 500 μM MeJA solutions (containing 0.1% Triton-X) 4 days prior to harvest, then heads stored at 4 °C and 20 °C. Subsamples of head tissues were collected after 2, 4, and 5 days of storage at 20° C and after 10, 20, and 30 days of storage at 4 °C and assayed for visual color, CO_2 and ethylene production, glucosinolate and total phenolic concentrations, tissue antioxidant activity by the 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid)(ABTS) assay, and anticancer bioactivity by the quinone reductase (QR) assay. The MeJA treatment of cauliflower increased head tissue glucoraphanin, glucobrassicin, and neoglucobrassicin concentrations by 1.5, 2.4, and 4.6 fold over controls, respectively, but had no significant effect on total phenolics. MeJA treated cauliflower showed higher QR activity compared to controls stored at both 4 °C and 20 °C. Total phenolics and tissue antioxidant activity (ABTS) in both treated and control cauliflower gradually increased during postharvest storage, with a greater increase at 4 °C than at 20 °C. There were no differences between the treatment groups for visual color measured by Hunter's colorimeter or for CO_2 or ethylene gas production. In conclusion, MeJA treatments were observed to enhance the putative health-promoting properties of cauliflower without a detrimental effect on the maintenance of postharvest quality.

(146) Optimum Methyl Jasmonate Application to Enhance Glucosinolate Concentration in Broccoli Florets

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Isothiocynates derived from glucosinolates in brassica vegetables have been reported to induce quinone reductase activity, an important cancer chemopreventative biomarker. Methyl jasmonate (MeJA) has been shown to increase glucosinolates and reduce insect damage in broccoli. For these reasons we have conducted

several studies to determine application protocols that maximize glucosinolate accumulation in broccoli florets. We investigated the effect of varying MeJA application concentrations (0, 62.5, 125, 250, and 500 μM), number, and application date in days prior to harvest of broccoli florets of the cultivar Green Magic. A single application of 250 μM of MeJA maximized glucosinolate concentration in broccoli florets. Two days of consecutive treatments of 250 μM MeJA further increased total glucosinolate concentrations (primarily gluconasturtiin and neoglucobrassicin) 4 days prior to harvest. In addition to glucosinolate levels the flavonoids, quercetin and keampferol, were observed to show significant increases when 62.5 μM MeJA was applied four days prior to harvest. These application protocols were found to maximize glucosinolate concentrations and putatively enhance the health promoting properties of broccoli florets.

Wednesday, August 1, 2012 Grand Ballroom

Fruit Breeding 1

(371) Identification of Intergeneric Hybridization in *Aronia mitschurinii* using Amplified Fragment Length Polymorphism Analysis

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Aronia Medik., commonly known as chokeberry, is a genus of deciduous, multi-stemmed, rosaceous shrubs native to eastern North America. Three species of chokeberry are commonly accepted, *A. arbutifolia* (L.) Pers., red chokeberry; *A. melanocarpa* (Michx.) Elliott, black chokeberry; and *A. prunifolia* (Marshall) Rehder, or purple chokeberry. In Europe, a fourth species of human origin is recognized as *Aronia mitschurinii* A.K. Skvortsov & Maitul. In North America this type of *Aronia* is represented as cultivars of *A. melanocarpa*, including 'Viking', 'Nero', and 'Aron'. This species is characterized by near homogeneity in seedling progeny, tetraploidy, and a distinct morphology. In comparison to *A. melanocarpa*, *A. mitschurinii* types have thicker diameter stems, a less suckering habit, wider leaf blades and larger fruits. It has been proposed that this genotype originated from Russian pomologist Ivan Michurin's early 20th century experiments involving *Aronia* × *Sorbus* hybridization. In this study we utilized amplified fragment length polymorphic (AFLP) markers to elucidate the relationships of *A. mitschurinii* to wild North American *Aronia*, ×*Sorbaronia* C.K. Schneid and seven genera from subtribe Pyrinae (Rosaceae). Data from seven primer combinations were interpreted by the NTSYSpc software package into a similarity matrix using Jaccard's coefficient. Clustering of AFLP data similarity data using the unweighted pair group method with arithmetic mean (UPGMA) identified *A. mitschurinii* as distinct from wild *Aronia*, grouping it most closely with ×*Sorbaronia fallax* and ×*Sorbaronia* 'Ivan's Beauty'. Non-metric multidimensional scaling (nMDS) also demonstrated a relationship between *A. mitschurinii*, ×*Sorbaronia fallax*, and *Sorbus* L.

(372) The Selection and Testing of New Candidates for an Apple Pollinizer

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Through the selection process of collecting pollen from 20 individuals of *Malus* 'Red Splendor' and the subsequent testing of their offspring in 4 different geographic locations, 6 of the 20 selections were ultimately chosen as pollinators for providing better single fruit weight, transect and longitudinal diameter, firmness, soluble solid content, soluble sugar content, soluble acid content, ascorbic acid content, and anthocyanin content of the fruit skin when compared to the control group of open pollinated *Malus* 'Snowdrift'. The six chosen (Nr. 2167, Nr. 2119, Nr. 5353, Nr. 1379, Nr. 1450, and Nr. 1539) have been selected as pollinators for both fruiting and ornamental tree applications because of their genetics that provide stronger physiological and biochemical indicators, as tested, in their offspring.

Specified Source(s) of Funding: Beijing Botanical Garden

(373) Apple Cultivar 'Honeycrisp' Exhibits Genetic Resistance to Apple Scab

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Apple breeders in the United States and other countries have focused on developing disease resistant cultivars as a way to improve the sustainability of apple (*Malus pumila* Mill.) production. A leading concern for many apple growers and consumers is the extensive use of fungicides in controlling apple scab [*Venturia inaequalis* (Cke.)Wint]. Genetic resistance has been introgressed into many breeding programs from related apple species (*M. floribunda*, *M. bacatta*, *M. bacatta jackii,* etc.). The genetic drag of poor fruit quality traits linked to resistance has hindered selection of superior cultivars with wide commercially viability. The cultivar Honeycrisp has shown resistance to apple

scab in organic field conditions but was not known to have any resistant parent. This has led to an investigation to explore the genetic resistance in populations derived from 'Honeycrisp' and its ancestors. A 2011 greenhouse seedling screening of two subpopulations of 'Honeycrisp' × 'Gala Twin Bee' (a susceptible genotype) progeny show a segregation ratio of 1 resistant : 1 susceptible [X^2 (N = 316) = 0.114, P = 0.736; X^2 (N = 114) = 0.561, P = 0.454]. Three other seedling populations of 'Honeycrisp' x susceptible parent exhibited a 3 resistant : 1 susceptible ratio suggesting the presence of two genes in 'Honeycrisp' (X^2 (N = 203) = 0.199, P = 0.656; X^2 (N = 150) = 0.009, P =0.925; X^2 (N = 106) = 0.013, P = 0.911). The putative 'Honeycrisp' parent, 'Keepsake', and grandparent, 'Frostbite', each were crossed to a susceptible cultivar and the progeny populations exhibited a 1:1 segregation ratio [X^2 (N = 101) = 0.802, P = 0.371; X^2 (N = 31) = 0.209, P = 0.209, respectively]. It appears that at least one resistance gene present in 'Honeycrisp' can be traced through these ancestors. Results from screenings in Spring 2012 to test possible escapes and evaluate different pathogen isolates should provide additional support for either the 1 or 2 gene model of genetic resistance in 'Honeycrisp'. Molecular markers will be utilized to map the resistance gene(s) and elucidate the inheritance of the resistance trait.

(374) Fruit Texture Trait Phenotypes of the RosBREED Apple Reference Germplasm Set Database

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Marker-assisted breeding is facilitated by marker-locus-trait associations validated in germplasm relevant to a particular breeding program. Establishing these associations depends on having an extensive, reliable phenotype database for traits of interest in this germplasm. A reference germplasm set of 496 individuals including cultivars, selections, and seedlings was identified as part of the USDA–SCRI RosBREED project. The germplasm set provides allelic representation of historic and current parents in RosBREED demonstration apple breeding programs at Cornell University, Washington State University, and the University of Minnesota. Phenotyping at the three locations was conducted according to standardized protocols that specified fruit harvest maturity and focused primarily on fruit traits evaluated at harvest and following 10 and 20 weeks of refrigerated storage. Phenotypic data were collected for the sensory texture traits of firmness, crispness, and juiciness, as well as instrumental texture measures using the Mohr® Digi-Test (Washington State University and University of Minnesota) and Effegi penetrometers (Cornell University). In 2010 and 2011, fruit from 215 and 330 individuals were harvested, respectively, and a total of 367 individuals were evaluated over the two years. As each location had a largely unique set of individuals as well as differing environmental conditions, means, ranges, and phenotypic variances for traits varied greatly among locations for some traits. For example, the mean ±se for the Digi-Test firmness measure M1 at harvest in University of Minnesota reference germplasm was 74.0 ± 2.3 N (2010) and 73.0 ± 1.2 N (2011) compared to 78.8 ± 1.3 N (2010) and 80.6 ± 1.2 N (2011) for that of Washington State University. Year-to-year repeatability of traits at a location was generally low to moderate with Pearson's correlation coefficients ranging from 0.14 to 0.48 for sensory crispness, 0.30 to 0.42 for sensory firmness, and 0.37 to 0.54 for Digi-Test Cn (a measure of crispness). Correlations between sensory and instrumental texture measures were high in some instances (e.g., Spearman's rank correlations for Digi-Test M1 and sensory firmness at the University of Minnesota were 0.73 and 0.75 in 2010 and 2011, respectively). Phenotypic data for the RosBREED apple reference germplasm set, including many components of texture, flavor, appearance and storage disorders, are curated and available for use by the international community of apple breeders and allied scientists in the Breeders Toolbox at the Genome Database for Rosaceae (www.rosaceae.org).

Specified Source(s) of Funding: Specialty Crop Research Initiative Competitive Grant 2009-51181-05808 of the USDA's National Institute of Food and Agriculture

(375) Functional Variants Provide Strategies to Improve Breeding for "Fresh Sensation" in Apple

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Discoveries in genomics provide new, useful information on genetic control of important traits in apple (*Malus domestica* Borkh.). Converting these discoveries into genetic tools would enhance efficiency of apple breeding via marker-assisted selection compared to conventional phenotype-based approaches. Developing new cultivars that produce delicious fruit in abundance is the major goal of apple breeding programs. Meeting or exceeding consumer expectations requires this fruit deliver a consistently fresh sensation, even after long term storage. We define apple fresh sensation as a combination of crispness, acidity, and juiciness. A location in the apple genome associated with these traits, the malic acid, or *Ma* locus, was reported a decade ago. We have identified *Ma* variants that appear to predispose certain cultivars to more consistently produce apples with a fresh sensation: high crispness, acidity, and juiciness. As part of the USDA–NIFA funded the RosBREED project, we are developing, validating, and implementing predictive genetic tests that can identify useful variants through pedigree-based analysis and thereby predict genetic potential for many fruit quality traits, including fresh sensation. Screening over 1000 apple cultivars, breeding selections and seedlings for two simple sequence repeat markers flanking the *Ma* locus revealed numerous variants associated with fresh sensation differences. High-resolution SNP marker data from the RosBREED project is identifying other regions in the apple genome associated with fresh sensation and identifying and characterizing functional variants for application in apple breeding programs.

Specified Source(s) of Funding: The RosBREED

(376) Identification of the Relationships between Individual Sugars, Sensory Sweetness and QTL Detection for Sweetness in Apple

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Apple (*Malus ×domestica* Borkh.), a member of the Rosaceae family, is the fourth most important global fruit crop in the world based on annual production. Washington State accounts for approximately 60% of total U.S. dessert apple production. There is an increasing demand for new apple cultivars in the world, but apple breeding is very time-consuming, and can take almost 20 years from the initial cross to cultivar commercialization. DNA-assisted methods are improving the efficiency of apple breeding by enabling more informed parent combinations for the initial cross and selecting desired genotypes at the early seedling stage. Improvement of fruit quality is the principal goal of the apple breeding program in Washington State University and sweetness is one of the most important fruit traits in apples. Sensory sweetness is the human response to the complex of sucrose, fructose, glucose and sorbitol contained in the apple fruit. The relative contribution of individual sugars to sensory sweetness will determine which QTL to focus on and possible candidate genes for the development of usable markers. In USDA–NIFA funded RosBREED project, almost 1000 apple individuals from three different apple breeding teams (Cornell University, University of Minnesota, and Washington State University) have been phenotyped using standard protocol at harvest, 10-week and 20-week cold storage with 1-week shelf life in both 2010 and 2011 and used to generate a highly saturated SNP linkage map. Four individual sugars have been measured at each time from the germplasm set using gas chromatography. Principal component analysis (PCA) showed that fructose and sucrose have higher correlations with sensory sweetness in harvest samples from Washington State University, 0.51 and 0.50, respectively. QTLs linked to sweetness will be detected on apple chromosomes 3, 6, 8, 9, and 14, and used for marker-assisted apple breeding.

Specified Source(s) of Funding: RosBREED Project

(377) First Results of Screening of Olive Breeding Progenies and Wild Olives for Verticillium Wilt Resistance

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Verticillium wilt of olive, caused by the soilborne fungus *Verticillium dahliae* Kleb., currently represents the main phytosanitary limitation in olive orchards both for its destructive potential and control difficulties. In the framework of an integrated disease management strategy, the use of resistant cultivars represents an useful tool because of its low cost, efficiency and environmental friendliness. Most of the olive cultivars currently in use have been catalogued as susceptible or extremely susceptible to the highly virulent defoliating pathotype of *V. dahliae*, and only a reduced number of the evaluated cultivars showed a considerable level of resistance to the development of symptoms. The objective of this work was to select new olive genotypes showing higher levels of resistance to Verticillium wilt than current cultivars that could be used as new cultivars, rootstocks or genitors in future breeding cycles. For that, genotypes from open pollination of different cultivars as well as wild olive material from different origins have been evaluated. Plants were no-inoculated (water) or inoculated by dipping their roots in a conidia suspension of a defoliating isolate of *V. dahliae* and placed in growth chamber under controlled environmental conditions suitable for symptoms development for 16 weeks. 'Picual' (susceptible) and 'Frantoio' (resistant) were used as controls. Disease reaction was evaluated weekly by using a 0–4 severity scale. Symptoms started 4 weeks after inoculation in 'Picual' and 2 weeks in the most susceptible genotypes, whereas absence of symptoms throughout the evaluation period was observed in some genotypes from breeding progenies and wilds. Some of the evaluated genotypes were classified as highly resistant on the basis of external symptoms development and percentage of dead plants. The most resistant genotypes will be propagated for future trials to confirm their disease reaction under controlled and field conditions.

Specified Source(s) of Funding: INIA project RTA2010-00036 and IFAPA project PEI.PEI2011.1, both partially funded by European Regional Development Fund (ERDF).

(378) NC 430, a New Thornless Blackberry Cultivar

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NC 430 is a new erect, thornless, floricane-fruiting blackberry. NC 430 was selected in 1998 by J.R. Ballington. Replicated trials of NC 430 were established at the Piedmont Research Station (PRS) in Salisbury, NC, in 2007 and at the Upper Mountain Research Station (UMRS) in Laurel Springs, NC, in 2009. Data were collected from 2008–10 and 2010–11 at the PRS and UMRS respectively. In replicated trials at the PRS, with five other cultivars, NC 430 had the highest total, marketable and percent marketable yields. Over a 3-year period, marketable yield of NC 430 was 10,704 g/plant (21,434 lbs/acre). Fruit of NC 430 is medium size (6.6 g) has smaller drupelet and seed size compared to other cultivars. NC 430 produces fruit in the late season, with average date of harvest commencing in the third week of June, peaking in the second week of July and ending the first week of August. In post harvest evaluations, when blackberries were held 7 days at 4 °C, 90% RH in pint clamshells, NC 430 has a marketable score of 90.6, which is as good or better than the leading commercial cultivars. Soluble sugars content of NC 430 was 9.4% and pH was 3.57, traits that characterize NC 430 as sweet with low acid content. NC 430 is the first thornless, floricane-fruiting blackberry to be released from NC State University.

Specified Source(s) of Funding: The Southern Region Small Fruit Consortium, Golden Leaf Foundation, NC Tobacco Trust Commission

(379) Resistance of Breeding Program Selections and Cultivars to Pear Psylla

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Four *Pyrus communis* L. clones and 16 breeders' selections and cultivars with interspecific pedigrees involving *Pyrus ussuriensis* Max. or *P. pyrifolia* (Burm.) Nakai crossed with *P. communis* were evaluated for resistance to pear psylla (*Cacopsylla pyricola* Förster) using a nymphal feeding antixenosis assay. The most resistant clones were 'Batjarka' and 'Zelinka', two landrace cultivars from Eastern Europe. Four *P. ussuriensis* × *P. communis* hybrid selections (NJ B9 R1 T117, NJ A2 R21 T89, NY 10355 and NY 10359) and one *P. pyrifolia* × *P. communis* hybrid selection (NJ Rock R25 T238) were also significantly less susceptible than the susceptible control, 'Bartlett' (*P. communis*). As a species group, the *P. communis* clones were the most resistant, due to the Eastern European landrace cultivars. The *P. ussuriensis* × *P. communis* and the *P. pyrifolia* × *P. communis* hybrid groups were not significantly different from each other. These clones should be valuable genetic resources for the breeding of new pear cultivars with resistance to pear psylla.

Specified Source(s) of Funding: USDA–ARS–CRIS Project 1931-21000-017-00D

(380) Development of a Random Mating Population for Recurrent Selection in Peach

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The genetic variation in commercial peach germplasm is low. Closely related species such as *Prunus dulcis* (almond), *P. kansuensis* (kansu peach) and *P. davidiana* (davids peach) represent valuable sources of genetic variation. These species have been used to a limited extent in rootstock breeding but have been largely ignored in scion breeding. The reluctance to use related species in peach scion breeding results from the high penalty in fruit quality of early generation crosses and the number of generations required to produce selections with commercial fruit size and quality. Large population sizes are needed to reduce linkage drag. The generation of large populations from controlled crosses is very laborious in peach due to the low seed content of fruit and the low fruit set of hand pollinations. In this work we present a breeding scheme that uses male sterility to enhance outcrossing in peach, facilitating the generation of large segregating populations for recurrent selection.

(381) Description of Two Simply Inherited Traits in *Prunus campanulata*

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Evaluation of Taiwan cherry (*Prunus campanulata*) germplasm for the breeding of subtropical sweet cherries has identified two Mendelian traits. A genotype possessing standard five petal flowers of white color was hybridized with a pink colored multi-petal (10–25 petals) flowered genotype. All hybrids had pink flowers with approximately half processing the multi-petal trait. This observation shows that the white flower trait was recessive, and it appears to be analogous to the white flower trait in peach (*P. persica*). When expressed, trees lack anthocyanin and produce white flowers, green stems, green petioles, and golden yellow fruit at maturity. An F_2 was obtained from the hybrids and 766 seedlings were rated for the lack of anthocyanin. A chi square showed a fit for a 3:1 segregation with a 95% level of confidence. The white flowered offspring will be grown to maturity, and they are expected to segregate 1:1 for the multi-petal trait due to the trait's presence in the F_1 population.

(382) Identification of QTLs Associated with Powdery Mildew Resistance in Sweet Cherry

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Powdery mildew (PM), caused by the fungus *Podosphaera clandestina*, is one of the most serious sweet cherry diseases in the Pacific Northwest. Incorporation of natural resistance into elite sweet cherry cultivars seems to be an effective way to reduce reliance on fungicide and pesticide use and facilitate the transition to sustainable production systems with resultant increase in industry profitability. Currently, most commercial sweet cherry cultivars are susceptible to PM. PMR-1, an open-pollinated seedling of unknown origin with below average fruit quality, has been identified as immune to the disease. Other cultivars identified to date with putative resistance to PM are 'Chelan', 'Hedelfingen', 'Venus', and 'Moreau', of which only 'Chelan' has barely sufficient fruit quality for early season fresh marketing and is widely cultivated in Washington. Many elite commercial cultivars have been crossed with these parents, but nothing is known about the gene(s) underlying the resistance(s). An understanding of the genetic mechanisms underlying resistance or immunity will facilitate development of new cultivars that combine superior fruit quality with PM resistance. In this study, a total of 480 pedigree-linked individuals representing the U.S. sweet cherry Crop Reference Set and the Pacific Northwest Sweet Cherry Breeding Program's (PNWSCBP) Pedigree Set were screened for PM susceptibility or resistance using a 6-point scale, from 0 indicating 'no symptoms' to 5 indicating 'leaves completely infected.' An Infinium array including approximately 150 cherry single nucleotide polymorphism (SNP) markers with sufficient polymorphism was chosen from a total of 6000 SNPs developed by the RosBREED project (www.rosbreed.org) to provide genome-wide markers for determining marker-locus-trait associations. The FlexQTL™ software was used to integrate both the phenotypic and genotypic data to identify QTLs underlying PM resistance/susceptibility in sweet cherry. We identified two QTLs on linkage group (LG) 1. The first QTL mapped between 104.9cM and 111.9cM and was flanked by SNPs RS1.26215806 and RS1.27968875, respectively. The other QTL mapped between 132.4cM and 135.6cM and was flanked by SNPS RS1.33106240 and RS1.33907538, respectively. The haplotypes for these QTLs are discussed in relation to breeding for PM resistance in sweet cherry.

Specified Source(s) of Funding: USDA–SCRI, Washington Tree Fruit Research Commission and Oregon Sweet Cherry Commission

Wednesday, August 1, 2012 Grand Ballroom

Plant Nutrient Management 2

(170) Influence of Bicarbonate Concentrations in Nutrient Solution on the Growth and Stolon Production of 'Seolhyang' Strawberry Plants during Vegetative Propagation

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The objective of this research was to investigate how the variation in bicarbonate ($HCO3^-$) concentration in fertilizer solution influences the growth, stolon (daughter plant) production, and development of physiological disorders during the vegetative propagation of 'Seolhyang' strawberry plants. Cold-treated mother plants at 3 true-leaf stage were transplanted into wooden boxes (30 cm × 30 cm, 20 cm deep) containing coir dust + perlite (7:3, v/v) and fertilized with a modified Hoagland solution containing 60, 90, 120, 180 and 240 mg·L^{-1} of $HCO3^-$ as a constant feed as needed. The electrical conductivity (EC) in the nutrient solution was maintained at around 1.2 dS/m. The deficiency symptoms for B, Zn and Fe appeared on mother plants 60 days after transplanting in the treatments with 240 mg·L^{-1} $HCO3^-$. The deficiency symptoms in this treatment were spread to all plant parts including newly formed stolons in 90 days after transplanting. The treatments with 60 and 90 mg·L^{-1} HCO_3^- did not show significant difference in mother plant growth. When determined 120 days after transplanting, HCO_3^- concentrations higher than 120 mg·L^{-1} suppressed mother plant growth with reduced leaf numbers, chlorophyll contents and fresh weights. Plant growth suppression became more severe as HCO_3^- concentrations were elevated. In 120 days of treatment, the number of daughter plants produced per mother plant was 23 and 13 in the treatments with 60 and 240 mg·L^{-1} HCO_3^-, respectively. The fresh weight and total length of newly formed stonons per mother plant decreased from 185.2 g and 853 cm to 123.6 g and 544 cm, respectively, when HCO_3^- concentration was increased from 60 mg·L^{-1} to 240 mg·L^{-1} in nutrient solution. The result of this study shows that elevated nutrient HCO_3^- concentrations are detrimental to the growth and production of new stolons by 'Seolhyang' strawberry plants during the vegetative propagation phase.

(171) Influence of Bicarbonate Concentrations in Nutrient Solution on Mineral Contents of Plant Tissues and Root Substrate Solutions during Vegetative Propagation of 'Seolhyang' Strawberry

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The objective of this study was to investigate how the variation in bicarbonate (HCO_3^-) concentrations in fertilizer solution change the tissue nutrient content of 'Seolhyang' strawberry plants and chemical properties of root substrate during vegetative propagation. Cold-treated mother plants were transplanted to wooden boxes (30 cm × 30 cm, 20 cm deep) containing coir dust + perlite (7:3, v/v) and fertilized with a modified Hoagland solution containing 60, 90, 120, 180, and 240 mg·L^{-1} of $HCO3^-$ as a constant feed. The electrical conductivity (EC) in the nutrient solution was maintained at around 1.2 dS/m and plants were fertigated as needed. In every two weeks for 126 days after transplanting, root substrate solutions were collected and analyzed for mineral nutrient concentrations by ion chromatography. The tissue analyses were also made 126 days after transplanting for mineral nutrient content on a dry weight basis for the above ground plant parts. During the experiment period, the pH and concentrations of K, Ca, and Mg in soil solution were higher as the concentrations of HCO_3^- were elevated in nutrient solution. The pH and nutrient concentrations in root substrate solution became different from week 2 with more variation occurring as plants grew. The final pH measured 126 days after transplanting was 5.4, 5.8, 7.3, 7.9, and 8.3, respectively, for treatments with 60, 90, 120, 180, and 240 mg·L^{-1} HCO_3^-. But the electrical conductivity (EC) of soil solutions was not significantly different among treatments. Even though the HCO_3^- concentrations in nutrition solution were elevated from the beginning of the experiment, the HCO_3^- concentrations in soil solution became different at week 4. The elevation of HCO_3^- concentration in nutrient solution lowered Fe, Mn, Zn, and Cu contents in the above ground tissue when determined 126 days after transplanting.

(172) Physical and Chemical Properties of Carbonized and Expanded Rice Hull as Root Substrate Components in Korea

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The objective of this research was to investigate the physical and chemical properties of carbonized rice hull (CRH, called Huntan in Korea and Japan) and expanded rice hull (ERH) which are extensively used as root substrate components in Korea. The total porosity (TP), container capacity (CC), air-filled porosity (AP) and bulk density (BD) of ERH were 81.3%, 39.9%, 41.4%, and 0.11 g·cm^{-3}, respectively. The TP, CC, AP and BD of CRH were 77.6%, 64.1%, 13.5%, and 0.12 g·cm^{-3}, respectively. The percentage of easily available water (EAW) and buffering water (BW) in ERH were 38.0% and 44.1%, while those in CRH

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were 33.6% and 34.7%, respectively. The pH of ERH was 7.13, while CRH showed an extremely high pH (11.2). The electrical conductivity (EC) and cation exchange capacity (CEC) of ERH were 1.31 dS/m and 12.1 meq·100 g^{-1} for ERH and 4.86 dS/m and 7.8 meq·100 g^{-1} for CRH, respectively. The concentrations of exchangeable cations in ERH were Ca 0.05, K 0.12, Mg 0.34 and 0.09 cmol+kg^{-1}, but those in CRH were Ca 0.02, K 0.17, Mg 0.10 and 0.10 cmol+kg^{-1}. The concentrations of PO_4-P, NH_4-N and NO_3-N were 1.3, 5.4 and 1.1 mg·L^{-1} in ERH and 688.2, 1.0, and 0.7 mg·L^{-1} in CRH, respectively, when analyzed by saturation extraction method. Each of the ash contents and cold water-, hot water-, and alkali-extracts were 11.3%, 5.5%, 6.5%, and 18.8% in ERH, and 38.5%, 4.8%, 6.7%, and 9.0% in CRH, respectively.

(173) Effectiveness of Controlled-release Formulas in Strawberry Production in California

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Strawberry is the second heavily produced crop in the central coast of California and its estimated value is $605 million according to the Monterey County Crop Report. Consequently, it is one of the contributing crops to the increase in nitrate contamination of groundwater. New stringent requirements of nitrate-N (NO_3–N) levels in soils and groundwater in California may be soon applied. It became important now more than ever to use fertilization practices that minimize leachate beyond the root zone while maintaining optimal strawberry yields. Among fertilization practices adopted by growers throughout California is the use of controlled-release formulas (CRF). Pre-plant CRFs are expected to provide plant nutrients need efficiently, reduce contact between the transplanted daughter plants and the fertilizer to avoid any root damage, and potentially reduce nitrogen leaching. Field study conducted in the production season of 2009–10 and 2010–11 in Salinas Valley, CA, to evaluate yield in response to CRF's fertilizers containing various rates of N, P, K and micronutrients in a commercial production scale. The study was designed in a randomized complete-block design with four replicates of each treatment. Nutrient levels were assessed in both soil and plants tissues. Strong positive correlation was found between soil and plant (NO_3–N) suggesting that most of (NO_3–N) was taken by plants. At the end of the season, N (NO_3–N) levels were 8.9 ppm and 5.7 ppm from soil treated with growers' standard supply of soluble N and soil treated with CRF's, respectively. In midseason of 2010, yields were 1247 and 1091 (g/plant) from plants grown in plots treated with formulas 15–7–18 and 18–6–12, respectively; suggesting that high N rates did not necessarily provided higher yields. Additionally, in July 2010, marketable yield from plots fertilized with CRF 16–5–17 produced yield at a significantly higher rate than those fertilized with growers' standards water soluble fertilizer, 31.9% compared to 23.1%. Pre-plant CRFs can be promising soil fertilization practice that potentially reduces negative impact on the environment, reduces labor cost, and maintains optimal levels of yield.

(174) Biofortification of Zinc in *Trigonella foenum-graecum* and *Brassica chinensis* to Enhance the Nutritive Value

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Zinc (Zn) is an essential component of many biological processes. It is a co-factor for genetic material, whereby, its deficiency may result in reduced cognitive and/or immune functions. Approximately 30% of the world's population is zinc deficient. Typical symptoms in humans include severe diarrhea, undersized and suppressed ailment/wound recovery. The objective of this experiment was to employ biofortification of zinc to a level below the toxicity level in fenugreek *(Trigonella foenum-graecum)* and Chinese Pak Choy (*Brassica chinensis)*. Two experiments were conducted with the objective to increase the uptake and accumulation of tissue zinc content through various zinc source nutrient solution formulation. A modified Hoagland nutrient solution containing 300, 150, 75, 15, and 1.5 μM concentration of zinc was supplied to the plants. Both $ZnSO_4$ and $ZnCl_2$ were used as a zinc source. In experiment one, fenugreek plants grown in coir substrate were supplied with $ZnSO_4$ and $ZnCl_2$. Experiment two consisted of fenugreek seedlings grown in a growth chamber with similar Zn concentration made from $ZnSO_4$. Zinc source had no significant effect on plant growth and shoot fresh and dry weights in experiment one. There were also no visual signs of toxicity/deficiency across various Zn concentrations in both the treatments. However, as the supplied Zn concentration decreased, the rhizosphere pH increased and the EC declined. With increasing concentration of zinc supply to root zone, tissue Zn content increased while the tissue Cu and Mn declined.

Specified Source(s) of Funding: USDA

(175) Evaluation of Wollastonite as a Silicon Source for Production of Sunflower

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Silicon-accumulating plant species may benefit from supplemental silicon application during production with stronger stems and disease resistance. A greenhouse experiment was conducted to compare two methods of silicon supplementation: a weekly drench with a solution of 20.8% $Si0_2$ from potassium silicate (AgSil 25^{TM}) and pre-plant incorporation of 50.1% $Si0_2$ from the dry powder wollastonite (Vansil W-10^{TM}) at both a low and high rate (1.5 and 3 g Vansil per liter of substrate) into a peat-based mix. A control with no Si was also included. Growth of *Helianthus annuus* 'Ring of Fire' plants was evaluated at mid- and end-crop. The weekly silicon drench resulted in the shortest plants. Compared to the untreated control, the wollastonite and AgSil treatments all resulted in increased silicon concentrations in the substrate and plant tissue. The silicon level in the substrate and resulting silicon tissue concentrations were comparable between the low rate of wollastonite and the weekly AgSil drench. The high rate of wollastonite provided the highest silicon level in the substrate when compared to any other treatment, and tissue Si was comparable to the AgSil drench. Both wollastonite rates resulted in a higher substrate pH than the untreated control or AgSil drench. Therefore, horticultural substrate manufacturers and crop producers may reduce the amount of lime when wollastonite is incorporated pre-plant into peat-based substrates. Pre-plant incorporation of wollastonite shows promise as a less labor-intensive means to provide silicon to crops that accumulate it during production.

Specified Source(s) of Funding: Sun Gro Horticulture Ltd.

(176) Evaluating the Potential for Slag as a Source of Supplemental Silicon in Container Crop Production

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Evidence of the potential beneficial effects of supplemental silicon in fertility programs for crop production is plentiful. Recent acceptance of silicon as a fertilizer in organic practices increased the profile of the nutrient, so the potential sources of silicon must be determined. Slag is a granular by-product of iron processing, and depending on the smelting process, can vary greatly in its composition. Within any given smelting process, the resulting slag is predictable and consistent. We sought to determine if different slag types could be used as a supplemental silicon source in containerized crop production, and sought to determine if any heavy metals were also leached from the materials. Extractions (water and/or mild acetic acid solution) were made of slag and slag-sphagnum peat mixtures for predictions of Si availability. Additionally, the ornamental crop zinnia (*Zinnia elegans*) was grown in containers with slag and compared to zinnia grown in conditions receiving no supplemental Si or supplemental Si from different sources. Silicon availability differed greatly among slag types, with extraction methods not always able to predict silicon bioavailability. There appeared to be little change in silicon supply over time among the slag types. Some slag types caused pH to rise out of recommended range for plant growth, behaving like a liming agent. Perhaps most significantly, we detected no heavy metals in the leaves of zinnia, even after supplying doses of slag that were 30x above rates that would be applied in the field. Overall, some slag types appeared to have promise as a silicon source, but caution must be used to avoid pH rise.

(177) Exogenous Hydrogen Peroxide Impacts Shoot Biomass, Pigments, and Mineral Nutrient Concentrations in Basil (*Ocimum basilicum* L.)

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Plant responses to biotic and abiotic environmental stress conditions involve coordinated control of oxidant concentration in a variety of plant organelles. Plants utilize the rapid production of reactive oxygen species (ROS) to limit penetration of biotic pathogens. Hydrogen peroxide (H_2O_2) is the most stable and non-radical ROS. Within cellular metabolism, H_2O_2 is produced when O_2^- encounters protons in a reaction catalyzed by superoxide dismutase. Superoxide radicals are a main product of the photo-reduction of O_2 within thylakoids, and subsequently become converted to H_2O_2. Plant tissues can tolerate high concentrations of H_2O_2. H_2O_2 also act as a signal molecule for coordinated plant growth and morphogenesis. Studies have demonstrated the ability of to alleviate abiotic stress conditions through exogenous applications of H_2O_2; however, what remains unclear is the ability of use H_2O_2 to promote production of anti-oxidant compounds linked to nutritional quality in specialty vegetable crops. The objective of this research was to induce production of anti-oxidant carotenoid phytochemicals in basil (*Ocimum basilicum* L.) through exogenous applications of H_2O_2. 'Genovese' basil plants were grown in nutrient solution culture. At 28 days after sowing, plants were exposed to daily applications of H_2O_2 at concentrations of 0.0; 0.1; 0.2; 0.4; 0.8; 1.6; and 3.2 *m*Mol. Basil shoot tissues were harvested after 6 days of treatment applications, freeze-dried, and measured for pigments and mineral elements. There were significant decreases in shoot tissue and root tissue fresh mass with increasing H_2O_2 concentration in nutrient solutions. Shoot tissue β-carotene, lutein, neoxanthin, total carotenoid pigments, chlorophyll *a*, chlorophyll *b*, and total chlorophyll pigments increased then decreased in response to increasing H_2O_2 concentrations. Increasing H_2O_2 concentrations

in nutrient solutions resulted in significant decreases in the shoot tissue elements of K, Mg, Cu, Mn, Mo, and Zn. Data revealed the potential to increase anti-oxidant carotenoid pigments with proper H_2O_2 concentration management. However, H_2O_2 applications resulted in negative impacts on plant biomass and the accumulation of essential tissue nutrients.

(178) Controlled-release Fertilizer Drying Methods Effect on Nitrogen Recovery Analysis

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Controlled-release fertilizers (CRFs) are soluble nutrient sources coated with a polymer, resin, sulfur or a hybrid of sulfur and a polymer. These coated materials release nutrients in water at a predictable rate when used at the manufacturer specified temperature (e.g., 25 °C). Controlled-release fertilizers are dried when stored prior to nitrogen (N) analysis. However, no studies have evaluated the influence of drying methods on N analysis. Nitrogen may be subject to volatilization at high temperature and lower moisture content. The purpose of the study was to evaluate the effects of CRF drying method on N recovery rate compared to a non-dried control. Controlled-release fertilizers [PolyS 37N–0P–0K, (Everris; Marysville, OH); ESN 44N–0P–0K (Agrium AT; Loveland, CO); Multicote 40–0–0, (Haifa; Haifa, Israel)] equivalent to 1 g N were incubated in plastic zipper bags with 100 g of sand at 80% field capacity for 21 and 42 days before the drying treatments that consisted of oven drying (60 °C for 72 h), air drying in a greenhouse (21 and 17 days), desiccators drying (21 and 17 days), and a control (no drying). Nitrogen was analyzed by combustion [Antek 9000 N analyzer (Pac. Co., Houston, TX)]. A randomized complete block design consisting of three CRFs, four drying treatments, two durations of incubation replicated four times was employed. Crystals accumulated on the CRFs during drying, thus CRF continued to release nutrients that must be conserved until analysis. All CRF drying methods had similar N recovery rates with a mean ± sd, for the 21 day incubation, of 68.7 ± 2.6, 42.2 ± 1.4, and 59.9 ± 1.4 for PolyS, ESN, and Multicote, respectively, and for 42 day incubations of 47.2 ± 2.2, 41.5 ± 2.4, and 27.3 ±1.8 for PolyS ESN and Multicote, respectively. The drying treatments were not different from the non-dried control, therefore volatilization did not influence N recovery rate.

(179) Treating Runoff using California Native Plants as Biofilters

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Nitrate contamination of water systems from agricultural runoff is a pervasive problem in California. A substantial number of water bodies have been included on the State 303(d) list due to impairments that include benchmark exceedances of nutrients. The use of different types of vegetated buffers (bioswales, filter strips and constructed wetlands) has proved to be effective to filter the excess of pesticides, fertilizers and other pollutants from different sources of urban and agricultural runoff. These buffers intercept surface and subsurface flow reducing the movement of sediment and the delivery of different contaminants to water systems. As runoff water moves across the vegetated strips, it is filtered by physical, biological and chemical processes. Roots and rhizomes obstruct flow, facilitate sedimentation and provide surface areas for microbial activity. Nutrients and pesticides are taken up by plant root systems, decomposed by microorganisms or adsorbed into soil particles. However, the effectiveness of vegetative buffers depends on several factors, such as size, runoff flow, climate, soils, vegetation cover, and plant species. Our goal was to analyze the nutrient uptake efficiency of different California native plants that can be used to optimize the function of vegetated buffers to reduce nitrogen (N) and phosphorus (P) runoff and leaching. We compared the growth response and the accumulation of N and P in shoots of *Carex pansa, Carex praegracilis, Juncus patens, Juncus xiphioides, Sporobolus airoides and Muhlenbergia rigens*that were grown for 12 weeks with 0, 50, 100, and 150 ppm of N. The content of nitrate and orthophosphate in leachates collected from the different plants was also analyzed. As the N rate increased, the shoot and total dry mass of all the plant species increased and their root:shoot ratio decreased. *M. rigens* was the largest plant at all N rates. It had the greatest shoot, total dry mass and the highest content of N and P in shoots. When grown at 150 ppm of N, *M. rigens* had about three to four times more shoot dry mass than *C. praegracilis* and *J. xiphiodes* and about twice the content of shoot N and P. However, there were no significant differences in the content of nitrate and orthophosphate in leachates collected from these species. The relation between

biomass production, shoot N and P, and leachate volume, on the content of N and P in leachates collected from the different species will be discussed.

Wednesday, August 1, 2012 Grand Ballroom

Postharvest 2

(015) Properties of Nucleases Associated with Watersoaking and Programmed Cell Death in Ethylene-treated Cucumber Fruit

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Our previous studies have demonstrated that continuous ethylene exposure predictably induces acute tissue watersoaking of immature mini-cucumber fruit (*Cucumis sativus* L. cv. Manar) (Postharvest Biol. Technol. 2010, 58:13–20). The attendant changes, including loss of cell viability, increased total nuclease activity, and DNA fragmentation support the idea that watersoaking represents the culmination of stress-mediated programmed cell death (PCD) triggered by ethylene. Prior to the onset of watersoaking, increases in activity of two ethylene-responsive nucleases, with apparent MWs of 34.5 and 37 kDa, were detected by in-gel nuclease assay. The 37 kDa protein was ethylene induced and the 34.5 kDa was ethylene enhanced. The objective of the present study was to further characterize the ethylene-responsive nucleases. Mini-cucumber fruit at immature stage were provided with continuous air or 10 $\mu L \cdot L^{-1}$ ethylene for up to 6 d at 15 °C. Fruit provided with ethylene exhibited watersoaking at 6 d of treatment. Protein from epidermis-associated tissue was subjected to in-gel nuclease assay under different conditions or in-gel substrates to characterize the PCD-related nucleases. Activities of both nucleases were eliminated by 2-β-mercaptoethanol, indicating that disulfide bonds are required for activity. Both nucleases were bifunctional, degrading both DNA and RNA, and the calcium-specific-chelator EGTA (1 mM) inhibited activity which was partially restored by addition of 1 mM Ca^{2+} but not Mg^{2+}. Nuclease activities were strongly inhibited at pH below 6. However, they were detected at pH 7 to 9. Therefore, these nucleases might function in the nucleus or cytoplasm prior to tonoplast rupture during PCD. These results indicate that both nucleases exhibit DNase and RNase activities, and require Ca^{2+} and neutral/weak basic conditions for activity. In addition to the ethylene-responsive, bifunctional nucleases, two RNA-specific nucleases (17.5 and 22.3 kDa) were detected using RNA as in-gel substrate. The 17.5 kDa protein was ethylene induced and 22.3 kDa was ethylene enhanced. Contrary to the bifunctional nucleases, RNA-specific nucleases were calcium-independent and were not inhibited by 1 mM EGTA. In addition, RNase activity was detected below pH 7 and strongly inhibited above pH 8. Therefore, even after vacuole collapse during PCD, RNA-specific nucleases might maintain activity. The early appearance of bifunctional and RNA-specific nucleases in the development of ethylene-mediated PCD in mini-cucumber fruit parallels events occurring in several types of PCD in plants. We propose that PCD-like events may explain other types of postharvest disorders mediated by ethylene.

(016) Ingress of Gaseous 1-Methylcyclopropene in Tomato Fruit

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Recommended doses of gaseous 1-methylcyclopropene (1-MCP, SmartFresh™ Quality System) for harvested fruits and other plant tissues have been based on analyses of external levels required to attain desired responses; however, no information is available regarding the extent and rate of 1-MCP ingress. This study addressed ingress of gaseous 1-MCP in tomato fruit exposed to 20 $\mu L \cdot L^{-1}$ 1-MCP followed by sampling of internal atmosphere from fruit immersed in water. Harvested, unwaxed tomato fruit accumulated 1-MCP rapidly, reaching maximum values of approximately 6 to 8 $\mu L \cdot L^{-1}$ within 3 h at 20 °C. Internal gaseous [1-MCP] declined approximately 60% to 70% within 1 h of removal and was nearly depleted within 3 h. 1-MCP ingress was similar among fruit of all ripening stages and reduced 45% in fruit coated with commercial wax. Diffusion of gaseous 1-MCP through inert matrices (e.g., glass microfibre filters) positioned between double-flask chambers occurred rapidly (< 30 min) through dry filter paper but was completely prevented through hydrated filter paper, providing evidence that water constitutes an effective barrier to 1-MCP diffusion. Blocking 1-MCP ingress through peduncle and style scars by application of a water barrier resulted in a 50% to 60% reduction in accumulation of internal 1-MCP, indicating that 1-MCP ingress also occurs through epidermal tissues. Fruit preloaded with 1-MCP and immersed in water for 2 h retained from 45% to 70% of 1-MCP levels measured immediately after removal from the gas, indicating that significant quantities of 1-MCP remain in gaseous form and are not rapidly sorbed or metabolized by tomato fruit tissue. Diffusion of gaseous 1-MCP occurred rapidly through baby spinach and bok choi leaves, but was nearly completely prevented in epidermal and peduncle-scar disks of tomato and other fruits. Recent work in our lab

demonstrated that excised tissues of some fruits can metabolize 1-MCP through apparent wound-induced, free-radical chemistry and are not suitable models for estimating 1-MCP ingress properties. Rapid ingress of 1-MCP was also observed in tomato fruit exposed to aqueous 1-MCP. Immersion in aqueous 1-MCP at 1 $mg \cdot L^{-1}$ for 1 or 2 min resulted in internal [1-MCP] of around 4 and 5.8 $\mu L \cdot L^{-1}$, respectively. Analysis of internal [1-MCP] provides another tool for investigating variable responses of different fruits/cultivars to the low levels of 1-MCP ($\leq 1 \mu L \cdot L^{-1}$) employed commercially. 1-MCP ingress is likely influenced by epidermal morphology, composition and architecture of native and applied waxes, and tissue hydration.

Specified Source(s) of Funding: Specialty Crops Research Initiative Grant 2009-51181-05783 from the USDA National Institute of Food and Agriculture. AgroFresh, Inc.

(017) 1-Methylcyclopropene–mediated Phosphorylation of Ethylene Receptor in Tomato Fruit: Implications for Inhibition and Recovery of Ripening Capacity

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Application of 1-methylcyclopropene (1-MCP), an ethylene antagonist, to climacteric fruits is an effective technique for maintaining quality and extending shelf life. The effects of 1-MCP are most evident with fruits treated prior to ripening initiation. Fruits treated before ripening initiation exhibit significantly compromised ripening competence, resulting in excessive/abnormal texture, reduced pigment accumulation, and altered volatile evolution. Although delaying 1-MCP treatment until after ripening initiation can circumvent these problems, treatment with some fruits is less effective and faster ripening recovery is observed. Different degrees of ripening inhibition in response to 1-MCP have not been explained at the molecular level. One possible explanation is that 1-MCP, in binding irreversibly to the ethylene receptor (ETR), alters ETR conformation or other properties. Since previous reports have indicated that ETR exhibited autophosphorylation activity in vitro, we speculate that 1-MCP alters ETR phosphorylation state. Here, we propose a novel theory in which 1-MCP-mediated inhibition of ripening, and subsequent recovery, is due to ETR phosphorylation status. Phosphorylation state of ripening-related ETR in tomato, LeETR4, was analyzed using phosphate-affinity gel electrophoresis. LeETR4 was phosphorylated in untreated immature and mature-green fruit, and non-phosphorylated after ripening initiation. Interestingly, 1-MCP ($2 \mu L \cdot L^{-1}$) treatment rapidly switched non-phosphorylated LeETR4 to the phosphorylated form whereas ethylene induced dephosphorylation. Exposure to 2,5-norbornadiene (NBD), a reversible cyclic-olefin ethylene antagonist, also induced LeETR4 phosphorylation, yet removal from NBD resulted in rapid dephosphorylation. The reversible phosphorylation state of LeETR4 in response to NBD application/removal is consistent with the reversible inhibitory effect of NBD unlike 1-MCP. Based on these observations, we assumed that the phosphorylation state of ETR is related to the progress of fruit ripening. We next examined the effect of 1-MCP on LeETR4 phosphorylation state in fruit subjected to extended storage. 1-MCP treatment at mature-green stage resulted in persistent phosphorylation state through nine days, which was consistent with strong inhibition of ripening. This observation indicates that 1-MCP–engaged LeETR4 was neither degraded nor dephosphorylated during storage. By contrast, in fruit treated with 1-MCP at turning stage, phosphorylated LeETR4 disappeared at 4 days and non-phosphorylated form appeared. This alternation of phosphorylation status is consistent with faster ripening recovery in 1-MCP–treated turning compared with mature-green fruit. Taken together, phosphorylation status of LeETR4 closely paralleled ripening progress. We conclude that the primary response to 1-MCP treatment is maintenance or induction of ETR phosphorylation, resulting in the suppression of ethylene signaling and inhibition of ripening.

Specified Source(s) of Funding: AgroFresh, Inc. and SCRI Grant 2009-51181-05783

(018) Does Prior Storage in Air at Optimum or Higher Temperature Influence the Potential Benefit of Controlled Atmosphere for Broccoli in Simulated Marine Shipments?

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Broccoli may be shipped for up to 3 weeks in mixed load marine containers to supply U.S. military bases in the Pacific region and is one of the most commonly rejected fresh fruit and vegetable items upon arrival. Preliminary experiments with fresh broccoli indicated that temperature control during simulated shipping could maintain the product's quality for 30 days, which is longer than the time required to transport the crop by sea within the Pacific region. Thus, we considered that the products may not always be freshly harvested before shipping. In this research we focused on the effect of controlled atmosphere (CA) on the postharvest quality of broccoli that was stored in air at different temperatures before CA storage. Fresh broccoli ('Green Magic') was obtained from a packinghouse in Palatka, FL, within an hour of harvest. The broccoli was transferred in an air-conditioned vehicle to the Postharvest Horticulture Laboratory at the University of Florida in Gainesville and stored overnight at 0.5 °C. The broccoli was equally divided into three groups. The first group was immediately placed into CA (1% oxygen plus 10% carbon dioxide) or air at 0.5 °C. The second and third groups were stored for 5 or 10 days, respectively, at 0.5 °C or 5 °C before transfer to CA or air at 0.5 °C. Color changes, weight loss, chlorophyll fluorescence, and overall vi-

sual quality were evaluated after 10 and 20 days of storage and 20 days of storage plus 3 days shelf life at 20 °C. Respiration rate and ethylene production was also measured at the time of evaluations. The results of the experiment indicated that the use of CA for broccoli storage at 0.5 °C did not maintain a higher product quality or extend its shelf life compared to air storage even if the product was stored for 10 days at 5 °C before the CA. Optimum temperature management alone is sufficient to manage fresh broccoli during shipping for up to 3 weeks in marine containers.

(019) Ethephon and Other Chemical Stresses Increase the Incidence of Tip Rot in Mississippi Sweetpotatoes

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Sweetpotato is a high value crop with an estimated production value of over 478 million dollars in 2010 (USDA, National Agricultural Statistics Service). Mississippi production of sweetpotato increased from 13,000 acres, in 2000 to 23,000 acres, in 2011. With this increase in acreage comes a pressure to harvest these acres while maintaining size and quality of the roots. Harvest is often delayed due to dry conditions that promote skinning (the mechanical removal of skin) or excessive rain events preventing mechanical harvest. Preharvest application of ethephon has been reported to harden or set the skin and therefore, reduce skinning in sweetpotato. However, it was reported to increase the incidence of a relatively new disease in sweetpotato roots, named tip rot. At this time the causal pathogen of tip rot is not known, but it appears that stress and soil moisture influence its incidence. In an effort to understand the relationship between stress and tip rot in sweetpotato, ethephon and two herbicides (Paraquat and Aim) were applied to the foliage 5 days before harvest at the Pontotoc Experiment Station in Mississippi. Storage roots were harvested and stored to evaluate the incidence of tip rot after 2 months. In addition, on-farm trials with ethephon were conducted to determine the potential increase in the incidence of tip rot in commercial fields. Three treatments were a water control, a 0.84 and 1.68 kg·ha^{-1} a.i. all treatments included a 0.25% v/v crop oil concentrate. Treatments were applied using a back pack CO_2 sprayer with a 3 m boom with 8003 flat fan tips calibrated to spray 191 L·ha^{-1}. Three strips 47.5m by 3 rows wide were each treated with an assigned treatment 5 days before harvest. Half of the sampled roots were taken to storage while the rest were taken to a curing room. Tip rot was found in sweetpotatoes from each area regardless to the treatment. In the first study, tip rot incidence was 0.6%, 4.6%, 6.7%, and 13% for the untreated, Aim, paraquat, and ethephon, respectively. Similarly, the incidence of tip rot increased across on-farm trials from 2% to 6% with ethephon rate ($R^2 = 0.96$). The use of active curing (29 °C and 90% RH for 4–7 days) immediately after harvest reduced the incidence of tip rot in both treated and non-treated roots to near 0.

(020) Effect of Curing on Sweetpotato Organic Acid Content

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Organic acids are important constituents of flavor and other quality attributes in sweetpotatoes. Changes in organic acid content were determined in 'Beauregard' and 'Evangeline' sweetpotato roots after 7 days of curing at 21 °C and 32 °C. Malic acid was the principal organic acid in roots of both cultivars at harvest and after curing. Citric and succinic acids were the secondary and tertiary organic acids detected. Malic and succinic acids increased during curing, while citric acid decreased. The increase in malic and succinic acid content during curing was accentuated at the higher curing temperature (32 °C). Concurrently, the decrease in citric acid during curing was more pronounced at 32 °C than 21 °C. Total organic acid content slightly increased in both cultivars after curing.

(021) Fruit Quality of Fresh Cut Seedless Watermelon

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Watermelon is a good source of vitamin C and contains the antioxidants and anti inflammatory compounds citrulline and lycopene. Fresh cut watermelon is used as a value added product and as a consumer-friendly fruit package. In the United States, fresh cut watermelon is often prepared in-store using deli boxes and cubes or blocks of fruit tissue. Fruit tissue sitting in juice is undesirable and associated with soft watermelon texture. Within watermelon fruit, slight differences in ripeness have been reported, with the blossom end ripening before the stem end. In this experiment, fruit of three seedless cultivars precooled to 4 °C and surface sterilized with a 100 ppm chlorine spray were cut into thirds (stem end, mid and blossom end). Fingers or blocks of fruit (6 × 2 × 2 cm or 6 × 6 × 2 cm) were cut and placed in deli boxes then held at 1 °C for 7 and 14 days. The percentage of juice leakage differed among cultivars and averaged 3%, 4.5%, and 5.7% after 0, 7, and 14 days. 'Crunchy Red', 'Melody', and 'Genesis' had 4.2%, 6.5%, and 6.5% juice leakage, respectively, after 14 days storage. Average lycopene (53 mg/kg), soluble solids content (SSC) (10%) and pH (5.6) did not change significantly with storage interval or type of cut.

Lycopene content was highest in 'Crunchy Red' (56.2 mg/kg) and lowest in 'Genesis' (50.8 mg/kg). Lycopene and SSC were slightly higher from tissue cut from the mid section of the fruit. Juice leakage was slightly increased in the flesh cut as fingers. Overall, the storage interval and cultivar had the most influence on juice leakage and lycopene content.

(022) Differential Response of 'Beauregard' Sweetpotato Storage Roots to Ethephon, 1-Methylcyclopropene and Water Submergence Treatments

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Effects of short-duration submergence of 'Beauregard' storage roots in ethephon (2-chloroethyl phosphonic acid), 1-MCP (1-methylcyclopropene), and water were examined. 'Beauregard' storage roots were cured for 1 week at 30 °C, 90% relative humidity (RH), and held at 15 °C and 85% RH until utilized. Submergence treatments were the following: 1 ppm 1-MCP, 2.6 mM ethephon and water. All submergence treatments included 0.1% Nu Film P® and were imposed for 1 hour. After 1 month, samples submerged in ethephon and water showed signs of localized tissue death (necrosis), as confirmed by trypan blue staining. Necrotic tissue was observed on storage root surfaces and tips. The responses included pitting-type damage associated with chilling injury as well as necrotic tissue associated with tip rot- or end rot-like symptoms. The development of lenticel-like features was also observed on the surface of storage roots treated with ethephon. Storage roots treated with 1-MCP failed to show evidence for localized tissue death even after 3 months of observation. The results suggest the involvement of ethylene in the development of pitting- and tip rot-like injury in 'Beauregard' sweetpotatoes.

Specified Source(s) of Funding: AgroFresh

(023) Effect of Postharvest Storage Conditions on Shelf Life of Kale (*Brassica oleracea* var. *acephala*)

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Kale (*Brassica oleracea* var. *acephala*) is a leafy vegetable of increasing popularity due to its high nutritional content. Little is known about the postharvest of kale. After harvest, kale leaves quickly lose water and turn yellow when kept at unrefrigerated conditions, affecting its quality. The objectives were to determine the effect of cool storage and storage method on leaf water loss, leaf greenness, and leaf color in two kale phenotypes. Plants were planted in Winter 2011 and harvested in May 2011. The design was completely randomized. Treatments were storage temperature (5 °C or 18 °C, both at 90% to 95% RH), bagging (with or without plastic bag) and cultivar ('Red Russian' hybrid from the United States and 'Konavale' accession from Croatia). The rate of leaf water loss, leaf greenness (chlorophyll index), leaf color (l*, a*, b*), and leaf yellowing were observed every 2 days for a period of 10 days. Leaves stored at 5 °C for 10 days had lower rate of leaf water loss and lesser yellowing compared to leaves at 18 °C. 'Red Russian' had lower rates of leaf water loss and lesser yellowing than 'Konavale'. Bagged leaves showed much lower rates of water loss but increased levels of yellowing as compared to leaves stored without bags.

(024) Possible Amelioration by MA of Aroma Volatile Loss during Refrigerated Storage of Pink Tomatoes

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Fresh tomato fruit are chilling sensitive, but their sensitivity has been reported to decrease as they ripen. Modified atmosphere packaging (MAP) with reduced O_2 and elevated CO_2 slows the ripening process and has been found to reduce tomato chilling injury (CI) symptoms. Changes in the amounts of certain volatiles may be an indication of the occurrence of CI. Some of these compounds have been reported to contribute to the fresh tomato aroma. For some other fruits, 6-methyl-5-hepten-2-one (MHO), which gives a fruity/floral aroma, has been found to remain stable or decrease during storage at ambient temperatures and decrease at lower temperatures. In this study, pink ripeness stage tomatoes were stored in MAP at 12.5 (the reported chilling threshold temperature), 15 or 18 °C for 20 days. Gas exchange was allowed through microporous films covering three different sizes of holes on the containers. CO_2 was injected into the packages immediately after sealing to establish 3% to 10% CO_2 (expected equilibrium concentrations). Measurements of gas concentrations were made every 2 days and homogenized tissue samples for volatile identification were taken and stored in the freezer at the same time. Aroma volatiles were identified by GC-MS using SPME headspace analysis. Several volatile compounds were found to change during the storage period. The amount of total volatiles decreased during 20 days of storage in all treatments. Total aldehydes increased in fruit that were stored at 18 °C for 20 days, but at 12.5 °C aldehyde levels did not change for both MAP and air treatments. Also, total aldehydes as a percentage of total volatiles was higher in fruit stored in air than in MAP. MHO as a percentage of total aroma volatiles was higher in fruit stored in air than in MAP, but was unaffected by storage temperature. Thus, MAP did not overcome aroma loss in

tomatoes during low temperature storage. Further studies should address recovery of aroma volatile synthesis in low temperature MAP-stored tomatoes upon transfer to air at higher temperature.

Specified Source(s) of Funding: Specialty Crops Research Initiative Grant 2009-51181-05783 from the USDA National Institute of Food and Agriculture

(025) Low Temperature Storage Affects the Anthocyanins and Phenolic Compounds Accumulation in 'Coreano' Garlic (*Allium sativum*)

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Garlic quality is determined by the size bulb, uniform shape and absence of defects, additionally also the bulb color is an important feature of marketing process especially where the purple or red bulbs are appreciated. Previous experiments have shown that storage of "seed" cloves of 'Coreano' variety at 5 °C ahead the harvest time up to 6 weeks and increased the purple color of the bulb. The aim of the this work was to compare the anthocyanins contents and their profile as well as the total phenolic compounds of outer scale-leaves of garlic bulbs (*Allium sativum*) 'Coreano' cultivated from "seed" cloves stored at room temperature (RT) and 5 °C. Two sets of 'Coreano' garlic cloves were stored at those temperatures during 5 weeks. After the storage the bulbs were shelled and the selected cloves were planted at Cosio, Aguascalientes, Mexico, during the 2010–11 season. Periodically samples of five bulbs were taken and their outer scale-leaves were separated and the anthocyanins and total phenolic compounds were extracted with 5% acetic acid in methanol. Anthocyanins quantification was carried out by differential pH method and the total phenolic compounds were measured by Folin-Ciocalteu assay. Independent samples were used for the characterization of anthocyanins profile by HPLC–DAD–ESI–MS. The results were analyzed by analysis of variance and Tukey mean comparison test. The anthocyanins and phenolic compounds content were greater in samples whose "seed" cloves were stored at 5 °C (0.3802 mg cyanidin 3-glucoside (C3G)/g and 1.8737 mg gallic acid equivalents (GAE)/g respectively), while the samples whose cloves were stored at RT, the anthocyanins and phenolic compounds content represented only one-third of samples stored at 5 °C (0.1032 mg C3G/g and 0.6138 mg GAE/g, respectively). HPLC–DAD–ESI–MS analysis showed five anthocyanins in samples of outer scale-leaves, which were identified as cyanidin 3-glucoside and its malonyl and acetoyl derivates, two of these compounds have not been reported previously in garlic. Results indicated that storage at low temperature induced the accumulation of anthocyanins and total phenolic compounds and their HPLC profile of anthocyanins were slightly different in both storage conditions.

Specified Source(s) of Funding: CONACyT

(026) The Effect of Irrigation Method, Harvest Time, and Storage on Mechanical Injury and Tuber Quality of Tablestock Potato (*Solanum tuberosum* L.)

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Drip irrigation was evaluated as an alternative to conventional seepage irrigation to maximize water and fertilizer use efficiency, while maintaining yield and tuber quality. Potato varieties 'Fabula' and 'Red LaSoda' were irrigated using surface drip (SD), sub-surface drip, with tape buried 10.2 cm below soil surface (SSD), or seepage (SP) irrigation. Tubers were harvested 1, 2, and 3 weeks after vine kill. Tuber marketable yield and internal and external quality were determined at harvest. The freshly harvested tubers were stored for 14 days at 10 °C and 90% to 95% relative humidity. Tubers were analyzed every 7 days during storage for bruise susceptibility, firmness, and moisture and vitamin C content. To induce bruising, tubers were dropped individually from 90 cm onto a solid surface and held at 20 °C for 4 days, before evaluations for internal damage. Similar yields were obtained for SP and SD 'Fabula' plants, with an average yield 25% higher than SSD, whereas in 'Red LaSoda', SP yields were significantly higher than both drip irrigation methods. However, a higher incidence of physiological disorders was also observed in SP tubers for both varieties. Freshly harvested, SP irrigated 'Fabula' tubers were most susceptible to bruise injury at all the harvest times, with an average rating of 3.5, compared to 4.8 for the drip methods (rating: 5 = no symptoms of bruising; 1 = extreme bruising). In 'Red LaSoda', SP tubers had an average vitamin C content of 36.1mg/100 g during storage, which was 25% and 34% higher than SD and SSD, respectively. Vitamin C was also affected by time of harvest; it increased with tuber harvest maturity in both varieties. No other significant differences in tuber compositional quality were observed among the irrigation methods. The results indicated comparable yields and tuber quality for SP and SD irrigation in 'Fabula', whereas there seemed to be no advantage in using the drip methods in 'Red LaSoda'.

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Viticulture and Small Fruit 2

(281) Textural Analysis of Muscadine Grapes

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Muscadine grape (*Vitis rotundifolia*) berries have a relatively tough skin and a range of flesh textures from soft to firm. Fourteen muscadine cultivars and selections and two *Vitis vinifera* samples were evaluated for berry texture using a TA-XT2i texture analyzer (Stable Micro Systems, Surrey, UK) equipped with a 2-mm cylinder punch. Test speed was 1 mm/second and contact force was 1 g. Berries were punctured at the equator and maximum force and deformation at first peak were recorded for 40 berries for each genotype. The 2-mm cylinder punch demonstrated good separation of both within muscadine genotypes and between muscadine and *vinifera* table grape cultivars. Deformation at first peak (DFP) represents the distance the probe moves from initial contact with the berry surface until the skin ruptures. Maximum force (MF) represents the maximal force recorded by the probe until skin rupture. Ideal fresh market grape berry texture is generally considered to be a tender skin in combination with a crisp flesh. A tender skin would be represented by a low MF and a crisp flesh would be represented by a small DFP. DFP varied nearly two fold among muscadine genotypes. The highest DFP occurred among genotypes like 'Cowart', GA 5-1-28, and 'Nesbitt' with soft pulps similar to *Vitis labrusca* berries. The lowest DFP occurred among UGA selections and releases like 'Lane', GA 6-1-219, and GA 4-3-147 which were selected for firm flesh. Notably, GA 4-3-147 had a DFP similar to the *vinifera* table grapes. Lowest MF among muscadine genotypes was recorded in GA 4-3-147 at nearly 8 N and highest MF was 12.5 N for 'Nesbitt'. However, even the lowest MF for the muscadine genotypes was still over twice that of the *vinifera* table grapes. Texture analysis of muscadine showed a wide range for both DFP and MF. Selections chosen for firm flesh resulted in DFP similar to *vinifera* table grapes. While there was good variation for MF among muscadine genotypes, much improvement still needs to be made to have skin tenderness comparable to *vinifera* berries.

Specified Source(s) of Funding: Southern Region Small Fruit Consortium

(282) The Roles of *Rhizoctonia fragariae* and Terbacil in the Development of Black Root Rot in Strawberry

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Black Root Rot (BRR) is a disease complex that causes tissue decay in strawberry roots leading to loss of function and death over time. As a result of root death, above ground tissue cannot be supported. Organisms most commonly associated with BRR development are lesion nematode and soil-borne fungal pathogens such as *Rhizoctonia fragariae*, *Pythium* spp., and *Cylindrocarpon* spp. However, other factors may contribute to disease development by disrupting normal plant function and fine root development. These factors include dry or waterlogged soils, winter injury, nutrient deficiencies, and some chemical applications. The objectives of this research are to discover which strains of *R. fragariae* are present in Pennsylvania soils and to identify plant stresses that influence BRR development in strawberry plantings. Three commonly reported strains of *R. fragariae* (AG-A, AG-G, and AG-I) were isolated from symptomatic strawberry plants at 7 out of 8 farms sampled in Pennsylvania. An unreported strain was isolated from symptomatic plants at one farm location. Also, the application of a commonly used herbicide, terbacil (Sinbar WDG, Tessenderlo Kerley, Inc.), at various field rates (roughly equivalent to 0, 2, 4, 6, and 8 oz/acre in 25 gal of water), significantly decreased photosynthetic rates of 'Jewel' leaves causing disruption in normal physiological function and fine root development. Photosynthesis in leaves less than 10 days old was fully inhibited; however, photosynthesis in leaves older than 10 days was not affected by terbacil application. Photosynthetic levels of leaves returned to normal with 10 to 14 days after application. The inhibition of photosynthesis may stress the plant leading to increased susceptibility to R. *fragariae* infection and BRR development. These results suggest that strawberry growers should use a low concentration of terbacil or the equivalent to 1oz./acre in 25 gal of water. Growers should apply terbacil only when plants have produced multiple older leaves to limit the impact on photosynthesis. Also, growers should implement management strategies, such as crop rotation, to decrease populations of *R. fragariae* in strawberry plantings.

Specified Source(s) of Funding: North American Strawberry Growers Assoc., Pennsylvania Vegetable Growers Assoc.

(283) Greenhouse Production of Strawberries during the Winter

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Strawberries are one of American's favorite fruits and are available in grocery stores year round. Given increased shipping and other associated costs as well as the opportunity to provide a fresh, nutritious local product, our research team is exploring the feasibility of growing strawberries during the winter in Nebraska. Six cultivars plus two that were obtained as A+ grade crowns were potted up and grown on capillary mats in a double poly greenhouse. There were two benches each with six replications for a total of 12 replications for up to 48 plants per cultivar. Plants were potted in mid September and started flowering 8 days later (23 Sept.), but by 31 Oct., four cultivars showed fruit phylloidy. At that time, all plants showing fruit phylloidy were discarded (22 pots of 'Portola', 8 pots of 'Seascape', 4 pots of 'Chandler', 1 pot of 'Albion'). 'Albion' and 'Cavendish' were the first to fruit with 'Albion' peaking in early November and then not producing significant quantities until February. 'Seascape' A+ grade also followed a similar pattern. At peak, the last week in November, 'Albion', 'Seascape' A+, 'Evie-2' A+, 'Chandler', 'Cavendish' and 'Portola' produced approximately 1250 g. However, the next week individual cultivar production dramatically decreased. 'Evie-2' A+ grade started producing berries about mid-November and showed the best sustained production into January with about 230 g per week. In late February production increased again with 3–4 kg and more harvested on a weekly basis. Of the 6 cultivars, 'Albion' persistently produced runners rather than flowers. 'Cavendish' plants remained small and compact which supported repeated mite infestations. Individual cultivar weekly production patterns (mass and number) as well as °Brix will be presented in relation to which cultivar or cultivars are best suited for winter production.

Specified Source(s) of Funding: Nebraska Department of Agriculture Horticulture Specialty Block Grant Program

(284) Early Performance of Rabitteye Blueberry Cultivars under Conventional and Organic Practices

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Two rabbiteye blueberry trials were planted in Hope, AR, in Feb. 2009. One planting was prepared and managed using organic practices and the other using standard conventional practices. Each planting included cultivars Alapaha, Ochlockonee, Austin, Vernon, Tifblue, and Columbus, and each planting was a randomized complete-block design with cultivar as treatment factor and four blocks based on location within the planting. The first harvest was collected in 2011. Results indicate that 'Tifblue' may remain one of the highest yielding varieties in southern Arkansas. Each cultivar produced a unique harvest dynamic. 'Alapaha' peaked in late May; 'Austin', 'Vernon', and 'Columbus' peaking in mid-June; and 'Tifblue' and 'Ochlockonee' peaking in early July. Although, results are not statistically comparable, yields in the organic planting were higher in every cultivar, especially in 'Tifblue', where yields in the organic planting were twice those in the conventional planting. The consistency of higher yields in the organic planting was not expected, because disease susceptibility was expected to be seen in some cultivars in the organic planting. However, because there were not blueberries present prior to the current planting, initial disease and insect pest presence was low. Additionally, better weed control was acquired in the organic planting using a fabric weed barrier above the mulch layer in the summer. Herbicides were only temporarily effective constant encroachment of bermudagrass in the conventionally managed planting.

(285) Vegetative and Reproductive Traits of Southern Highbush Blueberry under Different Summer Pruning Systems

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Pruning is an essential component of blueberry management and in the southeastern U.S. summer pruning is done soon after harvest to stimulate growth. However, blueberry stem blight (*Botryosphaeria* spp.)—a major cause of decline and death of blueberry in the Southeast—can be spread from infected to non-infected canes by summer pruning. Therefore, summer pruning plays an important role in growth, yield, and survival of blueberry and research-based recommendations for pruning in the southeastern U.S. are needed. The objective of this study is to determine the effects of timing and severity of summer pruning on vegetative and reproductive growth, and the incidence of stem blight in 'Jewel' southern highbush blueberry. The following treatments were applied to mature plants of 'Jewel': 1) control—no pruning; 2) control—detailed hand pruning; 3) pruning 30% of existing foliage in early June (30% June); 4) pruning 30% of existing foliage in mid-July (30% July); 5) pruning 30% of existing foliage in early June followed by shoot tipping in mid-July (30% June+tip); and 6) pruning 60% of existing foliage in early June, followed by shoot tipping in mid-July (60% June+tip). At the end of the growing season, non-pruned plants had the greatest canopy volume, averaging 0.80 m^3, while 60% June+tip had the smallest volume, averaging 0.41 m^3. All 30% pruning treatments, regardless of timing or tipping, had similar canopy volumes, averaging 0.61 m^3. Flower bud formation began between 6 Oct. 2011 and 20 Oct. 2011 for all treatments, and there was no clear differentiation among the treatments for timing of initiation. Flower bud density was greatest in the 30% July pruning treatment (0.32 buds/cm), compared with all other treatments, in which density ranged from 0.22–0.26 buds/cm. Flower bud number per shoot was greatest in the non-pruned treatment and least in the 30% and 60% pruning treatments, regardless of timing or tipping. Bud break started in early Jan. 2012 for all treatments and 50% bloom occurred by

early February. None of the treatments were affected by stem blight. The non-pruned plants produced the greatest new shoot growth and the greatest number of flower buds compared with all other treatments. The 30% July pruning resulted in the least amount of regrowth and was among the lowest in total flower bud number, probably as a result of the later timing that limited the ability for new flower bud initiation on the late regrowth.

(286) Vegetative Growth of Southern Highbush Blueberry Cultivars Obtained from Micropropagation and Softwood Cuttings in Two Florida Locations during First Two Growing Seasons in the Field

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The objective of this study was to evaluate vegetative growth of highbush blueberry plants derived from micropropagation and softwood cuttings under field conditions. The experiment was conducted at two locations with different average chill hour accumulation per season (temperatures from 0–7 °C): Citra, FL (420–540 chill hours) and Haines City, FL (110–220 chill hours) respectively. 'Emerald', 'Jewel', and 'Primadonna' were planted in a completely randomized block design with six treatments and five replications. Whole plants were harvested at four biologically significant points during the study: at planting, after the first growing season, after the first harvest, and after the second growing season. Average plant height and width, number major canes, and total shoot number were determined from 10 plants per treatment at planting and from one plant per replication at the other sampling dates. Stems arising from the first 12 cm above the soil line with a minimum diameter of 7 mm were recorded as major canes. Subsequently, plants were divided into roots, crowns, canes, shoots, and leaves, and dry weights were obtained for each. Results were evaluated by analysis of variance and treatments were compared using Tukey's HSD test at 5% significance level (SAS 9.2). Micropropagated plants of the three cultivars had more major canes and greater plant dry weight than plants from rooted cuttings at planting and after the first growing season**.** Location by propagation interaction was not significant, except for plant width and root to shoot ratio, and differences among propagation types were observed in Citra but not in Haines City. After the first harvest, treatment means across locations showed a significant increase in height, width, volume, number of canes and shoots, and cane and plant dry weights for micropropagated 'Emerald' and 'Jewel' compared to cutting-derived plants, but there was no significant effect on size or dry weight of 'Primadonna'. By Nov. 2011, cane and total shoot dry weights of micropropagated 'Emerald' and 'Jewel' plants were greater than plants from softwood cuttings, but plant dry weight was only greater for micropropagated 'Jewel' plants. Micropropagation resulted in higher leaf dry weight at the end of each growing season in Citra but not in Haines City. After the second growing season, micropropagated plants of all cultivars had more canes, total shoot number was greater only for micropropagated 'Jewel' plants, and there was no significant effect of propagation method on total shoots, size, or dry weight for 'Primadonna'.

(287) Nitrogen Fertilization Rate, Sawdust Mulch, and Pre-Plant Incorporation of Sawdust—Long-term Impact on Yield, Fruit Quality, and Soil and Plant Nutrition in 'Elliott' Blueberry

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A planting of 'Elliott' northern highbush blueberry was established in Oct. 2003. Treatments were: 1) raised beds constructed with or without the incorporation of sawdust; 2) with or without application of a sawdust mulch after planting; and 3) nitrogen (N) fertilizer rate (low: 22–56 kg/ha; medium: 67–168 kg/ha; and high: 112–269 kg/ha, depending on planting age). There was no significant effect of N rate on machine-harvested yield which increased from 10.8 t/ha in 2006 to 21.1 t/ha in 2011. While cumulative yield has not been affected by incorporation of sawdust or mulch, plots in which sawdust was incorporated before planting had a higher cumulative yield if no mulch was used (103.3 t/ha vs. 93.6 t/ha for mulched) whereas the opposite was true for plots in which no sawdust was incorporated (89.1 t/ha and 94.6 t/ha, for bare soil or with sawdust mulch, respectively). While leaf N concentration has been lower than recommended standards in some years, this has had no negative impact on yield. Nitrogen fertilization with the high rate decreased average berry weight in all years. Plots in which no sawdust was incorporated before planting had greater berry weight when sawdust mulch was used (2.13 g) compared to unmulched plots (2.09 g). To date, there has been no treatment effect on the firmness of berries picked by hand, just prior to machine harvest. Plants fertilized with the low rate of N had a lower fruit N concentration at harvest in 2010, but not in 2011. Fertilization rate and use of sawdust before or after planting has affected soil organic matter and nutrient content. Soil pH of plots fertilized with the high rate of N was lower than in plots fertilized with the medium or low rate of N in 2010. Implications of planting management on long-term sustainability will be presented.

Specified Source(s) of Funding: Oregon Blueberry Commission

(288) Seed Set and Berry Development in Commercially Grown Blueberry Cultivars

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The relationship between seed number and berry weight was evaluated for 10 highbush blueberry cultivars (Duke, Liberty, Bluecrop, Bluejay, Legacy, Draper, Reka, Aurora, Ozarkblue, and Bluegold) throughout their respective fruiting seasons in 2009 and 2010. In each cultivar, fruit were harvested weekly, from which 10-berry samples were selected for each of three berry size categories (smallest, medium and largest diameter fruit for the respective cultivar). Seeds were separated from fruit by smashing and decanting fruit pulp by hand. Air-dried seeds retained by a 0.57-mm wire mesh screen were counted as viable seed, and weights of viable and unviable seed recorded. There was a positive linear relationship between the number of viable seeds/berry and berry weight in all cultivars except 'Draper'. Some cultivars with longer fruiting seasons ('Duke', 'Liberty', 'Legacy', 'Aurora,' and 'Ozarkblue' in 2009; 'Aurora' and 'Ozarkblue' in 2010) tended to have more seeds/berry in early-harvested fruit than in late-harvested fruit within berries of a similar weight. 'Aurora', 'Bluegold', and 'Liberty' produced small, but commercially acceptable fruit, with as few as 1 seed/berry in 2009. In contrast, 'Bluejay' and 'Bluecrop' had at no fewer than 32 or 43 seeds/berry, respectively, in 2010. The highest mean number of viable seeds/berry was recorded in 'Bluecrop' in 2010 (65 seeds) and the lowest in 'Bluegold' and 'Liberty' in 2009 (15 and 16 seeds/berry, respectively).

Specified Source(s) of Funding: Oregon Blueberry Commission

(289) New Discoveries in Cranberry Bud Development

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Cranberry (*Vaccinium macrocarpon* Ait.) is a perennial fruit crop native to northeastern continental America. Terminal buds of cranberry contain a vegetative meristem and, at times, flower initials that are important determinants of next season's crop. Biennial bearing is believed to contribute to the reproductive fate of buds, so that uprights fruiting one year will be less likely to set reproductive buds and fruit the following year. Currently, the industry uses visual assessment of bud external appearance to predict potential yield. Buds that are perceivably large and round are considered to be reproductive (fruiting), whereas small and narrow buds are considered to be vegetative. Such methods of yield prediction are widely used among growers and the industry. Yet, the margin of error between predicted and expected yield is often large. In order to improve the accuracy of yield prediction, it is necessary to develop a more complete understanding of cranberry bud development. The objectives of this project are to: 1) characterize bud development and flower initiation throughout an entire growing season; 2) compare development across several cultivars; and 3) determine the relationship between bud external appearance and the presence/absence of flower initials. One hundred uprights of the cultivars Searles, Stevens, Crimson Queen, and HyRed were collected every 2 weeks from a marsh located in central Wisconsin. Sampling extended from March to Dec. 2011 and will continue in 2012. Uprights were dissected and examined using light and scanning electron microscopy (SEM). Flower initials were first visible by 29 July. Preliminary results indicate that many of the assumed vegetative buds contain flower initials, which is counter to conventional knowledge on cranberry bud development. An exception to this finding was found with the older cultivar, Searles. These data suggest that recently released cultivars have a greater capacity to form flowers, regardless of the previous or current year's fruiting status. Continued monitoring and assessment of bud fate will occur in 2012. Based on the presented results, current approaches to yield prediction may be in need of reevaluation. Furthermore, these findings lay the foundation for additional investigations on the physiology of bud development in cranberry. An enhanced understanding of cranberry bud development is imperative as we seek to improve our understanding of yield.

(290) Type of Stem Cutting Affects Asexual Propagation of Sparkleberry (*Vaccinium arboreum*)

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Sparkleberry, *Vaccinium arboreum*, is one of the few *Vaccinium* species that can tolerate a wide range of soil conditions. Commercial blueberries, particularly *Vaccinium corymbosum*, have very specific needs for optimum growth; hence, growing sites are limited. Sparkleberry can potentially be used as a rootstock or in breeding efforts to gain desirable traits in commercial blueberry production. Sparkleberry is also an attractive woodland shrub or small tree for xeriscaping and native plant landscaping in the southeast United States. Currently, *V. arboreum* plants are commercially propagated from seeds, as asexual propagation techniques have been unsuccessful. A viable way to clonally propagate sparkleberry is necessary to allow for selection of plants with desirable rootstock and ornamental characteristics. The objectives of this study were to determine whether cutting type (softwood, semi-hardwood, or hardwood), cutting position (terminal or subterminal), IBA concentration, or the interaction

of these treatments influence rooting of *V. arboreum* stem cuttings. Only juvenile wood was used in this study. Greatest rooting percentages were obtained from softwood cuttings (29.2% to 43.2%). Limited rooting occurred with hardwood cuttings (2.0% to 10.6%). Rooting percentages were variable for semi-hardwood cuttings (9.2% to 28.5%). The IBA treatments did not affect rooting percentages of sparkleberry stem cuttings. Since previous studies have reported little to no rooting success of sparkleberry stem cuttings, the rooting percentages observed using juvenile softwood cuttings were encouraging and provide basis for further research to improve asexual propagation techniques.

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Weed Control and Pest Management

(117) Efficacy and Safety of Selected Herbicides on Container-grown Herbaceous Ornamental Plants

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In containerized production of herbaceous ornamentals, weedy plant species compete for moisture and nutrients, often resulting in ornamentals with reduced growth and poor aesthetics. Hand weeding is costly and labor intensive. Many currently available herbicides labeled for use on agronomic crops cannot legally be used for weed control for many container-grown herbaceous ornamentals because the products have not been labeled for use on those crops. The U.S. Department of Agriculture's IR-4 Project coordinates research to determine the efficacy and safety of pest control products on horticultural crops. The objectives of the 2011 study were to determine weed control efficacy and effects on crop plant growth of four preemergent herbicides (Certainty, Echelon, Freehand, and Snapshot) on 13 species of container-grown herbaceous ornamentals (*Artemisia frigida*, *Geranium macrorrhizum*, *Helianthemum nummularium*, *Hierochloe odorata*, *Lamiastrum galeobdolon*, *Liatris spicata*, *Matthiola incana*, *Phlox subulata*, *Santolina chamaecyparissus*, *Scabiosa columbaria*, *Tagetes erecta*, *Veronica spicata*, and *Veronica austriaca* subsp. *teucrium*). Although not all four products were evaluated on all 13 species, two products were evaluated on *Helianthemum nummularium* and *Liatris spicata*. Each product was evaluated at three rates: the suggested label rate (1×), two times the suggested label rate (2×), and four times the suggested label rate (4×). Plants growing in the treated containers were compared to plants growing in the weedy control (WC) and weed-free control (WFC) containers. Each treatment was replicated five times, and the experiments were conducted two times. In all containers except the WFC containers, 20 seeds of each of five weedy plant species were sown into growing media prior to the first application of herbicide products. For each experiment, the herbicide products were applied two times, with the second application 6 weeks after the first. Counts of weedy plant species growing in each container were taken in August. Height and width measurements were recorded for each plant at the beginning and end of each experiment. Phytotoxicity data were collected periodically after herbicide applications. Each plant was harvested in mid August, placed in a paper bag, dried in a drying oven, and then weighed to determine dry mass. Results indicate that weed control efficacy improved when herbicides were applied at rates greater than the 1X rate. When applied at the three rates evaluated, Echelon, Freehand, and Snapshot had no adverse effects on the crop plants on which they evaluated. Certainty at all three rates stunted the growth and damaged some of the *Liatris spicata* plants.

Specified Source(s) of Funding: USDA IR-4 Project (http://ir4.rutgers.edu/)

(118) Evaluation of Anaerobic Soil Disinfestation (ASD) for Warm-season Vegetable Production in Tennessee

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Anaerobic soil disinfestation (ASD) is a non-chemical, pre-plant soil treatment developed to control soilborne plant pathogens, plant-parasitic nematodes, and weed populations in specialty crop production systems. Soil treatment by ASD involves the incorporation of a labile carbon source, tarping with plastic, and irrigation of the topsoil to saturation (~5 cm irrigation) in order to create conditions conducive to anaerobic decomposition of the added carbon source. A field study was implemented in Mar. 2011 in Knoxville, TN to evaluate potential carbon sources for ASD prior to production of fresh-market tomato (*Solanum lycopersicum* cv. Red Defender) and bell pepper (*Capsicum annum* cv. Red Knight X3R). Carbon sources included: 1) dried molasses (5.6 $Mg \cdot ha^{-1}$); 2) cereal rye (*Secale cereale*) cover crop residue (9.3 $Mg \cdot ha^{-1}$); 3) cereal rye residue supplemented with dried molasses (1.1 $Mg \cdot ha^{-1}$); 4) mixture of mustard (*Brassica juncea* and *Sinapsis alba)* and arugula (*Eruca sativa*) cover crop residue (5.8 $Mg \cdot ha^{-1}$); 5) mixture of mustard/arugula cover crop residue supplemented with dried molasses (1.1 $Mg \cdot ha^{-1}$); 6) mustard seed meal (2.2 $Mg \cdot ha^{-1}$, biofumigant control); and 7) an untreated control. Plots (22.3 m^2) were arranged in a randomized complete block design. Following incorporation of amendments and cover crops, raised beds were formed in the center of each

An asterisk (*) following a name indicates the presenting author.

plot and irrigated. Treatment continued for a 3-week period, during which time soil redox potential (a measure of anaerobic activity shown to be correlated with pathogen mortality during ASD treatment), soil temperature, and soil moisture were continuously monitored. Following ASD treatment, tomato and bell pepper were transplanted on half of each plot and treatment impacts on vegetable yield, plant nutrition, soil fertility, weed control, and plant disease evaluated. Accumulation of anaerobic conditions was highest ($P < 0.05$) in both treatments which included cereal rye residue as a carbon source and lowest in the untreated and biofumigant controls. Weed populations were low throughout the study, and all treatments were generally similar to the controls in numbers of monocot and dicot weeds. Marketable yields of both tomato and bell pepper did not differ among treatments suggesting that pathogen and weed pressure were not high enough at this site to adequately evaluate ASD treatment.

Specified Source(s) of Funding: Funded in part by USDA–NIFA Methyl Bromide Transitions Agreement 2010-51102-21707

(119) Response of Broccoli and Cabbage Hybrid Cultivars to Clomazone

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Clomazone herbicide (Command 3ME) is registered for cabbage in the U.S., but not for other cultivar groups within *Brassica oleracea*. Cabbage cultivars vary in clomazone tolerance, and recommended use rates can cause severe foliar chlorosis and yield reduction to susceptible cultivars. The objective of this research was to compare the tolerance of broccoli and cabbage cultivars to clomazone in order to assess the potential for using clomazone for weed management in broccoli production. Broccoli (Captain, Green Magic, Legacy, and Patron) and cabbage (Bravo, SC 100, Stone Head, and Vantage Point) cultivars with varying tolerance to clomazone were selected from previous reports or based on observations from preliminary screening experiments. In a greenhouse concentration-response experiment, seedlings were transplanted into potting medium containing clomazone at 0, 0.25, 0.5, 1.0, 2.0, and 4.0 mg ai/kg soil. 'Bravo' cabbage was most susceptible, and its injury ratings at 0.5 mg/kg were similar to ratings for the other cabbage cultivars at 2.0 mg/kg. 'Bravo' shoot weight reduction at 0.25 mg/kg was similar to the other cabbage cultivars at 1.0 mg/kg. The broccoli cultivars also varied in clomazone tolerance. 'Patron' was highly susceptible, exhibiting injury and shoot weight reduction similar to 'Bravo'. 'Green Magic' was most tolerant, and it exhibited injury and growth reduction levels similar to the tolerant cabbage cultivars. A field experiment was conducted to assess the tolerance of the eight cultivars to clomazone applied pre-transplanting. Application rates were 0.28 (the recommended rate for broccoli on sandy soils) and 0.56 kg ai/ha for an experiment planted in Mar. 2011 and 0.28, 0.56, and 1.12 kg/ha for an experiment planted in Sept. 2011. Clomazone at 0.28 kg/ha cause only minor chlorosis to the susceptible cultivars, 'Bravo' and 'Patron'. Injured plants recovered, and no chlorosis was visible at maturity. At 1.12 kg/ha all cultivars exhibited chlorosis early; however, the tolerant cultivars recovered rapidly and no injury was visible at mid season. At 1.12 kg/ha, 'Bravo' and 'Patron' exhibited severe chlorosis early, and moderate chlorosis persisted until harvest. Clomazone did not reduce average head weight or percentage of plants producing marketable heads. This study indicates that the range of clomazone tolerance in broccoli cultivars is similar to that in cabbage cultivars, and that the herbicide can be used safely on tolerant broccoli cultivars at rates that are labeled for cabbage.

(120) Foliar Applications of Micro- and Macronutrients to Control ACP in Citrus

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One of the major diseases affecting citrus production in Florida is Citrus Greening Disease (HLB), whose major vector is the Asian Citrus Psyllid (ACP, *Diaphorina citri*). This destructive disease has affected citrus crops in Florida, Mexico and Brazil. The insect vector (ACP) has spread throughout Florida and Texas. Being that there is no cure for the bacterial disease HLB, many approaches have been made in order to repel and control ACP, from intensive chemical control programs to mechanical control. Another approach that has shown effectiveness in sustaining production in infected orange orchards in Florida has included a nutritional management program using the "Maury Boyd cocktail" that contains a combination of micro- and macro-nutrients. However, few studies have focused on nutrient management impacts on grapefruit (*Citrus paradisi*) production in relation to ACP control. This study focuses on manipulating different micro- and macronutrients found in the Maury Boyd cocktail (i.e., potassium, calcium, etc.), and their effects on ACP populations. Preliminary results have demonstrated positive results showing that calcium alone and in combination with other nutrients, has an impact on decreasing ACP populations in mature 'Rio Red' grapefruit trees.

Specified Source(s) of Funding: Texas Citrus Producers Board

(121) Genetic Variability of *Mycosphaerella fijiensis* Morelet from Mexico Mediated Microsatellite Markers

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Knowledge of genetic variability of *Mycosphaerella fijiensis* is important for understanding the biology of populations. This information can help us to predict the evolutionary potential of populations and establish more efficient strategies to control and the disease. In Mexico, *M. fijiensis* was found for first time in the States of Chiapas and Tabasco in 1981, while in the State of Colima was identified in 1989, followed by Michoacan in next year. The aim of this study was to determine the genetic variability of 83 isolates of *M. fijiensis* from regions of the Colima, Jalisco, Michoacan, Tabasco and Chiapas States; for this goal it was conducted the analysis of 10 SSR loci. The results have demonstrated an average of 3 alleles by locus, and has been identified a total of 30 alleles. A percentage of 96.6% of polymorphic alleles were obtained. It was found 5 alleles in the locus MfSSR41, whereas *Mf*SSR306, *Mf*SSR333 and *Mf*SSR315 loci showed 2 alleles each. The dendrogram showed four groups; Group I included isolates from Colima (20 isolates), which showed a genetic similarity of 1.0. Group II comprised six isolates from Tabasco and nine of Michoacan. Group III consisted of 12 from Michoacan and 2 from Chiapas, the latter are genetically less similar. Group IV was comprised of 20 of Chiapas and Tabasco 14. The clusters show genetic variability. There was genetic variability among isolates of Colima, whereas if there between Michoacan. The more isolated genetically variable could adapt more quickly to host resistance or fungicides. This work is being funded by FORDECyT–CONACyT contract No. 116886

Specified Source(s) of Funding: Consejo Nacional de Ciencia y Tecnología

(122) A Non-protein Amino Acid from *Crotalaria juncea* Foliage with Allelopathic Potential

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Crotalaria juncea L. (sunn hemp) is a leguminous fiber crop that has shown excellent potential for use as a summer cover crop and green manure. Because of its prolific biomass production, sunn hemp readily suppresses weeds in situ as a cover crop, as well as when shoot residue is retained as organic mulch. We have previously reported on the allelopathic potential of water-soluble extracts and dried residues of sunn hemp shoots of a single commercially available sunn hemp cultivar. Because we had access to a number of sunn hemp accessions collected from various parts of the world, a study was designed with the objective of characterizing the nature and properties of allelochemicals in sunn hemp accessions. Bioassays for radicle growth inhibition were conducted with water eluates from thinly sliced leaves, stems and seeds and all three tissues were demonstrated to contain the inhibitory potential. All of the 14 sunn hemp accessions originating from the United States, India, Brazil, South Africa, Pakistan, and Nigeria were found to have water-soluble allelochemicals in leaves, suggesting that the presence of allelochemicals is widely distributed in this species. The highest level of inhibitory potential was found in accession IN-86 from India. Further characterization of IN-86 leaf eluate indicated that the inhibitory compound(s) was/were not soluble in chloroform, stable when boiled for 10 minutes, and resistant to 1 N HCl. Binding and elution from AG1(OH^-) ion exchange resin also were observed. HPLC/MS analysis of leaf eluates of IN-86 showed the presence of a compound with an m/z of 148, consistent with the spectrum for hydroxynorleucine, a phytotoxic non-protein amino acid previously reported in seeds of *C. juncea*. We suggest that development of weed control strategies using allelochemicals derived from biomass of select sunn hemp genotypes may be feasible.

Specified Source(s) of Funding: Southern SARE Research and Education Grant L08-205

(123) Effects of Cover Crops on Soil Environmental Factors and Weed Suppression

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Weed control in organic systems is often solely dependent upon cultivation and use of cover crops due to prohibited use of synthetic herbicides. Cover crops suppress weeds both physically and chemically by altering the soil microenvironment and increasing competition for resources. The purpose of this study was to quantify the effects of eight cover crops on soil environmental factors and weed suppression in a field setting. Cover crop treatments included alfalfa (*Medicago sativa* L. 'Vernal'), crimson clover (*Trifolium incarnatum* L.), Dutch white clover (*Trifolium repens* L.), annual ryegrass (*Lolium multiflorum*

Lam.), winter rye (*Secale cereale* L.), soybean [*Glycine max* (L.) Merr. 'Viking O.2265'], forage radish (*Raphanus sativus* L. var. *longipinnatus* 'Tillage Radish'), hairy vetch (*Vicia villosa* Roth.), and two mixtures—crimson with Dutch white clover and winter rye with hairy vetch. Cover crops were seeded at two planting dates in mid summer 2011 in Durham, NH, in a randomized complete-block design with four replications. A fallow (no cover crop) treatment was included in the study. Cover crop and weed density and biomass, percent light transmittance at soil surface, leaf area index (LAI), soil temperature and soil moisture were measured in each treatment in early fall. Significant correlations were found between the percentage of light transmittance, soil moisture and soil temperatures, and total weed biomass. Greater cover crop biomass was associated with reduced light transmittance, lower soil temperatures, and decreased weed biomass. Forage radish, hairy vetch, crimson clover, and the crimson–Dutch white clover mix produced leaf canopies with highest LAI and least light transmittance at ground level. High LAI and lower light levels at soil surface corresponded with lower soil temperature in these plots. Dutch white clover produced the least dense leaf canopy and had plots with highest densities of weeds. Of these crops, forage radish seeded at 28 kg/ha was most effective in reducing total weed density and biomass. More specifically, forage radish was markedly more effective at suppressing crabgrass (*Digitaria* spp.), a problematic weed prevalent at the field site. Forage radish is a new cover crop for the Northeast and has been touted for N sequestration and soil quality benefits. In addition to these potential benefits, this cover crop appears to be highly effective at suppressing weeds and may be useful in organic production systems.

Specified Source(s) of Funding: USDA–Hatch, New Hampshire Agricultural Experiment Station

(124) Effects of Phosphite on *Fusarium oxysporum* in *Washingtonia robusta*

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Fusarium wilt is a lethal, vascular wilt disease of palms. It is caused by the fungus *Fusarium oxysporum* f. sp. *palmarum* (*F. o. palmarum*) in *Washingtonia robusta* and *Syagrus romanzoffiana*. Currently, there is no treatment for this disease. This study was conducted to determine if *F. o. palmarum* has in vitro sensitivity to phosphite and to compare the results with greenhouse trials to determine if phosphite has direct and/or indirect effects on the pathogen in *W. robusta*. We tested two isolates of this fungus: one isolated from *W. robusta* (PLM-249A) and one isolated from *S. romanzoffiana* (PLM-140B). Seven concentrations (0, 1, 5, 10, 20, 40, or 60 $\mu g \cdot mL^{-1}$) of potassium phosphite (phosphite) were used to evaluate their effects on in vitro fungal growth, using 1/5-strength potato dextrose agar (PDA) as the base medium. Growth of both fungal isolates consistently decreased as the phosphite concentration was increased. Growth suppression of the two isolates was similar at 1, 5, 10 and 20 $\mu g \cdot mL^{-1}$, but PLM-140B had greater growth suppression than PLM-249B at 40 and 60 $\mu g \cdot mL^{-1}$. Forty greenhouse-grown *Washingtonia robusta* seedlings were treated with soil drenches or foliar sprays of phosphite, each at concentrations of 2.64 $mL \cdot L^{-1}$ and 5.28 $mL \cdot L^{-1}$. Five weeks later they were inoculated with *F. o. palmarum* to determine the efficacy of phosphite in controlling Fusarium wilt in vivo.

Wednesday, August 1, 2012 Grand Ballroom

Bioenergy

(108) Strategies for Increasing the Harvest Window of Sweet Sorghum in Arizona

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As our dependence on fossil fuels is being weaned, domestic alternatives to petroleum are being investigated. We have previously reported that sweet sorghum (*Sorghum bicolor* Moensch) can be grown in Arizona with reduced inputs and on marginal lands not otherwise suitable for food crops. Current harvest times are determined by flowering; 30 days after half of the plants are flowering. In previous studies, we collected single stalk samples over the entire growing season and hypothesized that some lines could be harvested earlier with the same sugar yield, thus reducing time and inputs, while adding the potential for a second crop. In regions with longer growing seasons, such as Arizona, the capability to have multiple harvests or double crop sweet sorghum is important as it adds flexibility to management systems and extends the harvest season, as well as providing a more constant availability of feedstock for processing facilities. Four varieties (Dale, M81E. 350FS, and Sugar T), with different days to maturity, were planted on 26 May 2011, and harvested at four dates (90, 120, 150, and 180 days after planting). The harvested area was 3.05 m in the middle two rows of each plot, with three replications. Stalks were cut at 3 cm above the soil level and the field weight of the plots recorded. A sub-sample of 15 cut plants was weighed, then stripped of leaves and panicles, and weighed again. The 15 stripped stalks were run through a roller mill, and the juice collected and weighed. °Brix was recorded in the field, and juice samples transported on ice to the laboratory for sugar analysis using HPLC. The field biomass did not change significantly among any of the harvests or varieties. There were significant interactions among varieties and harvest dates for juice weight; with juice weight highest for 350FS and Sugar T at all harvest dates, but not significantly higher than M81E at 120 and 180 days. There was a significant increase in

total sugar, with most varieties doubling between 90 and 120 days, but the differences between the last two harvests were not significant. We have previously shown that biomass and total sugar are the best predictors of ethanol yield, so these data indicate that 350FS, M81E, and Sugar T can all be harvested at 150 days, 30 days earlier than predicted by plot flowering, and Dale harvested at 120 days after planting.

Specified Source(s) of Funding: Sun Grant, Western Region

(109) Exploration of Simple Sequence Repeat (SSR) Markers from *Miscanthus*

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The genus *Miscanthus* has been focused as an alternative bioenergy crop because of its higher productivity potential, non-food crop, marginal land use and stress resistance. However, despite the agronomic and economic significance, the whole genome and molecular markers study of the *Miscanthus* is primitive. Molecular markers associated with agriculturally important traits can be used for MAS (Marker Assisted Selection) at early stage to accelerate breeding of valuable cultivars. In the previous study, we obtained the ESTs (Expressed sequence tags) from the cDNA libraries using different tissue of leaf and rhizome in the *M. sinensis* (diploid) and *M. sacchariflorus* (tetraploid). In this study, we used a SSR search-module program 'SciRoKo' to find SSR markers. The number of SSR motif in the EST library was 1,158 for *M. sacchariflorus* (leaf: 549, rhizome: 609) and 1,724 for *M. sinensis* (leaf: 948, rhizome: 776). The most common repeat motifs were tri-nucleotide, while penta-nucleotide was lowest. Among the SSR markers detected, major tri-nucleotide repeats were CCG and AGC. Based on the ORF Predictor to screen the SSR location in the genome, the majority of the SSR motifs were located in the ORF regions than untranslated regions (UTR). Even though the tri-nucleotides were localized in the ORF region highly, di- and tetra-nucleotides were more frequent in UTR regions. We will use those SSR markers to identify enhanced biomass *Miscanthus* genotype and to map the quantitative trait loci (QTL) of interest.

Specified Source(s) of Funding: This work was supported by grants from the Next-Generation BioGreen 21 Program, RDA and from the IPET, MFAFF of Korea.

(110) Assessment of Glucose and Stem Dry Weight among 16 *Crotalaria juncea* Accessions for Potential Cellulosic Ethanol

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Sunn hemp, *Crotalaria juncea* L. is a tropical legume grown primarily for fiber, cover cropping, and as a green manure crop with the potential to contribute to sustainability. Sunn hemp stems are potentially high sources of cellulose for the production of cellulosic ethanol. Sixteen sunn hemp accessions were grown in Griffin, GA, during 2008 and examined for stem glucose and stem dry weight. The data were subjected to an analysis of variance and cluster analysis. Significant variation for both glucose and stem dry weight were found among these 16 sunn hemp accessions. We found that the accessions, PI 250487, PI 337080, and PI 219717 were the highest producers of glucose averaging 813 mg/g per accession while PI 468956, PI 234771, and PI 322377 stems weighed the most averaging 234 g per accession. Cluster analysis separated sunn hemp accessions into four groups (clusters) based on very high, high, medium, and low concentrations of glucose. Some of these sunn hemp accessions could be used for the production of cellulosic ethanol as well as parents in a hybridization program for enhancing glucose and stem weight.

(111) Chromosome Doubling and Fertility Restoration in *Miscanthus* ×*giganteus*

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Miscanthus ×*giganteus* is a highly infertile allotriploid ($2n = 3x = 57$) hybrid between a tetraploid *Miscanthus sacchariflorus* ($2n = 4x = 76$) and a diploid *Miscanthus sinensis* ($2n = 2x = 38$). This hybrid has considerable potential as a bioenergy crop; however, the lack of fertility has restricted the use of *M.* ×*giganteus* for crop improvement through conventional breeding approaches. Chromosome doubling can be a viable approach for restoring fertility in interspecific hybrids. In the current study, oryzalin-mediate in vitro chromosome doubling was used to develop hexaploid *M.* ×*giganteus* cytotypes which were assessed for fertility. Pollen viability staining increased up to 88% in the hexaploid cytotypes compared to 34% for triploid *M.* ×*giganteus*. To further test fertility, reciprocal crosses between hexaploid *M.* ×*giganteus* and diploid *M. sinensis* were conducted. A total of 466 seed were obtained from approximately 4,000 individual florets from 8 hexaploid *M.* ×*giganteus* inflorescences. Many seeds appeared to abort and contained little or no endosperm. Therefore in vitro embryo culture was utilized on MS media supplemented with 20 μM 6-benzylamino purine. Forty-six embryos germinated, however, only nine developed into plantlets that could be transferred to the greenhouse. Using flow cytometry, all recovered plants were determined to be tetraploid representing hybridization events between hexaploid *M.* ×*giganteus* and diploid *M. sinensis*. In contrast, all progeny from diploid *M. sinensis* were diploid, most likely arising from selfing. The restoration of fertility to *M.* ×*giganteus* may allow this valuable germplasm to be incorporated into future breeding programs for bioenergy crop improvement.

(112) Research of Switchgrass Growth Habits and Its Mutagenesis

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Bioethanol can be obtained from grains or cellulosic biomass. It has been known that switchgrass, which is a lignocellulose source can become a potential cheap, renewable biomass material to produce bioethanol. The amount and quality of switchgrass leaf biomass are determined not only by the ontogenetic processes within the leaf, but also are known to be affected by environmental conditions. In this experiment, we first investigated the growth habits of switchgrass 'alamo' under different stress (drought and salt treatment) conditions during leaf emergence. Each treatment cycle was administered for 5–10 days. We recorded changes in root length before and after the treatments, and observed roots' growing region. According to the data, our primary results showed that the root growth primarily occurs at the very tips. For the salt treated plants, total cessation of root growth was observed, while for the drought treated ones, root growth was observed until the plant experienced complete water scarcity. Second, we investigated the mutagenesis of switchgrass. We treated the seeds with sodium azide and EMS (Ethyl Methan Sulfonate), calculated the germination rate after treatments, and tried to find mutant individuals which have resistance to stress environment. Switchgrass "foxtail" seeds were soaked in distilled water over night and then were dipped in 2% and 4% phosphate buffer solution of EMS for 8 hours. Another batch of 'alamo' seeds were soaked in distilled water over night and then treated with 5 mM, 10 mM, 20 mM oxygenated sodium azide for the following durations: 1, 2, and 4 hours, respectively. The results showed that the best condition for sodium azide mutagenesis for alamo was at 10 mM for 4 hours, which resulted in a 50% germination rate. As for the EMS mutagenesis, better condition came at 2% for 8 hours treatment, which got a 40% germination rate. Our identification of mutant individuals is still in progress and we will further study how the root apex growth affects the plants emergence, vegetative growth, maturation and senescence, especially under stress conditions.

Specified Source(s) of Funding: NIFA–AFRI and Capacity Building Program

Wednesday, August 1, 2012 Grand Ballroom

Floriculture

(257) Response of Selected Garden Rose Cultivars to Salt Stress

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High-quality water supply is often limited to gardening and landscaping in many regions of the world. Soil salinity is exacerbated due to irrigation with low quality water. A greenhouse study was conducted to evaluate six garden rose cultivars ('Caldwell Pink', 'Marie Pavie', 'New Dawn', 'The Fairy', 'Knock Out', and 'Carefree Delight') in response to salt stress. Plants grown in 5.7-L containers with a peat-based substrate were subjected to three salinity levels, 1.5 (control), 4.0 and 8.0 dS/m electrical conductivity (EC) (moderate and high salinity levels). The salt solutions were prepared by adding sodium chloride (NaCl) and calcium chloride ($CaCl_2$) at 2:1 molar ratio to nutrient solution containing 125 mg·L^{-1} 15 N–2.2 P–12.4 K. At moderate and high salinity levels, shoot growth decreased in all cultivars with the exception of 'New Dawn', and with 'Marie Pavie' and 'Caldwell Pink' having the greatest growth reductions (69% and 68%, respectively) at 8.0 dS/mEC. Flower numbers decreased at high and moderate salinity levels in all cultivars except 'New Dawn' and 'Knock Out'. In 'The Fairy', 'Marie Pavie', and 'Knock Out', no differences were found in leaf conductance between 1.5 and 4.0 dS/m EC, and it was reduced at 8.0 dS/m EC in all cultivars. 'Caldwell Pink' and 'The Fairy' had greatest reductions in leaf conductance at 8.0 dS/m EC, followed by 'Marie Pavie', 'New Dawn', 'Carefree Delight', and 'Knock Out'. Chlorophyll fluorescence decreased as salt level increased, which was lowest in 'Caldwell Pink'. The six rose cultivars responded differently to elevated salinity, and 'New Dawn' was considered to be more tolerant to salt stress compared to the other five cultivars with its least reductions in shoot growth and flower numbers and highest chlorophyll fluorescence.

(258) Disease Development in Ethylene Insensitive *etr1-1* Petunia Infected by *Thielaviopsis basicola* under Low Phosphorus Stress

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Thielaviopsis basicola is a soil-borne, plant-pathogenic fungus devastating many bedding plants and floricultural crops. Plants infected by this fungus are characterized by stunted shoot growth, yellow or necrotic leaves, and black regions on roots, hence the common name "black root rot." Despite the significance of black root rot disease, little is known about how the disease is influenced by plant hormones and nutrition. In preliminary

experiments, we observed chlorotic and necrotic leaves developing from the lower stem of petunia infected by *Thielaviopsis basicola*. The absence of typical root symptoms prompted us to question whether the severity of shoot disease symptoms is directly related to the extent of root infection. Therefore, this study was conducted to elucidate how disease development symptoms are influenced by the interaction of phosphorus nutrition and ethylene sensitivity, and whether a correlation exists between the degree of disease symptom development in the shoot and the fungal population in infected roots. Low phosphorus dramatically enhanced disease symptom development, as measured by percent necrotic leaves, in both wild-type and *etr1-1* petunias during a 7-week period after transplanting. Ethylene insensitive *etr1-1* petunia developed earlier and more severe disease symptoms than the wild-type during the first 4 weeks after transplanting, but showed less severe symptoms at 7 weeks as compared to the wild-type, indicating that ethylene plays an important role in symptom development. Disease symptom development was positively correlated with the number of colonies that grew from root segments plated on a *Thielaviopsis* selective medium (TB-CEN) in both wild-type and *etr1-1* petunia. The *etr1-1* petunias displayed more severe disease development symptoms compared to wild-type when the roots were equally infected by *T. basicola*. Inoculation methods and environmental conditions considerably influenced disease severity.

(259) Using Light Emitting Diodes for Early Development of Flowering Plants

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Panels of light emitting diodes (LEDs) designed for plant growth often provide spectral peaks centered on blue (450 nm) and red (630–660 nm) wavelengths. The primary reason for using a spectral profile of this type is the observed high rates of photosynthesis. Although red and blue irradiance may effectively drive photosynthesis, most plants have developed in a continuous natural light spectrum. Flowering and morphological development may be altered in a monochromatic spectrum compared to day light conditions. In addition, plant pigments readily absorb the red and blue wavelength energies resulting in limited transmission through leaves and canopies. A balanced spectrum may therefore, be more beneficial for overall crop growth and development. Using white LEDs or adding orange, orange-red and white LEDs to traditional red/blue grow light LEDs may be beneficial for fast production of high quality crops. Studies are needed to identify crop production applications where LEDs of limited as well as more balanced spectral energy distribution offer advantages. Four types of LED panels were evaluated for use during early development of the sunflower 'Sunny Smile'. The panels consisted of red LEDs (peak at 665 nm) supplemented with 10% blue LEDs (455 nm), blue LEDs (455 nm), white LEDs (3700 K), or a combination of 50% red (660 nm), 10% orange–red (635 nm), 10% orange (600 nm), 20% blue (450 nm) and 10% white (3700 K) LEDs. In addition, red (peak 635 nm) with 10% blue LEDs (peak 455 nm) in a fluorescent style arrangement and T5 fluorescent tubes were included. The sunflowers were propagated from seeds and transplanted 10 d later into 10 cm diameter containers. The plants were grown under the distinct light sources for 16 daily h, during a limited 14-d period initiated at transplant for the first set of plants and 14 d following transplant for a second set of plants. Photosynthetic photon flux (400 to 700 nm) at plant height was approximately 150 μmol·m^{-2}·s^{-1}. The plants were compared to sunflowers grown in a greenhouse of natural light supplemented with high-pressure sodium irradiance. Preliminary results suggest the various light sources support proper growth and development with only minor differences in rate of flowering and morphology. On average, flowering was recorded 8 weeks following transplant at a plant height of 25 cm and 20 developed leaves below the flower.

(260) *Cymbidium* Forcing Culture with Summer Cooling Systems under Night Interruption Cultivation

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This study was conducted in a commercial greenhouse to examine the effects of summer cooling control during forcing culture of *Cymbidium* 'Red Fire' and 'Yokihi', which included night interruption (NI) in winter. The greenhouse was divided into two sections for separate cooling control during the long day summer season. One section was cooled by a mist system (Mist), while the other was cooled by a shade screen (Shade). During short day season, the plants were grown with NI with low light intensity (LNI) of 3–7 μmol·m^{-2}·s^{-1} or high light intensity NI (HNI) of 120 μmo·m^{-2}·s^{-1} for 4 hours (22:00–02:00 HR), whereas the control plants were grown under natural short day condition. Summer cooling for 9 weeks and winter night interruption for 16 weeks were employed twice during the experimental period of two years. Day temperature was approximately 2 °C lower in the Mist than Shade, while the relative humidity of the Mist and Shade was 80 ± 5% and 55 ± 5%, respectively. The daily light integral of the Shade compartment was only 48% that of the Mist condition. The time to flowering pseudobulb emergence from initial planting for 'Red Fire' and 'Yokihi' was reduced by LNI and HNI regardless of the cooling treatments but the promotion effect was more in the Mist condition than the Shade. Leaf number and pseudobulb diameter increased more in the Mist condition than in Shade after 1 year cooling treatment. The plants that received NI followed by Mist condition flowered within 2 years, however, none of the plants flowered under the Shade condition. The time to flowering of the plants decreased and the number of flowers increased more in HNI than in LNI group. *Cymbidium* 'Red Fire' and 'Yokihi' could reach flowering within two years by summer cooling with Mist and winter forcing by NI treatment.

Specified Source(s) of Funding: National Research Foundation of Korea

(261) Experimental Variables to Consider When Using the DTPA Extraction Method for Estimating Micronutrients in Peat-based Substrate

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Estimating plant-available copper (Cu), iron (Fe), manganese (Mn), and zinc (Zn) in horticultural substrates is important in developing management practices for producing crops that are free of nutrient disorders (toxicity or deficiency) related to these micronutrients. The chelating agent diethylenetriaminepetaacetic acid (DTPA) is commonly used in extraction methods to estimate soluble Cu, Fe, Mn, and Zn in soil and soilless substrates. There are numerous variations of the DTPA extraction method, and the objectives of the study were to assess the experimental variables associated with (1) DTPA concentration, (2) pH/buffering of extractant solution, and (3) equilibration time, on extraction of micronutrients from peat-based substrate. Treatments included unbuffered 2, 4, and 6 mM DTPA extractant solutions at 15, 30, 45, and 60 min equilibration times (Expt. 1); and 4 mM DTPA extractant solutions buffered to pH 5.5, 6.0, 6.5, 7.0, 7.5, and 8.0 at 45 min equilibration time (Expt. 2). A 1:2 dilution by volume substrate:extractant solution method was used. Controls were deionized (DI) water extractions. In Expt. 1, extractant DTPA concentration and equilibration time were significant for Cu and Fe at $P < 0.05$, but there was no interaction between these variables. DTPA concentration but not equilibration time was significant at $P < 0.05$ for Mn and Zn. For Cu and Fe, as DTPA concentration increased or equilibration time increased, soluble levels of these metals also increased. For Mn and Zn, DTPA concentration was not different but was significantly greater than the DI water extraction. In Expt. 2, buffered DTPA extractant treatments were significant for Cu, Fe, Mn, and Zn ($P < 0.01$). From pH 5.5 to 8.0, Cu (0.05 to 0.02 mg·L^{-1}), Fe (3.61 to 0.01 mg·L^{-1}), and Zn (0.25 to 0.15 mg·L^{-1}) concentrations in extracts steadily decreased linearly ($r^2 > 0.93$). Concentrations of Mn decreased from pH 5.5 to 6.0 [3.14 mg·L^{-1} Mn (mean for pH range)], leveled-off from pH 6.5 to 7.0 (2.84 mg·L^{-1} Mn), and decreased again from pH 7.5 to 8.0 (2.32 mg·L^{-1} Mn) with data fitting a 3rd order polynomial ($r^2 > 0.99$). The results of the study demonstrate the importance of considering chelating agent concentration, pH, and equilibration time for DTPA extractions when interpreting results of this soil/soilless test method when estimating micronutrients from peat-based substrate.

(262) Identification and Characterization of Genes Differentially Expressed in *Phalaenopsis aphrodite* Roots under Nutrient Deficiency Stress

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Phalaenopsis aphrodite Rchb. f. is an epiphyte native to tropical broadleaf forest in Taiwan. Epiphytic roots attach to the surface of tree trunks instead of growing in soil. Unique structures and morphology of *Phalaenopsis* roots include velamen outside epidermis, passage cells in endodermis, absence of root hairs, and lack or absence of branch roots. Understanding the mechanism of nutrient uptake and metabolism in *Phalaenopsis* is important to determine how efficient nutrient usage is achieved under intermittent supply. *Phalaenopsis* Sogo Yukidian 'V3' was fertilized with various deficient concentrations of N, P, and K every 2 weeks. After 8 weeks of treatment in 30/25°C, plants were transferred to 25/20°C to induce spiking. No apparent phenotype differences were observed from treatments of N, P, or K deficiency after 8 weeks in the vegetative stage. However, the treatments affected spiking rates dramatically and deficiency symptoms started to show on the leaf after flowering. Microarray analysis revealed differential gene expression in roots. There were 11 up-regulated and 37 down-regulated genes commonly appearing in roots under N, P, or K deficiency stress. The transcript level of a phosphate transporter increased significantly under phosphate deficiency. One of the zinc finger transcription factors, GATA, increased under N, P, or K deficiency stress. Mineral contents between treatments were analyzed using inductively coupled plasma spectroscopy. Leaf iron concentration was lower under phosphate deficiency.

(263) Biocontainers and the Bigger Picture: Evaluating the Overall Performance of Plastic Pot Alternatives in Greenhouse Production of Coleus (*Solenostemon scutellarioides*)

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Recent market research indicates that the adoption of biocontainers as part of a sustainable growing and sales strategy is an effective means of garnering consumer interest. Plastic container alternatives are commercially available in a wide variety of shapes and sizes. However, use of biocontainers among commercial growers is still relatively sparse. Past survey work has attributed this, in part, to concerns regarding the compatibility of biocontainers with existing production practices. This comprehensive project compares the performance of seven biocontainers to a conventional plastic control in actual

and simulated commercial production processes. In the first experiment, containers were run through mechanized filling and planting systems at a commercial production site to assess filling success and resistance to damage. Following these trials, containers were transported via box truck approximately 200 km to quantify and compare levels of shipping damage. Results of this work indicate that container type does not influence filling success; however, damage rates during both filling and transport differed among the products tested. A second set of studies using the same container types investigated plant growth and pot integrity in response to three different irrigation methods (e.g., hand watering, drip irrigation, and ebb-and-flood). Final dry mass and plant volume measurements showed uniform plant growth among containers within the irrigation methods examined, despite some noted differences in container media chemistry (particularly pH). Mechanical testing of new and used containers showed significant differences in strength with respect to container type. In addition, used and wet new containers exhibited lower resistance to crushing or puncturing when compared to similar dry new containers. Results of this work highlight some potential limitations of biocontainers with regard to damage resistance. However, with respect to plant growth, biocontainers appear to be an appropriate surrogate for conventional plastic containers.

Specified Source(s) of Funding: IL Dept. of Ag. Specialty Crop Grant Program, Project number SC 10-36

(264) Liming Requirements for Greenhouse Substrates Containing Wood Aggregates

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Perlite is the primary aggregate in greenhouse substrates and is the most expensive (by volume) component of greenhouse mixes. Due to rising costs and the non-renewable nature of perlite; alternative aggregates are currently being investigated for use. This research evaluated loblolly pine (*Pinus taeda* L.) chips as one such alternative. Loblolly trees were harvested, chipped and hammered milled through a ¼-inch screen on 8 Mar. 2011. Peat-based substrates were amended (v/v) with 20% or 40% perlite (PL) or woodchips (WC) for a total of four substrates. All substrates were amended with 0, 1.4, 2.7, 4.1, and 5.4 kg·m^3 dolomitic limestone, resulting in 20 substrates treatments. Rooted liners of *Chrysanthemum* ×*morifolium* 'Mildred Yellow' were transplanted into six reps of each substrate. Plants were fertigated as needed with 200 ppm nitrogen (derived from a 20–10–20 soluble fertilizer) and pour-throughs were conducted weekly to monitor substrate pH. After nine weeks shoots were harvested for dry weight determination. Shoot growth of chrysanthemum in all substrates containing PL or WC increased as lime rate increased from 0 up to 2.7 kg·m^3 where plant growth was greatest. Shoot growth was statistically similar and showed the same growth trends between PL and WC substrates (at 20 and 40%) and at all lime rates in this study. Substrate pH was often higher in 40% PL or WC than in 20% all lime rates and at all measuring dates. pH of WC amended substrates was always equal or higher than PL at the same percentages and at the same lime rates throughout the study. Results show that wood chip aggregates can replace perlite in a peat-based substrate with no changes in plant growth or liming requirements when growing chrysanthemum.

(265) Plant Growth Regulator Impact on Verbena Branching and Performance

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Plant growth regulators (PGR) are often used to enhance branching and hence increase the number of flowering shoots of many ornamental crops. In this study, the effectiveness of three PGRs, Augeo, Configure, and Florel, at two rates as a foliar spray on branching and plant performance of two cultivars of *Verbena* sp. ('Balazvelu' Aztec™ Blue Velvet and 'Balazwilro' Aztec™ Wild Rose) were investigated in greenhouse experiments in two Texas locations (El Paso and Overton). Overton is in the humid sub-tropics while El Paso has an arid environment. Rooted cuttings were transplanted to 4-inch square pots during mid-May and PGRs were applied as a foliar spray 8 days after transplanting in both locations. To compare the efficacy of PGRs, a group of untreated and un-pinched plants served as un-pinched controls, and another group of untreated but pinched plants served as pinched controls. At Overton, 23 days after treatment, the quality rating was higher than the untreated-not-pinched for all of the treatments except Augeo at 800 ppm and Configure at 300 ppm. Both Florel rates at 500 and 1000 ppm were better than the control. Thirty-three days after treatment, the quality rating, flower number, and shoot number was best on plants treated with Augeo at 400 and 800 ppm. At El Paso, the PGR treated plants had lower visual quality rating regardless of cultivar. The effect of PGR on shoot number varied with cultivar. Phytotoxicity was observed with all treatments in El Paso, but only with the high rate of Configure in Overton. The difference in response to PGRs between locations is likely due to the difference in climate zone.

Specified Source(s) of Funding: IR-4

(266) Postharvest versus Field Performance of Gomphrena

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Cultivars of ornamental annual species are commonly evaluated for field performance prior to commercial introduction. Evaluation for postharvest performance is less common and there is very little information relating these two characteristics. With this as our objective, 17 cultivars of gomphrena were grown to flowering in 10-cm pots and evaluated in a simulated interior postharvest environment (21 °C with fluorescent lighting on 16 hours per day) for 30 days. Plants were assigned a performance rating every 10 days based on lower leaf yellowing and flower senescence. After 20 days, all plants had good performance, but after 30 days, those cultivars with mediocre or poor performance exhibited yellowing lower leaves and senescent flowers. Additional plants were field planted in beds and evaluated during the growing season from May to September in Texas. Plants in the field were fertilized, weeded and watered as needed. Monthly, plants were rated for landscape performance and flowering. During mid-summer, all cultivars were performing well. By the end of the season, mediocre and poor performers exhibited decreased flowering and unhealthy foliage. In general, postharvest and field performance was similar. Eight cultivars exhibited good postharvest and field performance both. 'Buddy Rose', 'Buddy White', and 'Gnome White' exhibited poor postharvest and field performance both. 'All Around Purple', 'Audray Bicolor Rose', and 'Las Vegas White' exhibited mediocre postharvest and field performance both. 'Gnome Purple' exhibited mediocre postharvest performance and poor field performance. The exceptions were 'Buddy Purple' and 'Las Vegas Pink' which exhibited good postharvest performance, but performed poorly in the field. At the marketable stage, another set of plants were sealed in 55-gal treatment chambers and exposed to 0 or 5 ppm ethylene for 24 hours in the dark. Plants were evaluated for symptoms of ethylene damage including flower wilting and abscission and leaf senescence. After 24 hours of exposure to ethylene none of the cultivars showed any symptoms of ethylene damage, suggesting that Gomphrena are insensitive or have very low sensitivity to ethylene.

(267) Measuring Hydraulic Conductance as a New Technique for Assessing Root Growth in Greenhouse Substrates

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Previous research on wood-based greenhouse substrates has reported enhanced root growth of herbaceous plants compared to traditional greenhouse substrates. These reports have not adequately explained or quantified the differences in root growth that have been observed. Several new techniques are being developed and investigated as potential new methods of assessing and quantifying root growth, one being the use of the Hydraulic Conductance Flow Meter (HCFM). The HCFM provides a value of root conductance which is reflective of root mass and development. Shoots can also be measured with the HCFM, and these values with root conductance values can be correlated with dry weights as an assessment of overall growth. Freshly harvested loblolly pine (*Pinus taeda* L.) was hammer-milled through a 6-mm (1/4 inch) screen after being initially processed either through a wood chipper or wood shredder. Perlite (PL), wood chips (WC) or shredded wood (SH) were amended to peat (v/v) at 15%, 30%, and 45% making a total of nine substrates. On 1 Feb. 2012, uniform seedlings of *Tagetes erecta* 'Inca Orange' (marigolds) were transplanted into 1-L plastic pots with six replications of each substrate. Marigolds were grown for 6 weeks, at which time plants were prepared for root conductance measurements. Plants grown in 15% WC or SH amended substrates had higher root conductance values than plants grown in 15% PL amended substrate which tended to correlate with root mass development. Root conductance in substrates amended at 45% incorporation was similar across all three components (PL, WC, and SH). These data suggest that root development is enhanced in wood amended substrates at smaller percentages of incorporation. Further investigations using this technique may provide direct correlations for quantifying root system development of greenhouse crops during production.

(268) Hydrologic Properties of Potential Wood Components for Greenhouse Substrates

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Much work has been done to determine the moisture characteristics of various components of horticultural substrates. However, wood based components have not been fully explored. Moisture retention curves of two wood materials were compared to some traditional substrate components peat, coir, and perlite. Freshly

harvested loblolly pine (*Pinus taeda* L.) logs were hammer-milled through a 6-mm (1/4 inch) screen after being initially processed with either a wood chipper or a wood shredder. The chipped process produced a "blockular" aggregate type product (WC), while the shredding process produced a more fibrous material (SH). The WC and SH had total porosities of 78% and 84%, respectively, which was lower than that of the peat and coir and higher than the perlite. Air filled porosity between 0 and free drainage (3.8 cm) was two to three times greater in WC and SH compared to peat, coir, and perlite. WC and SH tended to have very similar curves as a whole, yet SH tended to hold slightly more water at all points than WC. The WC and SH tended to release a larger majority of their water at very low pressures than that of the peat, coir, and perlite. Under the highest pressure settings, 100, 200, and 300 cm, the WC and SH tended to hold water similarly to peat and perlite, with coir releasing more than the others. This research has identified the water retention properties of SH and WC which will be helpful in finding the best scenarios for their use as components for greenhouse substrates.

(269) Evaluating Heat Tolerance in *Impatiens walleriana* 'Super Elfin XP White' Following the Application of Pageant

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Strobilurin fungicides are widely used on turf and ornamentals for disease control. Additionally, they have been reported to increase stress tolerance in agronomic crops through increased production of antioxidant enzymes. Pageant (pyraclostrobin + boscalid), a strobilurin fungicide labeled for disease control and plant health, was applied to *Impatiens walleriana* 'Super Elfin XP White' 72, 48, 24, or 1 hour before exposing plants to a heat event. There were two control treatments, one with plants exposed to the heat event and one with plants maintained at 18.3 °C /21.1 °C (day/night). The heat event was expressed in a programmable growth chamber over three 24-hour periods with 12-hour days at 35.5 °C (90 °F) and 12-hour nights at 32.2 °C (83 °F). Pageant was applied as a foliar spray: 0× (non-treated) or 1× (0.228 $g \cdot L^{-1}$). Photosynthesis (Pn), stomatal conductance (Gs), and leaf area index [LAI (leaf dry weight per leaf area as $g \cdot cm^3$)] were measured before, during, and the day after the heat event. In addition, leaf samples were collected at the end of the heat event, immediately frozen in liquid nitrogen, and stored in a –80 °C freezer until determination of glutathione reductase concentration. Prior to the heat event, Pn, Gs, and LAI showed no significant differences among treatments. After the third day of the heat event, heat-treated plants had significantly higher Pn readings compared with nontreated plants maintained at ideal conditions ($P = 0.0088$). However, after the heat event, Pn and Gs were similar among all treatments, whereas LAI was greater in impatiens sprayed with Pageant 48 or 24 hr before the heat event compared to the nontreated plants receiving no heat event ($P = 0.0039$). Preliminary enzyme analysis indicates impatiens treated with Pageant did not have increased concentration of glutathione reductase ($P = 0.3282$). Based on these results, Pageant applied to impatiens does not appear to increase heat tolerance.

(270) Use of Biocontainers for Short- and Long-term Greenhouse Production

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Past biocontainer research in greenhouse production has generated mixed results with regard to plant growth and appearance. In several instances, conventional plastic containers have outperformed biocontainers alternatives. However, these differences were typically seen in studies where watering was applied uniformly across container types without regard to individual container porosity. As such, differences in plant performance may be confounded by the presence of unequal media moisture levels. This study expands on past research, comparing nine commercially available biocontainers (i.e., bioplastic, bioplastic sleeve, coir, pressed-manure, peat and paper, slotted rice-hull, solid rice-hull, straw, and wood pulp) to a conventional plastic control. Short-term (Sunpatiens 'Compacta') and long-term (Lavender 'Elegans Ice') crops were grown for 6 weeks and 12 weeks, respectively. Irrigation need was monitored by pot type and applied as needed to limit differences in media moisture conditions. Plant volume and soil chemistry measures (EC and pH) were collected on a bi-weekly basis. At the conclusion of the experiment, final leaf area and aboveground dry weights

were measured and compared across pot type within each of the species assessed. For both of the long- and short-term crops investigated, pot type had no significant impact on plant volume, leaf area, or aboveground dry weight. Soil pH did differ by container type. However, this statistical significance does not appear to translate into biological significance with regard to plant performance. Pots from this growth experiment were analyzed to assess impact of crop production length on residual container strength (compared to new containers). Results from this mechanical testing and the above greenhouse trial are part of a larger, multi-institutional research endeavor that is assessing the biological, environmental, and economic implications associated with the integration of biocontainers in horticultural production.

Wednesday, August 1, 2012 Grand Ballroom

Genetics and Germplasm 2

(412) The USDA Warm Season Grass Collection: Opportunities for Ornamental Breeding

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The National Plant Germplasm System (NPGS) maintains a diverse collection of warm-season grass germplasm that can provide the material needed for research and plant breeding projects. The warm-season grass germplasm collection contains over 7200 accessions representing 102 genera and 482 species that have been collected from 103 different countries. The collection includes many species of forage, turf, ornamental and native grasses. Most species are maintained as seed, but there are several species maintained clonally. Popular ornamental warm season grass genera such as *Pennisetum* can be found in the collection, but lesser known taxons such as *Themeda*, *Triraphis*, and *Anthephora* show potential for ornamental breeding. The collection also contains numerous native grass species inluding switchgrass, big bluestem, sand bluestem, little bluestem, indiangrass, blue grama, black grama, and side oats grama. For a complete listing of germplasm in the collection, visit the NPGS website at www.ars-grin.gov/npgs. The purpose of the collection is for the preservation of warm-season grass gerplasm for future generations and is freely distributed for research\breeding purposes. Data associated with each accession, including passport data, descriptor data, and characterization data, are managed through the Genetic Resources Information Network, and is available on the NPGS website.

(413) Yield Performance of Cowpea Genotypes Grown in Alkaline Soils

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Cowpea or Southernpea [*Vigna unguiculata* (L.) Walp.] is an important legume crop used as a feed for livestock, as a green vegetable and for consumption of its dry beans which provide 22% to 25% protein. The crop is very sensitive to alkaline soil conditions. When grown at soil pH of 7.5 or higher, cowpea develops severe leaf chlorosis caused by deficiencies of Fe, Zn and Mn resulting in stunted plant growth and yield reduction. We evaluated in replicated field experiments at St. Croix, U.S. Virgin Islands, and Miami, FL, four plant introductions (PIs) and one commercial cultivar some of which have shown some tolerance to alkaline soils in unreplicated, seed regeneration plots of the U.S. cowpea collection. Alkaline soil conditions at St. Croix were severe resulting in average yield of genotypes at this location being significantly lower and 69% less than that in Florida. Nevertheless, some genotypes performed well at both locations. For example, PI's 582605 and 582674 had significantly higher yield at both locations as compared to other genotypes used in the study. These genotypes may serve as an alternative to growers in areas where agricultural production is restricted by high soil alkalinity.

(414) Analysis of the North American Plum (*Prunus* L.) Species using Simple Sequence Repeat (SSR) Markers

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North America is a center of diversity for *Prunus* species. Tree architecture, endodormancy requirement, heat requirement, fruit development period, fruit size, fruit texture, fruit flesh, disease resistance, and adaptive changes to multiple environmental conditions, are a few examples of the tremendous genetic variability available in the plum germplasm. Wild native *Prunus* species constitutes an important source for genetic diversity for stone fruit breeding and selection. The study of genetic variability within the subgenus *Prunus* section *Prunocerasus* was the primary objective of this research. In addition, the transferability and polymorphism level of 41 simple sequence repeat (SSR) markers distributed across the peach genome (~15–25 cM) in section *Prunocerasus* was studied. A total of 11 North American plum species were used to determine the genetic diversity available in section *Prunocerasus*. One genotype per species for: *P. americana* Marsh., *P. angustifolia* Marsh., *P. geniculata* Harper, *P. hortulana* L.H. Bailey, *P. maritima* Marsh., *P. mexicana* S. Watson, *P. munsoniana* W. Wight & Hedrick, *P. persica* (L.) Batsch cv. Okinawa, *P. pumila* L., *P. umbellata* Elliot, and *P. fasciculata* (Torr.) A. Gray (outgroup) were used for the preliminary screen. The number of alleles per locus (A), effective

number of alleles (Ae), observed heterozygosity (Ho), expected heterozygosity (He), Wright's fixation index (F), polymorphism information content (PIC), and Nei's genetic distance (GD) per locus were calculated. A rooted Neighbor-Joining tree was constructed using Nei's genetic distance. An average of 10.7 A, 0.58 Ho, 0.31 F, and 0.82 PIC were observed. The peach SSR markers were found to be widely transferable and applicable to the study of wild *Prunus* species genetic diversity.

Specified Source(s) of Funding: Stone Fruit and Citrus Breeding and Genetics Program at the University of Florida, Gainesville, FL. and USDA–ARS grant 5306-21000-018-00D

(415) Genetic Diversity Assessment of *Musa* spp. Germplasm using SSR Markers

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The USDA–ARS Tropical Agriculture Research Station is responsible for conserving germplasm of a number of important agricultural crop species. Among these, a *Musa* spp. collection has been established and is comprised of diploid, triploid, and tetraploid accessions of cultivated, ornamental, wild and hybrid accessions. The collection is maintained in the field for characterization purposes and in tissue culture as a backup and for distributions. As a crop that needs to be vegetatively-propagated frequently, as in vitro plants are established and as accessions are added to the collection, care must be taken to avoid propagation mistakes. In an effort to estimate genetic diversity, to develop reference DNA profiles for clonal accessions and in order to identify any potential propagation mistakes, a set of 22 CIRAD-developed and Global Musa Genomics Consortium (GMGC) recommended SSR markers were screened on a total of 893 *Musa* spp. DNA samples. DNA samples for each accession were collected from four replicate field-grown plants and from a single individual replicate tissue culture plantlet and analyzed with representative DNA reference samples from the GMGC. Twenty-one out of the 22 SSR markers amplified well and generated an average number of 14.8 alleles per locus. The SSR locus, mMaCIR01 produced 26 alleles with 5 alleles being produced for mMaCIR307. Profiles for clonal plants from the field, tissue culture and from reference samples matched well across all 21 loci showing the technique's reproducibility. The average number of alleles, gene diversity estimates and representative accessions within subgroups indicate good genetic diversity for cultivated *Musa* spp. Cluster analysis showed that the accessions in the collection grouped according to their ploidy level and genomic compositions. The SSR markers used in the study were useful in distinguishing among most accessions to the subgroup level. However, observed phenotypic differences among accessions within particular subgroups, could not be resolved with genotypes generated. Field-observed phenotypic differences within subgroups (i.e., 'Cavendish') are thought to be due to point mutations and the SSR markers would not be expected to resolve these differences. The SSR markers were useful in identification of several mistakes in propagation, especially in the tissue culture collection, were phenotypic differences are difficult to observe. SSR fingerprint profiles and accessions are available through the USDA, National Plant Germplasm System, Germplasm Resource Information Network (GRIN–Global) database http://www.ars-grin.gov/.

(416) Genetic Diversity in Six Kentucky Spicebush (*Lindera benzoin* L.) Populations using Microsatellite (SSR) Markers

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Lindera benzoin L. or spicebush is an aromatic small native shrub that grows in the moist, understory areas of Appalachia and has potential as a new niche crop for small farmers. This plant was traditionally used as a tea by native cultures and early settlers. The berries can be used for jam and spicing of foods, and may have many health benefits including antioxidant compounds. Native spicebush patches also serve an important role in forest ecosystems around streams and rivers in terms of fruit production for animals, soil erosion control, and enhancing insect biodiversity. Populations of spicebush occur in a variety of light environments from forest interiors to canopy gaps and edge habitats. In many parts of the eastern United States, these edge environments are persistent and may have existed for hundreds of years. Spicebush may serve to hold ecological niches by outcompeting invasive plants compared to those in unchallenged areas. Genetic diversity of spicebush populations in Kentucky has not been examined in various forest regions and locations. The objective of this study is to determine the genetic diversity in six spicebush populations in Kentucky using simple sequence repeat (SSR) DNA marker systems. Leaf samples were collected from spicebush plants in the forests at the Kentucky State University Environmental Education Center (EEC), Cove Spring Park in Frankfort, KY, and at a location near the Kentucky River. Each population contained 20 individuals and two populations were sampled at each site. DNA was extracted using the DNAmite Plant Kit. Primers sb-A7, sb-A115, sb-B105, sb-B122, sb-C4, and sb-C10 labeled with FAM or HEX were used to amplify SSR products, and products were separated with a 3130 Applied

Biosystems capillary electrophoresis system. The software program Power Marker was used to examine genetic relationships among the spicebush genotypes. The SSR markers generated showed genetic variation among the spicebush genotypes. A number of selections with unique genotypes will be sampled and propagated for study in the KSU germplasm collection for potential cultivar development.

(417) Chromosome Numbers and Ploidy Levels of Chinese *Curcuma* Species

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The genus *Curcuma* L. is a member of the family Zingiberaceae consisting of about 70 species distributing mainly in South and Southeast Asia including China, India, Indonesia, Malaysia, Myanmar, and Thailand. Some species are also found in Australia and the South Pacific. *Curcuma* is an economically important genus; many species have been used as medicinal, spicy, and ornamental plants. It is estimated that there are more than 10 species occurring in China. However, highly morphological variation has led to a continuous debate on the exact number of species in China. To pursue a better understanding of species variation, a karyomorphologycal study was conducted on11 species collected from China. Results showed that there was only one species (*Curcuma flaviflora* S.Q. Tong) that was diploid with $2n = 2x = 42$, one species was tetraploid (*C. kwangsiensis* S. G. Lee & C. F. Liang) with $2n = 4x = 84$; and the rest were triploid ($2n = 3x = 63$). The basic chromosome number is $x = 21$. The chromosome sizes of all studied species are very small, ranging from 0.5 to 2.0 μm, creating a great challenge for karyotype analysis. Diploid *C. flaviflora* produces viable seeds, which are the main source for propagation. Tetraploid *C. kwangsiensis* can reproduce asexually and sexually whereas triploids are unable to produce seed and therefore rhizomes are their primary organ for propagation. This study suggests that polyploidy is common in *Curcuma*. The fact that majority of species are triploid indicates that triploidy may have some type of competitive advantage over diploids and tetraploids; triploid individuals do not require seed production to survive because of asexual rhizome propagation and therefore advantageous traits become fixed in natural populations.

(418) Interspecific Hybridization among the Eastern United States Native Phlox Species

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Interspecific hybridization has played a role in the development of improved *Phlox* cultivars, but thorough delineation of sexual compatibility by systematic crossing experiments among the species is lacking. Over 60 species of *Phlox* native to North America, and of these, 25 are native to the eastern United States. Despite the economic importance of a few of these well-defined eastern species, this group also contains many highly variable, ornamental, and taxonomically muddled species whose interspecific crossing compatibility remains unrealized. To test such relationships, we have implemented a crossing scheme between numerous genotypes of the 25 phlox species native to the eastern United States utilizing germplasm that includes wild collected and cultivated material. Thus far, we have completed over 15,000 pollinations comprising over 500 cross combinations performed in a partial diallel. Attempts have been made to recreate putative horticultural and naturally occurring hybrid taxa described in the literature. A minimum of 50 pollinations per reciprocal cross has been performed. Success of a given cross is heavily influenced by phylogenetic relationships and style length. Crosses between short-styled species within section Divaricatae generally have a high rate of success when made in both directions, although crosses involving some wild-collected genotypes of *P. amoena* and *P. floridana* are only successful when these species are used as female parents. This may be due due to cytoplasmic effects or differences in ploidy. Hybridization between species in different sections have a low rate of success. Crosses between *P. paniculata* (section Paniculatae) and *P. carolina* (section Ovatae), both long-styled, are only successful using the former as the female parent and only using selected genotypes. Crosses between long and short-styled taxa generally fail to produce seed; only the cross of *Phlox drummondii* × *Phlox paniculata* has produced seed. The hybrid nature of the progeny from this cross has yet to be determined. A panel of 10 microsatellite (SSR) and various flower and leaf morphological markers measured using Tomato Analyzer software are being used to assess putative hybrids. Assessment of hybrid fertility to produce advanced generations is ongoing.

(419) Characterization of U.S. Native *Coreopsis* and *Rudbeckia* Germplasm Conserved at the Ornamental Plant Germplasm Center

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Coreopsis and *Rudbeckia* are two genera of herbaceous ornamentals which have many species native to the United States. Since 2006 both genera have been priorities for conservation at the Ornamental Plant Germplasm Center (OPGC), a gene bank which is part of the U.S. Department of Agriculture National Plant Germplasm System. About 28 species of *Coreopsis* are native to the U.S. including annual, perennial, subshrub and shrub forms; the OPGC currently conserves over 100 accessions representing 19 species. *Rudbeckia* is a genus of 23 species of annual, biennial, and perennial types; currently over 200 accessions of *Rudbeckia* representing 18 species are being conserved at the OPGC. To fill

gaps in our knowledge about these accessions we are working to characterize wild-collected accessions and compare them to commercially-available cultivars using a set of 53 descriptors which have been selected to identify differences in factors such as growth, leaf and flower morphology, phenology, production, quality, invasiveness, disease, and stress tolerance. Differences within species have been identified for characteristics such as flower size, flower color, plant height, flowering time, hardiness, and disease resistance. For example, *Rudbeckia* floral color and pattern variation is most prevalent in species of the Rudbeckia and Dracopis sections of *Rudbeckia* (*R. hirta, R. triloba, R. amplexicaulis,* and other species) while little variation has been observed in species of the Macrocline section (including *R. laciniata, R. maxima, R. mohrii,* and others). Additionally, variation for disease resistance is primarily noted between the species, although some accessions have been identified which exhibit reduced susceptibility to a disease within a species, for example powdery mildews on *R. hirta*. Characterization of accessions may also help identify new commercial possibilities for the floriculture industry. For example, *R. auriculata* is a species native only to southeastern U.S. (Georgia, Alabama, and Florida) but has overwintered in Columbus, OH (USDA Plant Hardiness Zone 6a). Ultimately our goal is to make more information about germplasm conserved at the OPGC available to public and private researchers, thereby making this germplasm more valuable and increasing its utilization in plant breeding and other programs. Conserved plant material is made freely available in small quantities to researchers and educators worldwide through the Germplasm Resources Information Network (GRIN) database, www.ars-grin.gov; characterization data will also be distributed via the GRIN website.

(420) Relationships among Germplasm Accessions of Viola and Phlox Examined by Analysis of Flower Color and Morphology using Tomato Analyzer™ Image Analysis Software

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Computer-based analysis of digital images has been used to objectively characterize morphological variation found in plants, including shape and color of leaves, flowers, and fruit. Tomato Analyzer™ (TA) is a free software initially developed for rapid, high volume analysis of tomato fruit morphology as well as color, using digital images generated with flat-bed scanners. Application of TA has expanded to describe fruit quality in avocado (*Persea*) and grapes (*Vitis*) as well as for embryo size in seeds of cucumber and other Cucurbitaceae.. We have used TA to examine flower and leaf traits in 128 accessions of *Viola*, including nearly 100 cultivars of *V.* x*wittrockiana* as well as putative progenitor species such as *V. tricolor*, *V. altaica* and *V.corsica*. We have also been using TA with *Phlox* species native to Eastern North America (*P. paniculata*, *P. pilosa*, *P. divaricata*, etc.) to assist us in identifying products of interspecific hybridization experiments. For each accession 4 plants had 5 flowers scored for 28 traits describing shape (e.g., height to width ratio, area to perimeter, etc.); size, and color. We have found TA to be a robust and useful tool for phenotypic analysis of flower traits that can then be compared with genotypic analysis of the plants. Significant differences were detected in flower/petal shape, size and color of *Viola* accessions using ANOVA, and grouping by Principal Coordinate Analysis and Neighbor-Joining trees created distinct clusters mainly by color and size in *Viola,* but by species in *Phlox*. We found little variability in the analysis of leaf morphology of *Viola*, but useful differences in the leaves of *Phlox*. The capability of such speedy, large volume analysis could be a valuable tool to botanists delimiting species, populations, and individuals by objectively describing various character traits. Similarly, horticulturists and plant breeders could score variation between cultivars or advancements over generations in a breeding program. As seen in tomato, the pairing of objectively scored, quantitative traits, such as those described by TA, with molecular data could be a powerful method in describing the patterns of variation in germplasm collections of ornamental plants.

Specified Source(s) of Funding: USDA–ARS NPGS

(421) Evaluation of a Collection of Lotus (*Nelumbo* spp.) Germplasm for Ornamental Medicinal and Food Crop Potential

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Sacred lotus (*Nelumbo nucifera*) is an herbaceous perennial macrophyte that grows in stagnant waters. Considerable variation in flower color and shape makes sacred lotus one of the most popular ornamental plants cultivated in Asia. For centuries, various parts of the plant have been used in folk medicine and the plant's medicinal properties are currently being investigated and refined in pharmaceutical labs. Lotus produces starchy rhizomes, leaves, petioles, seeds, flowers and other edible tissues. American lotus (*N. lutea*) is an emersed native that is typically found in muddy, shallow waters such as lake margins and in water as deep as 2 m. American lotus is native to the eastern and central portions of the USA ranging from Maine to Wisconsin in the north, and in the south from Florida to Texas and northeastern Mexico. The overall objective of this

study is to evaluate vegetative growth, ornamental characters and cropping potential of selected accessions of ornamental, edible sacred lotus and American lotus. The Aquatic Plant Science lab (University of Florida) and the USA–SINO Research Center for Aquatic Vegetables and Ornamentals (Auburn University) have joined efforts to explore the genus. Experimental plots have been established at UF Fort Lauderdale Research and Education Center to facilitate these evaluations. Previous surveys revealed that consumers prefer medium or large plants with pink, red, yellow or white flowers, in double or multi-petal forms. Based on these consumer preferences and performance studies (conducted at Auburn University and its Experiment Stations), the cultivars 'Dense Dew', 'Friendship Pink', 'Pink in Green Layers', "Guifei Zhuijiu', 'Beautiful Bowl', 'Brocade Flag', 'Illustrious Youth', 'Juicy Peach', and 'Leadership' have been selected as desirable pink flower producers. Red flowered lotus with potential are 'aH3', 'Camellia Red', '04-R-31', and '04-R-07', while white flowered cultivars include 'Karizma', 'Birthday Peach', 'Decorated Lantern', 'Jewel Flower', 'Little Brocade-edge', and 'Wenjun Fuhong'. Native taxa of American lotus are also being evaluated to assess intraspecific biodiversity; future studies based on these experiments will identify the species' potential as a source of novel genetic material.

(422) Genetic Variation for Winter Hardiness in Rosemary (*Rosmarinus officinalis* L.)

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Winter-hardiness is an important agronomic trait for perennial horticultural crops such as rosemary (*Rosmarinus officinalis* L.). For many species winter-hardiness is reported as an average, without taking into account genetic variation within the species. A randomized, replicated winter hardiness field study was conducted at the NMSU Agricultural Science Center near Artesia, NM, during the winter of 2010–11 with 89 genetically distinct clonal lines of rosemary. The study showed extremes of variation in winter hardiness from total plant loss to minimal damage. Several clonal lines with an ability to withstand freezing temperatures (as low as –21 °C) were identified. Winter survival ranged from 0% to 100% in the collection of lines studied. Winter hardiness could be classified into (a) absolute leaf tissue survival; and (b) regrowth ability. Absolute leaf tissue survival was limited to only a few clonal lines. In contrast, regrowth from the base was apparent on several lines that appeared to be dead in early March. The clonal line known as "White Flowered" exhibited the best winter hardiness and optimal phenotype with limited injury and rapid spring regrowth.

(423) Improvement of *Stevia rebaudiana* Biomass Production and Steviol Glycoside Synthesis

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Stevia rebaudiana (stevia) is an herbaceous perennial native to Paraguay that produces high concentrations of non-toxic, non-nutritive ent-kaurene diterpenoid glycosides, some of which are approximately 300 times sweeter than sucrose. Stevia is an obligate outcrossing species, thus likely maintaining a high degree of heterozygosity and subject to improvement through breeding. Important breeding objectives for stevia improvement include an increased rate of biomass production, inhibition of flowering during the growing season, and high concentrations of steviol glycosides such as rebaudioside A (reb A). Approximately 700 plants from an open-pollinated stevia population from China were evaluated in a field plot at Michigan State University for phenotypic and steviol glycoside analysis. The population exhibited considerable variability for many traits, including steviol glycoside concentration. For example, reb A concentration ranged from less than 5 mg/g dry tissue to over 125 mg/g dry tissue. Total steviol glycoside content was correlated positively with plant vigor and not correlated with development rate (node appearance rate) or branching, indicating that breeding for high rates of biomass accumulation should not have negative effects on sweetener production. Ten individuals were selected based on steviol glycoside profile and used to generate a series of half-sib families. Several traits, including flowering date and leaf size, varied in a family-specific manner and will be discussed.

Wednesday, August 1, 2012 Grand Ballroom

Organic Horticulture 2

(057) Physiochemical and Functional Properties of Organic or Conventional Strawberry

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Recently, organic fruits or vegetables receive the increased attention since people are aware of personal health and environment. However, little scientific data have been given for benefits of organic fruits and consumer's trust. In this study, strawberries were cultivated conventionally or organically and their qualities were evaluated with respect to physiochemical properties and physiological functions. Organic strawberry showed 2 times harder and 1.2 times sweeter but 15% lower fruit weight, compared to those of conventional one. Organic strawberry had a 22% and a 11% higher amount of dietary fiber and crude protein, than those of conventional one, respectively. Organic strawberry contained a half amount of essential minerals like iron (4.3 vs. 8.8 ppm), magnesium (1.0 vs. 1.4 ppm), zinc (1.4 vs. 2.6 ppm), but did no difference in other compounds like sodium and potassium, compared to those of conventional one. For functional characterization, organic strawberry had a 55% higher amount of beta-carotene (13.1 μg/100 g), but 11% or 14% lower amounts of vitamin C (44.5 mg/100g) or flavonoids (2.9 mg/g), compared to conventional strawberry. There are similar with total phenolic contents between conventional and organic ones. In addition, organic strawberry showed higher antioxidant and NO scavenging activities with 167 uM of vit C eq. and a 35%, compared to those of conventional strawberry with 149 uM of vit C eq. and a 25%, respectively. Overall, those results indicate that organic strawberry exhibited better product quality and physiological functions than conventional strawberry. This study was financially supported by Jellanamdo Agricultural Research and Extension Services.

Specified Source(s) of Funding: This study was financially supported by Jellanamdo Agricultural Research and Extension Services

(058) The Right Time to Plant Fall Crucifer Cover Crops in the Great Lakes Region

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In order to get the benefits of a cover crop, the cover crop must grow vigorously. One of the main determinants of growth rate is planting date. We determined the appropriate planting dates for late-summer cover crops for use on organic vegetable farms in the Great Lakes region. We measured how quickly soil was covered and the ability to compete with weed seedlings, as well as biomass production during the available growing period. Mustard could be sown until late August, requiring 1500 to 2000 GDD_{32}. All the crucifer cover crops examined produced minimal biomass by frost if they experienced fewer than 1000 GDD_{32}. Biomass increased linearly with GDD thereafter. The rate of increase will depend on nitrogen fertility and other factors, but relative rates were clear. Mustard, turnips and rapeseed had the same rate of increase, producing about 2 tons per acre after 2000 GDD_{32}. Forage radish (including the whole swollen hypocotyl) grew about twice as fast, and canola about half as fast. Thus the cold-hardiness of canola did not allow it to be planted later than the other cover crop types. The current enthusiasm for forage radish as a cover crop is justified when they are planted early,that is when there are 1700 to 2300 GDD_{32} remaining in the season. Late-planted crucifers not only provide minimal biomass, but they survive the winter better resulting in undesirable early-blooming volunteers. These values allow growers to adjust planting dates based on climate data for their farm. The optimum planting dates in western New York to southern Michigan are approximately 10 Aug. to 20 Aug.

(059) Impact of Cover Crop Based Reduced-tillage Systems on Eggplant Yield, Weed Populations, and Soil Quality in Organic and Conventional Production

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The detrimental impacts of intensive soil tillage on soil quality are well documented. However, research is still lacking on the impact of alternative reduced-tillage systems on specialty crop yields and weed control in the Mid-South, USA. This is especially true in the case of organic specialty crop production systems, where weed control in reduced-tillage settings cannot rely on synthetic herbicides. In order to evaluate these questions, a field study was implemented beginning in Oct. 2010 in Knoxville, TN to evaluate cover crop based reduced-tillage organic and conventional production systems in comparison to conventionally tilled, plasticulture controls. Treatments included: 1) OrgTill- organically-managed plasticulture system with conventional tillage following a wheat (*Triticum aestivum* cv. Haas Cover)–crimson clover (*Trifolium incarnatum* cv. Dixie) cover crop; 2) OrgRT- organically-managed reduced-tillage system planted into roll-killed wheat-crimson clover cover crop residue; 3) ConTill- conventionally-managed plasticulture system with conventional tillage following a wheat cover crop; and 4) ConRT- conventionally managed reduced-tillage system planted into herbicide-killed wheat cover crop residue. Plots were sized 2.4 m by 9.1 m and were arranged in a randomized complete-block design with four replicates. In early May 2011, cover crops on were terminated and eggplant (*Solanum melongena* cv. Traviata) planted. Total yield of mar-

ketable eggplant did not differ between treatments (mean 16.4 $Mg \cdot ha^{-1}$). Weight of USDA Fancy grade eggplant was highest from the OrgRT treatment (4.8 $Mg \cdot ha^{-1}$), although this was statistically ($P > 0.05$) greater than only the ConTill treatment (2.2. $Mg \cdot ha^{-1}$). Weed control was generally good throughout the season, although total weed populations were generally higher in reduced tillage treatments compared to plasticulture treatments. Measures of soil quality indicated that the particulate organic matter–carbon (POM-C) and –nitrogen (POM-N) were highest in the OrgRT treatment, although only significantly so in the case of POM-N. As a measure of the active fraction of soil organic matter, this indicates that the OrgRT system may provide the greatest benefit to maintenance and enhancement of soil quality in vegetable production systems.

Specified Source(s) of Funding: UT AgResearch and Extension

(060) Effects of Pre-plant Compost and Subsequent Fertigation on Organic Production of Zinnia Cut Flowers in a High Tunnel

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This study evaluated the effects of pre-plant compost incorporation and subsequent fertigation during the growing season on organic production of zinnia (Benary's Giant Mix) cut flowers in a high tunnel. There were three pre-plant compost applications: composted broiler litter, vermicompost, and control (no compost). The compost rate used was 6 tons/acre and the compost was incorporated into the bed before laying the plastic mulch. Under each compost treatment, there were three fertigation treatments: no fertilizer, organic low [100 ppm nitrogen (N) from MultiBloom, a liquid catfish processing byproduct], and organic high (200 ppm N from MultiBloom). Each treatment combination included 16 zinnia plants which were planted half ft apart. Each treatment combination was replicated 3 times. Plants were transplanted into the beds in early September and each plant was supplied with 200 mL of solution from each fertigation treatment once a week. Zinnia stems were harvested as soon as the blooms were completely opened, starting from early October through November. Results indicated that during early stage of plant growth, plants that received compost had significantly higher SPAD reading than plants did not receive any compost, and plants that received composted broiler litter had significantly higher SPAD reading than plants that received vermicompost. Plants that received composted broiler litter had significantly higher plant growth index than plants that received no compost. However, plants that received vermicompost had similar plant growth index as plants received no compost. Results also indicated that both pre-plant compost incorporation and fertigation during the growing season increased the total number of stems produced.

(061) Improving Fall Organic Vegetable Crops with Summer Cover Crops

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Cover crops and chicken litter compost are two methods used to improve soils and vegetable crop production. A study is underway at Crystal Springs, MS, testing the influence of four cover crops: sunn–hemp, sesame, sorghum–sudan grass, and a sunn hemp + sesame blend, in combination with four concentrations of chicken litter compost: 0, 1.25, 2.5, and 5.0 tons/acre. The cover crops, in four replicates, were established in Summer 2011, mowed and incorporated in. The chicken litter concentrations were applied within each subplot and tilled before bedding of broccoli cv. Marathon. Soil tests were done before and after the cover crop was incorporated, total tissue analysis was done on cover crop haulms and the harvested broccoli was weighed and counted in marketable and unmarketable groups. While the lowest yield resulted from sorghum with no chicken litter compost, the highest yield resulted from sunn hemp with 2.5 t/acre chicken compost. Comparing the marketable yield, sorghum with no chicken litter compost produced the lowest and sunn hemp with 2.5 t/acre chicken litter compost had the most.

Specified Source(s) of Funding: USDA Southern SARE

(062) The Use of Vermicompost as an Organic Fertility Source in Vegetable and Herb Transplant Production

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Fertility management can be challenging in the production of organic vegetable and herb transplants. Substrate incorporated fertilizer components may damage sensitive seedlings but also not supply enough nutrients when seedlings are grown for an extended period. In this project we examined the use of vermicompost (worm processed dairy manure, from Worm Power LLC) as one of the primary fertilizer components in organic production of transplants. The first trial was conducted determine the suitability of vermicompost and blood meal for supplying the nutrients in an organic substrate for seedling germination. A blend of 60% peat and 40% perlite (by volume) was supplanted with 0%, 5%, or 10% vermicompost (by volume). Blood meal was added to the mix at 0 or 7 lb/yd^3. Seeds of basil 'Casear', lettuce 'Buttercrunch', Mustard (*Brassica juncea*) 'Red Streaked Mizuna', and tomato 'Celebrity', were seeded in 200-cell plug trays and misted as needed. After four weeks germination and plant size were evaluated. Basil germinated well regardless of vermicompost and blood meal combination. In the absence

of blood meal, tomato germination was reduced slightly with increasing vermicompost. The combination of blood meal incorporation and vermicompost significantly reduced germination of lettuce, mustard, and tomato. Blood meal at the incorporated rate appears harmful. Vermicompost at 5% by volume led to suitable seedling size and good germination. Future work should refine the incorporation rates of vermicompost and blood meal. A second trial was conducted to determine the need for supplemental liquid fertilizer for growing on transplants for 8 weeks in an organic substrate in 4-inch (500 mL) containers. Seedlings of basil, lettuce, pepper 'Lady Bell F1' and tomato were transplanted in the peat and perlite substrate which contained 10% vermicompost and blood meal at 7 lbs/yd^3. Fertilization began 1, 3, or 5 weeks after transplanting and was provided as a weekly drench (150 mL) of 0, 100, or 200 ppm N from a conventional fertilizer (21–5–20) or an organic fish emulsion based fertilizer (Drammatic One, 4–4–1). For tomato, weekly liquid fertilizer treatments beginning by week 3 (conventional) and week 1 (organic) were required to obtain the greatest plant size. For pepper supplemental fertilizer was note required. For lettuce, optimum plant size required liquid fertilization beginning by week 3 at rates of 200 ppm N (conventional or organic). For basil, liquid fertilization beginning at week 5 may give a slight benefit in transplant size.

Specified Source(s) of Funding: USDA–NRCS–CIG, Toward Sustainability Foundation

(063) Strawberry Cultivar Evaluation under Organic and Conventional Fertilization

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The fast growing demand for organic strawberries in recent years has led to a rapid increase of organic strawberry production. Despite the expansion of organic strawberry acreage, one of the challenges facing organic strawberry growers is the lack of suitable cultivars selected or developed specifically for organic conditions. The objective of this study was to assess strawberry cultivar performance in response to organic vs. conventional nutrient management. Two strawberry cultivars including Treasure and Treasure Harvest and 3 advanced selections AA1, AA2, and AA3 were included in this greenhouse experiment. Strawberry plug plants were transplanted into 3.8-L plastic pots and grown with either organic or conventional fertilizer during Oct. 2011 to Feb. 2012. The organic fertilization treatment consisted of a mixture of processed, pasteurized poultry litter 3–0.9–2.5 (N–P–K) and Nature Safe organic fertilizer 10–0.9–6.6 (N–P–K), while synthetic fertilizer 16–1.8–6.6 (N–P–K) was used in the conventional fertilization treatment. Preplant application and side dressing of fertilizers were made in both organic and conventional treatments. A randomized complete block design with a two-way factorial treatment structure was used. There were 4 replications with 5 plants of each cultivar/advanced selection in each fertilization treatment per replication. Total marketable fruit yield per plant was significantly higher in 'Treasure Harvest' than 'Treasure' and the 3 advanced selections, whereas it did not differ significantly between organic and conventional fertilization treatments. 'Treasure Harvest' showed significantly greater total leaf area and shoot dry weight at final harvest than other strawberries, while 'AA3' and 'Treasure Harvest' had the highest root dry weight at final harvest. Varietal differences were also observed in total soluble solids content. 'AA2' and 'AA3' exhibited similar levels of average total soluble solids content which were significantly higher than that of 'AA1' and 'Treasure Harvest'. The fertilization treatment did not significantly affect the total soluble solids content of strawberry fruit. Twospotted spider mite infestations occurred in most of the strawberry plants; however, 'Treasure Harvest' demonstrated the lowest level of infestation as indicated by the percentage of infested leaflets per plant. The less severe infestation of twospotted spider mites in 'Treasure Harvest' probably contributed to its higher marketable fruit yield observed in this study. Although organic fertilization did not differentially impact strawberry cultivar performance in comparison with conventional fertilization, the effect of nutrient management and availability on organic strawberry production deserves further studies especially under field conditions.

(065) Influence of Management Practices on Lettuce Yield and Weed Population in Organic Production

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Management practices can vary significantly in organic crop production systems depending on the selection of inputs. The impact of different management practices on crop production is also affected by site-specific conditions. In this study, the use of cover crops, plastic mulch, and no-till was evaluated in organic lettuce production in sandy soils in north central Florida. Sunn hemp and sorghum–sudangrass were grown during Aug. to Oct. 2011 and terminated using a roller-crimper prior to fall production of 'Tropicana' green loose leaf lettuce in a certified organic field at the Plant Science Research and Education Unit in Citra, FL. Five treatments with different management practices were

established before the organically grown lettuce seedlings were transplanted into the research plots: 1) without cover crops and plastic mulch, tilled; 2) without cover crops but with plastic mulch, tilled; 3) with cover crops and plastic mulch, tilled; 4) with cover crops but without plastic mulch, tilled; and 5) with cover crops, no-till. A randomized complete-block design was used with 4 replications and 48 lettuce plants per treatment in each replication. Lettuce yields and weed populations were assessed. Establishment of lettuce plants was poor in the no-till plots primarily due to the high population of annual grass weeds at planting. The total marketable yields of lettuce were significantly higher in treatments with plastic mulch than those in the treatments without plastic mulch. Moreover, the no-till treatment had the lowest lettuce yield of all the treatments. Weed population assessment was conducted following the lettuce harvest. A 0.4 m^2 quadrat was used for estimating the populations of annual and perennial grass weeds, annual and perennial broadleaf weeds, and nutsedges. Results showed that the populations of grass and annual broadleaf weeds did not differ significantly among treatments. Treatments without plastic mulch and the no-till treatment resulted in significantly higher populations of perennial broadleaf weeds than the treatments with plastic mulch. A similar trend was observed when comparing the population of nutsedges among treatments. Regrowth of sunn hemp and sorghum–sudangrass was also noted with the no-till treatment. Considering the poor establishment of lettuce plants in the no-till plots, the use of strip tillage may be a more appropriate option than no-till to reduce the incidence of interference with the lettuce crop.

Wednesday, August 1, 2012 Grand Ballroom

Ornamentals/Landscape and Turf 2

(235) Performance of Native Connecticut Shrubs for Use as Invasive Alternatives

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There is increased interest in using native plant alternatives to invasive species for landscaping. Invasive Japanese barberry (*Berberis thunbergii*) and winged euonymus (*Euonymus alatus*) are used extensively in landscaping since they perform well in challenging landscapes, such as parking plantings. Some ornamental Connecticut native shrubs for which little is known regarding landscape suitability include American filbert (*Corylus americana*), buttonbush (*Cephalanthus occidentalis*), sweet fern (*Comptonia peregrina*), sweet gale (*Morella gale*), northern bush honeysuckle (*Diervilla lonicera*) and hardhack (*Spiraea tomentosa*). These six species were evaluated for their landscape suitability in parking lot islands to determine which can serve as suitable replacements for barberry and euonymus. Japanese barberry and euonymus were included in the planting as controls. The experimental planting was installed in June 2010 and consisted of 6 replicated planting blocks each with 5 individual shrubs per species, for a total of 240 shrubs. At 15 months post planting, the barberry and euonymus controls had performed well. Sweet fern, sweet gale and buttonbush had performed as well as the invasive controls. American filbert and northern bush honeysuckle also performed well, but blocks with wetter soils did not perform as well as blocks with dry soils indicating that these two species are best used in well-drained sites. Hardhack did not perform as well as the invasive control or other native shrubs evaluated and cannot be recommended. While the flowers of hardhack provided ornamental interest, plant appearance was variable and powdery mildew was problematic. This study shows that native plants can be suitable alternatives to invasives and some may perform well in landscape situations that are different from the native environments in which they are found. Buttonbush and sweet gale occupy swampy or edge of water habitats, but were able to perform well in a much drier landscape situation. This work clearly demonstrates the need to evaluate a prospective native ornamental plant for adaptability outside its apparent environmental niche. Evaluation of the planting will continue to develop information about long-term performance.

Specified Source(s) of Funding: USDA CTDoAG

(236) Evaluation of 53 Rose Cultivars Grown in Ground Beds at the Veterans Memorial Rose Garden

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The Veterans Memorial Rose Garden at Mississippi State University is a formal rose garden where a large variety of roses are grown with access to both researchers and public visitors. Fifty-three cultivars of roses from a number of classes and grown on *R.* ×*fortuniana* rootstock, 'Dr. Huey' rootstock or on their own roots are included in the collection. These roses were planted in spring, 2008 in ground beds around the periphery of the garden to demonstrate genetic diversity within the genus. Data was collected in November, 2008 and October, 2009 and included plant height, plant width, blackspot rating (incorporating both defoliation and infection), flower quantity and quality, foliage quantity and quality, and plant habit and vigor. The Horsfall–Barratt rating scale was used to generate scores for black spot (Horsfall and Barratt, 1945). Quality ratings were based on a scale of 1 to 10, worst to best and also averaged to provide an overall index of quality. Data are analyzed using the Glimmix and Corr Procedures of SAS. Growth types ranged from a large climber to a miniature rose. Plant height, is positively correlated to plant width ($r = 0.68$, $P < 0.01$), volume ($r = 0.84$, $P < 0.01$), and plant habit and vigor ($r = 0.50$, $P < 0.01$). Blackspot ratings also range greatly, especially since data is only from late fall when many roses are near winter defoliation and the climate has cooled. Blackspot is inversely correlated to flower ($r = –0.30$, $P < 0.02$) and foliage quantity and quality ($r = –0.59$, $P < 0.01$), as well as quality average ($r = –0.46$, $P < 0.01$). Plant width is positively correlated to blackspot ($r = 0.27$, $P < 0.04$), possibly

reflecting a spreading growth habit near the soil where spores can be splashed up. Flower ratings were biased towards roses that bloom well in the fall and near 1 for cultivars that bloom only in the spring. Flower ratings are inversely correlated to plant height ($r = –0.29$, $P<0.03$), volume ($r = –0.36$, $P < 0.01$) and blackspot ($r = –0.30$, $P<0.02$). Flower ratings are positively correlated to foliage ratings ($r = 0.32$, $P < 0.02$) and quality average ($r = 0.52$, $P < 0.01$). Smaller roses are bred to be floriferous, and spring only bloomers tend to be large roses. High levels of blackspot appear to reduce foliage needed to support bloom. Plant habit and vigor ratings are positively correlated to growth, foliage and quality average to < 0.01%. This information supports our efforts to determine sustainable rose cultivars suited for gardens in climates similar to east central Mississippi.

Specified Source(s) of Funding: Mississippi Agricultural and Forestry Experiment Station

(238) Effect of Pruning Severity on Flowering of Landscape Roses

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Roses planted in landscapes are a common feature in California. The severity of pruning has anecdotally been linked to flower production and flower quality but there are few reports of landscape-based research. We established a blocked trial with over 500 roses of 8 varieties. There were four pruning treatments: unpruned; pruned to a height of 0.91 m and 5 primocanes; pruned to 0.46 m and four canes; and pruned to 0.15 and three canes. Flower quality and stem length were unaffected by pruning treatment. Quantity of flower production was greatest in unpruned roses. There were few differences between moderate pruning severity treatments (0.91 and 0.46 height treatments).

Specified Source(s) of Funding: Hansen Trust

(239) The Effect of Root Size on Drought Stress and Landscape Performance of Roses during a Severe Drought

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Four own-root rose cultivars, Carefree Beauty™ ('Bucbi', CB), 'Frontenac' (Fr), Polar Joy™ ('Baiore', PJ), and Ramblin' Red ('Radramblin', RR), were planted in a minimal input garden setting and evaluated for landscape performance and drought stress. Experimental design was a RCB, with one plant of each cultivar per block (n = 4). Plants were originally planted in winter 2007 and irrigated regularly (approximately once weekly) during growing seasons one and two to ensure establishment. During years three and four, plants received no supplemental irrigation. In Summer 2011, northeast Texas experienced exceptional drought and heat. Temperatures exceeded 37.7 °C (100 °F) on 57 days and estimated pan evaporation rates frequently exceeded 10 cm/week. Landscape performance was rated monthly on a scale of 1 to 10, with 10 being exceptional and in full bloom. Plants received a drought stress rating using a 0 to 5 scale, with higher values representing increased drought stress symptoms on the foliage, such as wilt, loss of color, leaf scorch, and chlorosis. Plants were dug at the end of the study to evaluate the roots by carefully digging in a circular pattern, 60 cm from the plant stem. When individual roots were found, the root was carefully dug beyond the original radius until the entire length was exposed. CB and PJ had the highest landscape performance ratings. RR had significantly higher drought stress ratings than other cultivars. Surprisingly, no correlation was found between any variables of root size and drought stress. Root dry weight was, however, positively correlated with landscape performance, confirming the importance of root size for landscape performance during periods of extreme drought.

(240) Effects of Salinity and Waterlogging and Their Combination on Seed Germination and Seedling Growth of Four Turfgrass Species

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Salinity and waterlogging are two major abiotic stresses commonly associated with irrigated soils. In this study, four low-inputs turfgrass species (tall fescue, Kentucky bluegrass, blue grama, and buffalograss) were germinated under well-drained (control), waterlogged (i.e. flooded), saline (NaCl 5 $g \cdot L^{-1}$), or saline-waterlogged conditions in the greenhouse. Flooding with tap water did not inhibit seed germination or seedling growth although a low salt accumulation in the soil (soil salinity = 2.5 dS/m) was observed. Seedling number (SN), shoot fresh weight (SFW), root fresh weight (RFW), and the longest root length (LRL) were significantly decreased under saline and saline-waterlogged conditions with reductions ranging from 20.3% of the control in LRL to 70.0% of the control in RFW. Higher reductions in germination and seedling growth were observed in the salinity treatment, compared to the combined stresses, although soil salinity levels were similar between these two treatments (soil salinity = 29.9 dS/m in the salinity treatment and 31.9 dS/m in the combined saline-water-logged treatment). Tall

fescue was the most tolerant of saline and waterlogging stresses, followed by blue grama and Kentucky bluegrass; buffalograss showed the lowest tolerance.

(241) Glycinebetaine Seed Priming Improved Osmotic and Salinity Tolerance in Turfgrasses

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Exogenous application of glycinebetaine (GB), an osmoprotectant increases tolerance to stresses including salinity in various plants, information on turfgrass, however, is limited. In this study, GB, was used to prime turf seeds for enhancement of salinity tolerance during the seed germination and seedling stage when plants are more sensitive to stresses. Seeds of perennial ryegrass (PR, moderately salt tolerant), tall fescue (TF, moderately salt tolerant), creeping bentgrass (CB, moderately salt sensitive), and Kentucky bluegrass (KB, salt sensitive) were unprimed or primed with 50, 100, 150, or 200 mM solution of GB or distilled water (DW) and then germinated in the solution of DW, mannitol (causing osmotic stress only), or NaCl (causing both osmotic and ionic stresses) (their osmotic potential and salinity level were and –0.1 MPa and 0.1 dS/m, –1.0 MPa and 0.1 dS/m, and –1.0 MPa and 14.6 dS/m, respectively). Seed germination and seedling growth in mannitol or NaCl solution were improved after seeds were primed with GB. Different turf species showed different responses to osmotic stress and ionic stress. No difference in germination and seedling growth of PR, TF, and KB was observed between mannitol and NaCl treatments, indicating that osmotic stress appeared to more critical than ionic stress. For CB, the seed germination rate and seedling growth were lower in NaCl than in mannitol, showing an accumulative effect of both osmotic and ionic stresses.

(242) Effect of Mowing Height on the Appearance, Density, and Weed Competitiveness of Native and Adapted Fine Fescues

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The fine fescues have many characteristics that are beneficial to use in a landscaped yard but it has yet to establish itself as a prominent choice either by homeowners or contractors. Specifically, native fine fescues have adapted to arid environments and require much less water usage to sustain a visibly pleasing appearance such as that of the traditional Kentucky bluegrass. Little information is available on the behavior of most of our native and adapted grasses in a turfgrass situation. Thirteen Montana native and adapted fine fescue species and mixes were grown in 90 ft × 5 ft plots and tested during the growing season of 2010 and 2011. Subplots measuring 3.5 ft wide, intersecting the species plots, were mowed at four heights: unmown, and 3.2, 7, or 10.8 cm. Before plots were mown each week, overall height of the subplots was recorded. Fescue density and weed infiltration were measured at the end of the growing season. Homeowners and students were surveyed on their preference for the various species and mowing height. Several fine fescue species exhibited slow growth, produced very little biomass between mowings, and would therefore require little to no mowing. Density and weed suppression was high for most of the species, with lower densities and lower weed suppression occurring at the lowest mowing height. Homeowners preferences for species depended on the mowing height.

Specified Source(s) of Funding: Montana Ag Experiment Station

(243) Development of Best Turfgrass Management Practices Using DAYCENT Model

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In order to predict the best management practices for the turf industry in Colorado, the DAYCENT ecosystem model was parameterized and applied on turf ecosystem. In this study, the daily time step DAYCENT model was validated using field measured data of clipping yields, evapotranspiration (ET), deep percolation, nitrate leaching, and soil temperature from a 3-year lysimeter study. The prediction of ET and deep percolation was acceptable for the 3 years ($r > 0.6$). The simulation result of clipping yield was improved compared to the monthly time step CENTURY ecosystem model, with r value increased from –0.32 to 0.74. The long-term irrigation effect on Kentucky bluegrass biomass and soil carbon and nitrogen was examined. The annual net production is predicted to drop by 50% as irrigation decreases from 100% potential evapotranspiration (PET) to 60% PET in this semi-arid region. Irrigation replacing 100% PET poses much more risk than 80% PET on nitrate leaching in the long-term. Reducing mowing heights from 7 cm to 3 cm with clipping fully returned were predicted to have little influence on carbon sequestration rate and nitrate leaching rate. The simulation result suggests that the annual fertilization rates should be gradually reduced to approximately half of the initial rate after 10 years for both moderately and highly managed turf, and the rates could be further reduced with the increasing age of turf stand.

Wednesday, August 1, 2012 Grand Ballroom

Postharvest 3

(027) Biophysical and Hormonal Changes Can Trigger Postharvest Needle Abscission in Balsam Fir

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Postharvest needle abscission is a consequence of complex interactions among physiological, biophysical and hormonal factors. Efforts are being made to determine significant biophysical and physiological events related to postharvest needle abscission. It is known that initial postharvest average water consumption is 0.2 $mL \cdot g^{-1}$ per day, but gradually decreases by over 75%. It is hypothesized that some degree of postharvest water stress exists, which is manifested in changes in several biophysical parameters. Further, the changes in key endogenous hormones postharvest are yet unknown . Branches were collected from a clonal orchard and placed in water. Parameters such as needle loss, water use, relative water content, capacitance, membrane injury, and xylem pressure potential were recorded once a week until complete needle shed occurred. In addition, needles were sampled at the beginning of the experiment and during peak needle abscission and then subjected to hormonal analysis. It was found that needle abscission occurred within 24 days. During this time water use decreased by 50%, relative water content decreased by 23%, capacitance decreased by 64%, membrane injury increased by 100%, and xylem pressure potential decreased 4-fold. Abscisic acid increased by 32-fold and trans-zeatin riboside increased by 4-fold during peak abscission. Other cytokinins such as cis-zeatin riboside, isopentenyl adenosine, trans-zeatin-O-glucoside, and dihydrozeatin riboside all doubled during abscission. Finally, there was a 95% decrease in indole-3-acetic acid. Observed changes in all biophysical parameters, as well as abscisic acid, could be indicative of a possible postharvest water stress or dehydration. It is possible that dehydration-induced changes in biophysical and hormonal factors trigger and/or modulate postharvest needle abscission.

Specified Source(s) of Funding: AIF/NSERC–CRD

(028) Postharvest Needle Loss in Balsam Fir Can Be Reduced by Using Certain Needle Abscission Prevention Agents (NAPA)

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Needle abscission in Balsam fir Christmas trees has recently become a challenge to the Christmas tree industry. Postharvest needle loss is a complex phenomenon involving interactions among genotypic, environmental, postharvest conditions altering the physiological processes involved in needle abscission. The objective of these experiments was to evaluate several needle abscission prevention agents (NAPA) compounds to determine the effective compounds and concentration for improved needle retention. Two year old branches were used to evaluate four NAPA compounds (NAPA-101; NAPA-102; NAPA-103; NAPA-104) at 0, 1, 10, 100, 1000, and 10, 000 micromolar concentrations. Each treatment for each of the compounds was replicated three times. NAPA-101 did not show a significant difference; however, the 10 micromolar concentration was the most effective as needles lasted 20 days longer than the control. NAPA-102 did show a marginal significant difference and the 100 micromolar concentration significantly improved needle retention compared to other concentrations. Branches treated with 100 micromolar concentration of NAPA-102 lasted more than 80 days compared to the control which lasted for 60 days. Needle retention was significantly higher in branches treated with NAPA-103 at the 0, 1, and 10 micromolar than the ones treated with other concentrations, and the 10 micromolar concentration had needle retention over 70 days. NAPA-104 did not show any improvement in needle retention as the controls lasted longer than the other concentrations. Overall, NAPA-101 and NAPA-103 showed a 10 to 20 day improvement in needle retention at the 10 micromolar concentration. NAPA-102 also showed a 10 to 20 day improvement in needle retention, but was at the 100 micromolar concentration. It is speculated that these compounds may act by inhibiting ethylene synthesis and/or preventing auxin degradation.

Specified Source(s) of Funding: AIF, NSERC–CRD

(029) Screening NB Balsam Fir (*Abies balsamea* L.) Clones for Needle Abscission Resistance and Understanding the Genetic Shift to Pre- and Post-cold Hardening

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Postharvest needle loss in Balsam fir Christmas trees is a major issue in the Atlantic Canadian Christmas tree industry. It results in significant losses in income to producers and dissatisfaction with real trees among consumers, which may carry forward many years. Needle loss is a consequence of complex interactions among many factors, including genetic variations. A genetic tendency to either retain or shed needles postharvest has been observed. A study was completed to determine needle retention duration (NRD) of 206 Balsam fir clones located at the Tree Improvement Unit, Department of Natural Resources in Island View, New Brunswick, Canada. NRD was observed for both pre- and post-cold acclimation periods over the 2010–11 and 2011–12 seasons. Branches with 2-year-old growth were collected on 27 Sept. 2010, 11 Jan. 2011, 27 Sept. 2011, and 11 Jan. 2012 and transported in water to the Christmas Tree Research Centre, Truro, Nova Scotia, Canada. Branches were allowed to equilibrate to ambient laboratory conditions prior to experiment set up for 48 hours. Following a fresh cut, the branch weight was recorded and each branch was placed on a white, 8 × 10 inch foam tray at room temperature (21 °C ± 1 °C) under 24-hour fluorescent lighting (15 $\mu mol \cdot m^{-1} \cdot s^{-2}$). Needle loss was monitored every second day. Branches were gently brushed between the thumb and two fingers 5–6 times and the detached needles were collected and weighed. A final weight of each branch was taken when all of the needles had fallen. Clones with both high NRD and low NRD were identified. The

highest NRD was 43 days while the lowest was only 7 days. Interestingly, in low NRD clones needle retention improve after cold acclimation, however clones with a high NRD pre-cold acclimation needle retention decreased post- cold acclimation. This phenomenon has been observed in other studies in Nova Scotia as well. Also, NRD for high NRD clones dropped by about 10 days in year 2 while low NRD clones increased by about 8 days in year 2. The growing season in year 2 was abnormally stressful with higher than normal rainfall and a large gall midge infestation. It is thought that the trees were showing symptoms of this added stress by altering their NRD similar to what was seen during cold acclimation. In summary, there appears to be a genetic plasticity among genotypes for NAR, which is modulated depending on cold acclimation.

Specified Source(s) of Funding: AIF, ACAAF

(030) The Nature and Role of Volatile Terpene Compounds in Postharvest Needle Abscission

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Balsam fir [*Abies balsamea* L. (Mill.)] is a major conifer tree in a multi-million Christmas tree and greenery industry, preferred due to its shape, blue-green color and nice fragrance. The fragrance is due to aromatic volatile terpenes, which are known to play a major physiological role in natural defense against pest infestation and mechanical injury. Studies have shown that high concentrations of volatile terpenes are synthesized in conifers but there is only limited information on the physiological role of the volatile terpenes on postharvest needle abscission. It was hypothesized that volatile terpenes promote postharvest needle abscission in balsam fir trees depending on needle abscission resistance (NAR) of a genotype. Thus, the purpose of this study was to provide a fingerprint of all the terpenes available in postharvest balsam fir. Ten 2-year-old growth branches of two contrasting balsam fir genotypes that are low and high NAR and five 3-year-old seedlings were used for this study. Harvested branches and seedlings were sealed separately in a 4-L air tight glass jar for 30 minutes. Concentrations of volatile terpenes were determined by a head-space solid phase micro-extraction (SPME) procedure, followed by analysis using a gas chromatograph. Comparisons of terpene profiles showed that the high NAR genotype had 12 terpene compounds that consistently evolved in all the branches, compared to 8 and 5 terpenes for the low NAR genotype and seedlings, respectively. In addition, the total terpene concentration in the high NAR genotype was 7.3% and 16.1% higher than that of the low NAR genotype and the seedling, respectively, although the low NAR genotype had higher concentration of β-pinine than the high NAR genotype. This study confirms our preliminary study that showed that the high NAR genotype has a stronger fragrance compared to the low NAR genotype or the seedling. This suggests that volatile terpenes vary in availability and concentration depending on the NAR. It is possible that some of the specific volatile terpenes have specific roles to play in promoting or inhibiting needle abscission.

Specified Source(s) of Funding: AIF, NSERC–CRD

(031) The Relationship between the Gene Expression of Ethylene Receptors and the Recovery of Ethylene Sensitivity in Carnation Flower Petals

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In ethylene-sensitive plants, such as carnation, ethylene perception is considered an indispensable requirement to initiate and perpetuate the ethylene-mediated senescence program. Ethylene binding antagonists, such as 1-methylcyclopropene (1-MCP) compete for ethylene binding and block senescence. Despite its antagonistic propensity, plants treated with 1-MCP often recover sensitivity to ethylene post-treatment. We used carnations (*Dianthus caryophyllus* L. 'Glacier') to determine the relationship between petal inrolling patterns and the expression of genes involved in ethylene biosynthesis and ethylene signaling after treatment of petals with ethylene and 1-MCP. Petal inrolling began after 10 h of ethylene treatment and petals were completely inrolled within 1 h from the first visible sign of inrolling. In these petals, ethylene biosynthetic genes *DcACS1* and *DcACO1* increased greatly, but receptor and response genes *DcETR1* and *DcCTR1* were initially high and decreased gradually. When petals were treated with 100 $nL \cdot L^{-1}$ 1-MCP and then treated daily with 10 $\mu L \cdot L^{-1}$ ethylene, we monitored the gene expression changes after treatment with 1-MCP one, two, or multiple times at 3 d intervals. This study revealed that the mRNA levels of *DcETR1* and *DcCTR1* gradually decrease during ethylene treatment, but increase at certain times during flower development, and that this increase occurs concomitant with onset of petal inrolling. The results suggest that after treatment with 1-MCP, ethylene receptors genes are transcribed during flower development. The newly generated receptor proteins are likely to be bound with ethylene, leading to the observed recovery of ethylene-sensitivity in the petals post-treatment of 1-MCP. The current study also suggests that ethylene binding to new receptors is prevented by successive treatment of 1-MCP prior to regaining of ethylene-sensitivity, resulting in repression of petal senescence and inrolling.

Specified Source(s) of Funding: AgroFresh

(032) Effect of 1-Methylcyclopropene (1-MCP) and Antimicrobial Agent Treatments on Postharvest Quality of Selected Cut Flowers

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Postharvest quality (vase life or longevity) of cut flowers is one of the most important characteristics that determine consumer preference and satisfaction. Both ethylene sensitivity and microbial contamination play important roles in determining the vase life of cut flowers. The objective of this study was to evaluate the effect of 1-MCP and antimicrobial agents on postharvest quality of cut flowers with different levels of ethylene sensitivity. Flower stalks of rose (*Rosa hybrida*), gerbera (*Gerbera jamesonii* H.), carnation (*Dianthus caryophyllus*), and snapdragon (*Antirrhinum majus*) were obtained from a local commercial grower. Flower stems were trimmed to a length of 30–45 cm and placed vertically in a 250-mL flower bag containing sterilized water. Cut flowers were divided into two groups. One group was exposed to 0.9 $\mu L \cdot L^{-1}$ 1-MCP (0.14%, Rohm Hass) in sealed stainless steel containers at 20 °C for 16 h. The control group was held at 20 °C for 16 h without any 1-MCP treatment. Flowers were placed under controlled environmental conditions (relative humidity 60% to 75%, temperature 20 °C and dark) for 14 days. Quality measurements including water uptake, color, abscission and wilting, digital images and microbial populations of totals plate counts, as well as mold and yeast counts in vase water were conducted on d0, d1, d7, and d14. Measurement of chlorophyll fluorescence (CF) on the flower sepal as a physiological tool was also conducted. Treatment of 1-MCP significantly delayed the senescence of cut flowers, reduced wilting and abscission, especially for carnation, rose, and gerbera, while it had limited effect on snapdragons. Decrease of CF was also significantly delayed by 1-MCP treatment. Antimicrobial agents showed potential to reduce microbial population in stalk solution. However, no interaction between antimicrobial agents and 1-MCP was found. Changes in CF showed significant relationship to senescence of cut flowers. CF is an important quality parameter and should be incorporated in the postharvest quality evaluation of cut flowers.

Wednesday, August 1, 2012 Grand Ballroom

Vegetable Crops Management 2

(335) Fertilizer Effects of Soy-plastic Containers during Production and Transplant Establishment of Tomato and Pepper

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An obstacle to sustainability in the container-crops industry is the nearly universal reliance on containers made from non-renewable, petroleum-based plastics. As part of a project to develop and assess biodegradable plastics for their potential to replace petroleum-based plastics in specialty-crop containers, we evaluated prototype plastic containers made from soy (*Glycine*) protein for their effectiveness during production of plants in greenhouses and subsequent establishment of those plants outdoors. Our objective was to assess the function and biodegradation of soy-plastic containers during production and transplant establishment, with special attention to whether a fertilizer effect results from degrading containers before and after plants are installed in gardens. Plants of tomato (*Lycopersicon*) and pepper (*Capsicum*) were grown in soy-plastic containers and control containers of petroleum-based (polypropylene) plastic under greenhouse conditions for 4 weeks. The plants then were transplanted and grown in a garden plot for 5 weeks with containers removed and broken to pieces <4 cm long that were dispersed beneath roots of the transplant. At the end of greenhouse production, durability ratings were greater for control containers compared to soy-plastic containers, and plants grown in control containers were larger, greener (SPAD), and rated healthier than plants grown in soy-plastic containers. Measures of pH and EC of leachate suggest that the fertilizer effect from degradation of soy-based containers during plant production was excessive and decreased plant growth and health compared to controls. Growth and health of plants produced in soy-plastic containers improved during establishment in gardens with pieces of the containers degrading near roots. After 5 weeks of garden culture, plants of tomatoes produced in soy-plastic containers were larger and greener than controls, with no difference in health rating. Plants of pepper produced in soy-plastic containers were greener and healthier, but remained smaller, than controls. Average biodegradation during 5 weeks in the garden was 59% for soy-plastic containers and 0% for polypropylene containers. Although the design and material formulation of soy-plastic containers need to be improved to sustain container integrity and plant health during production, the establishment in gardens of plants produced in soy-based containers was promising. Post-production

fertilizer effects during biodegradation of soy-plastic containers appear beneficial, and the rate of biodegradation in garden soil was favorable for establishment of transplants.

(336) Relationship Between Soil Moisture Potential and Seedling Emergence in Cut and Peel Carrots

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Cut and peel, or Individually Quick Frozen (IQF) baby carrots are the recently introduced high value carrot products of the industry. Even though there are four baby grades, Fancy is the most preferable grade for IQF baby carrots processing. A critical issue with cut and peel carrot processing is the incidence of non uniform roots and lower percentage of required baby grades (only 30% to 33% out of total root weight). The objective of this experiment was to understand the relationship between soil moisture and seedling emergence to develop a soil moisture based seedling emergence model for cut and peel carrots. This experiment was conducted under controlled environmental growth chamber conditions with 8 different moisture regimes (–5, –10, –20, –30, –40, –50, –60, and –90 cbars). Growth chambers were adjusted to provide the following environmental conditions: 21 °C daytime temperature and 15 °C night temperature, with a photoperiod of 16 hours at a light intensity of 180 μ·mol·cm^{-2}·s^{-1}. Sealed, transparent, plastic boxes (30 cm in length) were filled with topsoil. The variety, Triton, was seeded 2.5 cm deep at the rate of 85 seeds/30 cm and the experimental design adopted was a completely randomized block design (RCBD). Soil moisture potential was continuously monitored using Watermark soil moisture probes installed just below the seeding depth. The number of seedlings emerged per day was monitored until completion of seedling emergence. Soil moisture potentials of –30 and –40 cbars showed quick and uniform seedling emergence compared to the other treatments. There was no seedling emergence at –90 cbars suggesting that soil moisture potential has a great role to play in delaying or inhibiting carrot seedling emergence, which may be one of the reasons for low Fancy grade recovery.

(337) Physiochemical Characterization of Subtropical Vegetables, Indian Spinach, Okra, and Molokhia

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Since rapid climate change over the world is progressing by global warming, many subtropical vegetables in Korea are tried to introduce as the countermeasure for global warming. In this study, we cultivated three subtropical vegetables, okra, indian spinach, and molokhia in field or green house. They were evaluated their physical properties and physiological functions for practical applications. Physiochemical properties of okra fruits, indian spinach leaves, and molokhia leaves were analyzed with respect to hardness, water content, sugar content, and inorganic compounds. Okra fruits had 91.3% of water content and 227 mg/g of reducing sugar, and 267–382 ppm of calcium. Indian spinach leaves had 93% to 95% of water content, 35–42 mg/g of reducing sugar and 73–110 ppm of calcium. Molokhia leaves had 70% to 77% of water content and 95–101 mg/g of reducing sugar and 255–288 ppm of calcium. Overall, field three vegetables had the tendency to possess higher physical hardness, more water and reducing sugar contents but lower amount of inorganic compounds, compared to those of green house vegetables. As results of functional analysis, molokhia leaves showed the higher total phenolic contents with 23mg/g than okra fruit (4.2 mg/g) or Indian spinach leaf (5.3 mg/g). Molokhia leaves had a 2–5 times higher beta carotene content than okra fruit or indian spinach leaves. Molokhia leaves showed the highest functional properties like antioxidant activity with 9.2 Vit.C.eq. μg and nitric oxide scavenging activity with 19.9% among vegetables. Compared to green house vegetables, field vegetables showed higher beta carotene content and nitric oxide scavenging activity and no difference in antioxidant activity. Those results could be useful for the scientific basis and criteria of practical application in future.

Specified Source(s) of Funding: This study was financially supported by Rural Development Administration (Project No. PJ 907042)

(338) Gourds in Asia

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Among the vegetables, the gourd group of crops belonging to family Cucurbitaceae form one of the large groups with its wide adaptation from arid to the humid tropics. In Asia, about 20 edible major and minor gourds are grown and consumed. Although the data on gourds alone are not easily available, they are grown in all Asian countries and are the most common food of a common man. Some of the common gourds are specific to Asia only. Cucurbits demonstrate wide adaptability, allowing the crops to grow in varied agro-climatic conditions. Among food crops, gourds are among the largest producers of biological water and are easily digestible. Gourds contain 80% to 90% water and also contain nutritive elements such as carbohydrates, protein, vitamins A and C, calcium, lycopene, phosphorus, potassium, and other properties, in addition to medicinal values. They are common crops in rural, urban, and peri-urban areas accessible to both rich and poor. Even with the gradual increase in production and consumption, the production of gourds is plagued by the occurrence of diseases and insect pests, inadequate availability of quality seeds, lack of maintenance of genetic varieties and of naturally occurring bio-diversities, and lack of knowledge on the international standard of quality production and postharvest handling. The thrust areas of development as identified are improvement in crop production, diversification in cropping pattern, utilization of available genetic diversities, reversal of postharvest losses, and value addition in food products. Gourds hold promise as supplementary food for common people.

Specified Source(s) of Funding: VEGINET

(339) Temporal Isoflavone Accumulation in Six Edamame Cultivars

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Edamame (*Glycine max* L. Merrill) is specialty-cultivars of vegetable-soybean selected for flavor, large seed size, and green seed yield. Consumption in the United States has increased largely due to their nutritional value and purported health benefits. Soybean isoflavone concentrations change with seed development, but few studies have evaluated edamame, which often has fewer isoflavones than agronomic type beans. The purpose of this study was to determine when isoflavones accumulate in six edamame cultivars. Edamame cultivars from Wannamaker Seed Company [Midori Giant (MG), Mojo Green (MOJO), and Sunrise (SR)] and Rupp Seed Company [BeSweet 292 (BS292), BeSweet 2015 (BS2015), and BeSweet 2001 (BS2001)] were harvested semi-weekly between 69 and 97 days after planting (DAP) for a total of nine harvests. The beans were frozen, lyophilized, ground and a 0.5-g sample was extracted overnight with 12 mL of solvent consisting of 0.1 n hydrochloric acid, acetonitrile, and deionized water (2:7:3, v/v/v). Soybean isoflavone and standard profiles for genistin, daidzin, glycitin, malonyl genistin, daidzein, glycitein, and genistein were performed on an Agilent 1200 series HPLC. Total isoflavone concentration peaked for MG, MOJO, and BS292 between 88 and 90 DAP and at 90 to 95 DAP for SR, BS2015 and BS2001. Total isoflavone accumulation is predominated by malonyl genistin, which at its greatest and least composed 76.4% and 50.8% of total isoflavones in BS2011 and SR at 97 DAP. For all isoflavone species, at 69 DAP BS2015 and MOJO had the lowest and highest concentrations, respectively, which is likely due to differences in cultivar maturation time. Daidzein, glycitein, genistein, daidzin, and glycitin concentrations ranged from 0.38 to 1.63, 0.02 to 0.5, 0.090 to 0.69, 0.12 to 0.81, and 0.15 to 0.83 μg/bean at 69 DAP, respectively. Genistin and malonyl genistin were not detected among cultivars at 69 DAP. Daidzin, glycitin, and genistin accumulated maximally between 88 and 95 DAP. At 97 DAP, there were cultivar differences in only daidzin concentration, which ranged from 3.4 to 16.4 μg/bean for BS2015 and MG. There were no differences between cultivars for the remaining isoflavones at 97 DAP with isoflavone concentration averages (μg/bean) for glycitin (4.2), genistin (4.8), malonyl genistin (55.5), daidzein (1.2), glycitein (3.2), genistein (1.8), and total (81.5). Although isoflavones are desirable, edamame quality characteristics such as texture and flavor would be reduced if harvest is delayed beyond 90 DAP (average harvest for cultivars) for isoflavone accumulation. Of isoflavones measured, malonyl genistein and glucosides predominate.

(340) Evaluation of Watermelon (*Citrullus lanatus*) Cultivars for Commercial Production in Southwest Indiana, 2011

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Watermelon production is of great importance in the state of Indiana. The industry was valued at $32 million in 2011, with the majority of the acreage located in southwest Indiana. Additionally, watermelons are also the largest in terms of acreage for fresh market vegetables in Indiana. Due to the significance of the watermelon industry in Indiana, improving production practices for increased sustainability and profitability is of great importance. There are various practices in commercial production that can affect yield and quality. One of the fundamental starting points is the selection of a variety with good yield, desirable fruit quality traits, and one that is suited to growing under local conditions. A field study with triploid watermelon cultivars was established (May 2011) in Vincennes, IN, at the Southwest Purdue Agricultural Center. The objective of the experiment was to evaluate yield and fruit quality of 25 triploid watermelon cultivars. The field site was selected and prepared by tillage, bed formation, and installation of plastic mulch and drip irrigation. Application of fertilizer was completed prior to bed formation in the following amounts: 350 lb (46–0–0), 100 lb (0–0–60), and 200 lb of pelletized lime. Transplants were taken to the field on 16 May 2011, and planted in the designated plots

as dictated by the randomized complete-block design. Plants were irrigated as needed throughout the season and treated with pesticides as dictated by MelCast and presence of any arthropod pests. There were no statistically significant differences in harvest data among the 25 cultivars with the exception of average fruit size. WDL9408 had greater average fruit weight than nine of the 25 cultivars evaluated. Numerically the three varieties with the highest yield were AC7187, Troubadour, and AC7267. With respect to fruit quality, RWT8231 had higher soluble solids content than 21 of the 25 cultivars. The other cultivars that did not differ with regards to soluble solids content included Indiana, Wrigley, and Affirmed. Although RWT8231 had high soluble solids, it was one of the lowest yielding varieties numerically. Fruit firmness of the varieties was not statistically significant. There was some statistical variation with regards to degree of seedlessness; however, they all fell in the range of no seeds with the exception of ACX6177FR. Presence of hollow heart this season was also very minimal. Of all the varieties, AC7267 had both relatively high sugar content and was one of the highest yielding varieties.

(341) Bell Pepper Variety Trials in Western North Carolina

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Colored bell peppers are not a widely produced commercial crop in western North Carolina, but have the potential to be economically viable for producers in this area. Two trials were conducted in 2010 and 2011 on a commercial pepper grower's farm in Haywood County, NC. Transplants were placed in the field using a randomized complete-block design, in double-row plots, on black plastic mulch covered beds with drip irrigation. Plants were supported with a stake and weave system. Fertility and irrigation were managed using standard grower practices and following the recommendations from the North Carolina State Cooperative Extension Service. Peppers were harvested and graded according to industry accepted grading standards at 3–4 times per season. Varieties were chosen for unique color qualities for example red, yellow, orange and brown fruited types. Some varieties changed from one season to the next depending upon acceptability and seed availability. Alliance and Mecate produced the greatest amounts of jumbo grade peppers than other varieties in 2010, while Chesapeake and Red Lion produced significantly fewer jumbo peppers than other varieties. In 2011, Mecate produced significantly great numbers of jumbo grade peppers than all other varieties. Two varieties performed well with regard to total marketable yield in 2011, Bianca and Flamingo. However, in this study year, Alliance and Karisma had the lowest total marketable yields. A complete variety list, results and photographs will be presented.

(342) Specialty Melon Cultivar Evaluation under Organic and Conventional Production in Florida

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Interest in production of specialty melons is increasing in Florida, particularly among small producers and organic growers. However, more research on yield performance and disease resistance of specialty melon cultivars is needed for quality production. In this study, 10 specialty melon cultivars were evaluated under both conventional and organic production. Selections include: Ananas melons 'Creme de la Creme' and 'San Juan'; Canary melons 'Brilliant' and 'Camposol'; Asian melons 'Ginkaku' and 'Sun Jewel'; Galia melons 'Arava' and 'Diplomat'; and Honeydew melons 'Honey Pearl' and 'Honey Yellow'. Muskmelon cultivar 'Athena' was included for comparison as the standard production melon. Cultivar evaluations were performed in Spring 2011 at the Plant Science Research and Education Unit in Citra, FL. A randomized complete block design was used with 4 replications and 10 plants per cultivar per replication. Harvest date, marketable yield, fruit quality, and disease and root-knot nematode damage were recorded for each melon. Most melon cultivars exhibited higher yield when grown conventionally compared to organic cultivation, while the Asian type melon 'Sun Jewel' produced higher marketable yield under organic production. 'Honey Yellow', 'Sun Jewel', 'Diplomat', and 'Honey Pearl' matured earlier than other specialty cultivars and earlier than 'Athena' by approximately 10 days. 'Camposol' demonstrated the highest marketable yield and produced the largest fruit. 'Diplomat' and 'Sun Jewel' had the highest percentage of culls due to fruit cracking prior to harvest, resulting in lower marketable yields. The total soluble solids content (SSC) of 'Honey Yellow' fruit exceeded 15 °Brix, the highest value among all the cultivars grown conventionally and organically. 'Brilliant', 'Sun Jewel', and 'Honey Pearl' had SSC above 12 °Brix. Disease damages were assessed based on visual ratings of disease severities. Gummy stem blight was identified on melons in the organic field, whereas powdery mildew and downy mildew were prevalent in the conventional field. 'Camposol', 'Arava', 'Diplomat', 'Honey Pearl', and 'Honey Yellow' showed less severe symptoms of gummy stem blight in the organic field trial, while 'Honey Yellow', 'Brilliant', 'Camposol', 'Sun Jewel', and 'Arava' were less susceptible to powdery mildew and downy mildew in the conventional trial. Roots were rated for damage

caused by root-knot nematodes in the organic trial. 'Athena' exhibited less galling compared to specialty melon cultivars. Among specialty cultivars, 'Camposol', 'Creme de la Creme', and 'Sun Jewel' demonstrated lower root galling ratings, and 'Honey Yellow' exhibited the highest rating.

Specified Source(s) of Funding: Southern Region ASHS

(343) Glucosinolate Variation among Six Cultigens of Broccoli Grown in Five Diverse East Coast Locations

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Broccoli (*Brassica oleracea* var. italica) consumption has increased in the United States, driven at least partially by recognition that it is highly nutritious and contains high concentrations of glucosinolates (GS). Glucosinolates are secondary metabolites in broccoli that when digested have a detoxifying effect. In particular, glucoraphanin and other GSs present in broccoli break down into anti-carcinogenic isothiocyanates (ITCs). The GS data presented here is part of a USDA–SCRI sponsored research project aimed at improving the consistency and profitability of broccoli production under growing conditions in the eastern United States. This project consists of a multi-disciplinary team of plant breeders, physiologists, production specialists, and economists. The team's goal is to develop a substantial eastern broccoli industry in the next 5–10 years. Producing broccoli in the eastern United States will reduce shipping cost and contribute to a more regionally based food production system. Broccoli production has traditionally been more challenging in this region due to variability in climatic conditions. Eastern climates often result in greater plant stress and disease incidences, resulting in inconsistent yield and quality. Therefore, the major emphasis of this project is to develop cultivars better adapted to production in the eastern United States while improving consistency in yield and nutritional quality. Since GSs are a significant health benefit of broccoli consumption and play a role in plant pest resistance; one of our team goals is to increase GS concentrations in new cultivars. The data in this presentation represent an effort to determine the genetic and environmental factors that have the greatest influence on GS profiles among current broccoli germplasm. Six cultigens were grown at five locations and two different time frames (production seasons) at each location. Floret tissue was analyzed for a complete profile of GS. Glucosinolate concentrations were significantly influenced by cultigens, location, season, and their interactions. The genetic and environmental factors associated with individual and total GSs will be discussed. The data from these first year evaluations will used by team members to improve consistency of quality in future broccoli cultivars and productions systems.

(344) Broccoli Pigment Profile of Six Cultigens Grown in Five East Coast Locations

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Brassica oleracea L. vegetables are recognized as excellent sources of nutritionally important dietary pigments, and broccoli (*B. oleracea* var. italica) makes major nutritional contributions to diets in the United States. Despite high consumption rates among eastern populations, very little broccoli is produced in this region. Unfortunately, current cultigens do not produce a consistently marketable product under eastern growing conditions. Our SCRI-Coordinated Agricultural Project consists of a multi-disciplinary team of breeders, physiologists, production specialists, and market developers with the goal of developing a substantial eastern broccoli industry in the next 5–10 years. Our project vision is to create a regional food network for broccoli, which may serve as a model network for popular and nutritiously important specialty crops. With the emergence of broccoli as the most important domestic *Brassica* crop, it most likely supplies more dietary carotenoid and chlorophyll phytonutrients than the other crops of this species. However, very little is known about the broccoli head pigment profile, or the levels of specific pigments and how they might vary among cultigens and wide geographic locations. For initial project evaluations, six broccoli cultigens were grown in the five East Coast locations of ME, NY, NC, SC, and VA under optimum and sub-optimum seasons during 2011. Pigments were extracted from freeze-dried floret tissues and measured for chlorophyll and carotenoid compounds. Floret tissue chlorophyll *a* was influenced statistically by location, cultigen, season, and their interactions, while chlorophyll *b* was influenced by location, cultigen, location × cultigen, location ×

season, and location × cultigen × season. Floret tissue β-carotene, lutein, neoxanthin, and violaxanthin varied statistically with location, cultigen, and location × cultigen. Pigment data from evaluations in the first year of our SCRI project will be used by team breeders and production specialists to develop and refine germplasm and growing practices to support a developing eastern broccoli production system.

Thursday, August 2, 2012 Grand Ballroom

Genetics and Germplasm 3

(424) Race, Interracial Admixture and Genetic Differentiation of Avocado (*Persea americana* Mill.)

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Avocado (*Persea americana* Mill.) is a major tropical fruit crop native to Mesoamerica and domesticated around 8000 to 7000 BC. It is a member of the Laureace family and currently classified into three subspecies or races: Guatemalan (G), Mexican (M) and West Indian (WI) according to their ecological adaptation, botanical descriptors and physiological traits. The goals of this research were to: a) to characterize race, interracial admixture, population structure, and genetic diversity of avocado accessions using a set of SSR markers and b) to evaluate the mislabeling errors present in these accessions. A total of 354 individuals from SHRS, Fairchild Farm, and *P. schideana* from Mexico were genotyped using SSR markers. Preliminary results indicated that mislabeling was estimated at 9.59%. SSR marker SHRSPa109 was the most informative locus followed by SHRSPa258 with 37 and 34 alleles, respectively, and average polymorphism information content (PIC) value of 0.76. The least informative loci were SHRSPa167 and SHRSPa177 with 4 alleles each. The observed heterozygosity (H_{obs}) was 0.59. Bayesian cluster analysis assigned groups into the Guatemalan, Mexican, West Indian races of *P. americana*, admixed interracial hybrids (G × WI, G × M, M × G, M × WI, WI × G, and WI × M), Complex Hybrids and *P. schideana*. Assignments were made based on coefficients of membership and degree of admixture or allelic contributions within a group. In addition, principal component analysis (PCA) and genetic distance analysis were calculated among all possible individual combinations within the SSR diversity data the results of which agreed with the Bayesian evaluation. The advent of DNA genotyping technologies has provided new avenues of research in plant genetics where population genetic approaches can be used to better understand genetic and phenotypic variation.

(425) Fruit Trait Phenotypic Dataset for RosBREED Apple Reference Germplasm Set

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Marker-assisted breeding is facilitated by marker-locus-trait associations validated in germplasm relevant to a particular breeding program. Establishing these associations depends on having an extensive, reliable phenotype database for traits of interest in this germplasm. A reference apple germplasm set of 496 individuals including cultivars, selections, and seedlings was identified as part of the USDA–SCRI RosBREED project. The germplasm set provides allelic representation of historic and current parents in RosBREED demonstration apple breeding programs at Cornell University (CU), Washington State University (WSU), and the University of Minnesota (UMN).

Phenotyping at the three locations was conducted according to standardized protocols that specified fruit harvest maturity and focused primarily on fruit traits evaluated at harvest and following 10 and 20 weeks of refrigerated storage. Descriptive statistics for phenotypic data at harvest only are reported for two years on 3 internal traits, 15 external traits, 7 sensory traits, 3 chemistry analyses, and 17 instrumental measurements (Mohr Digi-Test (MDT) and Effigi penetrometer). The number of individuals phenotyped at harvest varied each year with 215 genotypes evaluated in 2010 and 330 genotypes evaluated in 2011. A total of 413 unique genotypes were evaluated over both years. As each location had a largely unique set of individuals as well as differing environmental conditions, means, ranges and phenotypic variances for traits varied greatly among location subsets for some traits [diameter 2010, bitter pit 2010, pH 2010, weight 2011, soluble solids (°Brix) 2010, sensory sweetness 2011, MDT crispness (Cn) 2010 and 2011, MDT firmness at the core boundary (E2) 2010 and 2011, MDT firmness in region 2 (M2) 2010 and 2011, and MDT quality factor (QF) 2010 and 2011]. Other traits were quite similar across locations [pH 2011, sensory sweetness 2010, titratable acidity 2010 and 2011, soluble solids 2011, and MDT maximum firmness in region 1 (M1) 2010]. Year-to-year repeatability at a location, however, was generally moderate to high for Pearson's correlation coefficients for most traits (UMN = $0.36 < r < 0.75$, WSU = $0.34 < r < 0.80$, and Cornell = $0.30 < r < 0.90$). Phenotypic data for the RosBREED apple reference germplasm set are curated and available for use by community breeders and other scientists in the Breeders Toolbox at the Genome Database for Rosaceae (www.rosaceae.org).

Specified Source(s) of Funding: Specialty Crop Research Initiative Competitive Grant 2009-51181-05808 of the USDA's National Institute of Food and Agriculture

(426) Variability of Reproductive Characteristics in *Jatropha curcas* L. Accessions in South Florida

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Jatropha (*Jatropha curcas* L.) is a species in the Euphorbiaceae that has been identified as a potential bioenergy crop. The seeds contain oil of high quality already proven suitable for biodiesel and jet fuel use. However, jatropha is still non-domesticated. Breeding and genetic programs are limited. Key to any successful breeding program is the identification of genetic diversity. Efforts on introduction, collection, characterization, documentation, and preservation of genetic material are required. The evaluation of morphological and reproductive characteristics in previous studies with jatropha revealed a considerable amount of genetic variability that can be utilized to optimize characteristics directly related to yield. The objective of this study was to specifically evaluate the reproductive characteristics of 15 jatropha accessions in South Florida. For each accession, plant sexuality, inflorescence type, flower initiation, total number of flowers per inflorescence, number of male and female flowers per inflorescence, male:female flower ratio, fruit initiation, total number of fruits, number of fruits per branch, fruit set, fruit fresh weight, fruit yield, seed ripening, total number of seeds, number of seeds per fruit, seed fresh weight, seed dry weight, seed yield, seed length, thickness and width,100-seed weight, and oil content were evaluated. Number of inflorescences and inflorescence set were evaluated for two flowering span periods, while remaining characteristics were evaluated during three different seasons; spring, summer, and fall. Data were submitted to analysis of variance and the phenotypic correlation between pairs of floral, fruit, and seed components was evaluated for all jatropha accessions. Two flowering spans were identified throughout one year of evaluations, March through May, and August through November, respectively. Seeds ripened within 90 days and a 3-month harvest period was identified for each flowering span. There was significant variability among accessions for flowering characteristics, flowering spans and the interactions between them. The total number of flowers ranged from 68 to 225 for the first flowering span, and from 73 to 155 for the second flowering span. Maximum female flowers were 10 to 15, for the first and second flowering spans, respectively. Summer season favored female-type inflorescences, while Spring and Fall favored middle-type inflorescences. Significant differences were also observed for number of fruits per bunch and fruit set between flowering spans. Seed and oil characteristics also differed significantly. Phenotypic correlations were significant for all traits. The variability found in this study for jatropha accessions if of high importance for germplasm selection and application in crop improvement programs.

Specified Source(s) of Funding: FDACS - Farm to Fuel Grants Program

(427) Pollen Germination and Fruit Set in *Jatropha curcas* L. Accessions in South Florida

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Biofuels and bioenergy encompass a wide range of alternative sources of energy of biological origin. Jatropha (*Jatropha*

curcas L.) has become a species of interest worldwide because its seeds produce oil of high quality for biodiesel and jet fuel. However, the species agronomical characteristics and the potential seed production is still uncertain, as research programs in jatropha are very limited. Jatropha flowers are unisexual, monoecious, and cross-pollination is performed by insects. Under normal circumstances, jatropha shows protandry, whereby male flowers start opening from the first or second day of the inflorescence life (13–19 days), while female flowers open later, with 60% opening from the third to the fifth day. Therefore, the opening mechanism of female flowers in jatropha promotes out crossing and minimizes self-pollination. However, many studies have reported that this species is self-compatible with high fruit set percentages. Furthermore, jatropha is also capable of reproduction through apomixis. The objectives of this work were to assess pollen viability and fruit set during three seasons and to elucidate the pollination mechanisms in 17 jatropha accessions growing in South Florida. Pollination and fertilization are influenced by pollen deposition on stigma, nectar availability and pollen viability, which is strongly influenced by temperature, moisture and genotypic differences. In this study, the number of female flowers per inflorescence, male:female flower ratio, and fruit set were evaluated using four replications per accession. Fruit fresh weight, number of seeds per fruit, seed fresh and dry weight, and oil content were evaluated using 30 replications per accession. Data were submitted to analysis of variance. The number of female flowers per inflorescence, male:female flower ration, and fruit set were significantly influenced by seasonal changes and genotype for eight, four, and six accessions, respectively. Pollen germination percentage was also affected by the season and genotype, whereby 14 accessions had higher germination during summer, from which 8 accessions maintained higher germination percentage during fall. Seed characteristics were also significantly different as influenced by pollination mechanisms

Specified Source(s) of Funding: FDACS - Farm to Fuel Grants Program

(428) The First Genetic Map of American Cranberry and Identification of Quantitative Trait Loci for Fruit Rot Resistance

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The first genetic map of American cranberry (*Vaccinium macrocarpon* Ait.) has been constructed, comprising 14 linkage groups totaling 879.9 cM with an estimated genome coverage of 82.2%. This map, based on four mapping populations segregating for field fruit rot resistance, contains 136 distinct loci, and provides the first foray in the identification of regions associated with fruit rot resistance. Mapped markers include blueberry simple sequence repeat (SSR) and cranberry sequence-characterized amplified region (SCAR) markers previously used for fingerprinting cranberry cultivars. In addition, SSR markers were developed near cranberry sequences resembling genes involved in flavonoid biosynthesis or defense against necrotrophic pathogens, or conserved orthologous set (COS) sequences. The cranberry SSRs were developed from next-generation cranberry genomic sequence assemblies; thus, the positions of these SSRs on the genomic map provide information about the genomic location (but not the orientation) of the sequence scaffold from which they were derived. The use of SSR markers near functional sequences, in particular the COS-associated SSRs, plus 33 SSR markers from blueberry, enables comparisons of the cranberry map with other plant species' maps. Regions of the cranberry map showing synteny with grape, and a more limited conservation with *A. thaliana,* were identified. The cranberry map utilized markers that are highly informative and readily transferable to other crosses and closely-related species. Located on this map are quantitative trait loci (QTL) for field fruit rot resistance (FFRR, three loci), fruit weight (two loci), titratable acidity (one locus), and sound fruit yield (one locus). The sound fruit yield QTL was located near one of the fruit weight QTL, but might be pleiotropic. Two of the FFRR QTL are in regions of conserved synteny with grape and span defense gene markers, and the third FFRR QTL spans a flavonoid biosynthetic gene, however, functional attribution at this point is premature. Ultimately, a more densely populated map will be required, resulting in the 12 linkage groups which comprise the cranberry karyotype. This map will be used to facilitate future cranberry breeding efforts, particularly for improving fruit rot resistance.

(429) Collecting and Characterization of Leaf Mustard (*Brassica juncea*) in Korea

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Brassica juncea L. Czern. with vegetable, flavoring and oil potential has been a neglected genetic resources as far as collecting of indigenous germplasm in Korea is concerned. Howerver, rapid agricultural intensification means that the genetic diversity of wild species is severely threatened. Responding to these needs, the natural habitat and distribution of wild or weed types of leaf mustard (*Brassica juncea* L. Czern.) were surveyed from 2004–07 in the Korean peninsula, in Jeju Island, and in Ulleung Island, and the seeds were collected and their habitat population size were investigated. The natural populations of wild mustard were found in different location in the southern and western parts of the Korea peninsula, in Jeju Island, and in Ulleung Island near fields, roadsides, riversides, and residences. The population size were larger in the southwestern part than in other regions. The colors of seed coat were brown, dark brown, and yellow. Most of the collected samples were long-day plants, and flowering in April in the field, but some samples flowered regardless of the daylength. These materials were conserved in National Agrobiodiversity Center, NAAS, RDA, and will used for breeding and research materials in future.

(430) Genetic Diversity and Cluster Analysis of Eastern Filbert Blight Resistant Hazelnut (*Corylus* spp.) Germplasm

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European hazelnut (*Corylus avellana* L.) is a high-value, low-input crop traditionally grown in Mediterranean regions. Its production in the U.S. is limited due to its susceptibility to the devastating fungal disease eastern filbert blight (EFB), which is found only in North America. Currently, there are limited sources of genetic resistance to this disease found in *C. avellana*. Development of hazelnuts with stable genetic resistance could significantly increase the acres of hazelnut production in the U.S. At Rutgers, the screening of large germplasm collections of *C. avellana* from Eastern Europe and parts of Russia has identified numerous new plants expressing resistance to EFB. However, other than geographic origin, little is known about the genetic diversity and relatedness of these new potential sources of resistance. In this study, 170 EFB-resistant and tolerant seedlings, as well as 179 known cultivars and breeding selections representing a wide spectrum of geographic origins and a number of known sources of EFB-resistance, were assessed using 30 genomic SSR markers. The goal was to examine the relatedness and genetic diversity present in and among the new seedlings to identify potential novel sources of EFB-resistance, as well as to evaluate the seedlings in respect to known cultivars and existing sources of EFB resistance. The resulting SSR data was used to evaluate polymorphism information content, allele frequencies, and heterozygosity. Additionally, cluster analysis was performed on the data and relationships were resolved between new EFB resistant seedlings and standard cultivars known to confer disease resistance. By better understanding genetic diversity in the new germplasm, the hazelnut breeding program will be able to direct its efforts into utilizing and maintaining multiple, unrelated sources of resistance in its breeding lines, where goals of developing durable, long-lasting resistance to EFB is a priority.

Specified Source(s) of Funding: New Jersey Agricultural Experiment Station, the Rutgers Center for Turfgrass Science, and USDA Specialty Crops Research Initiative Competitive Grant 2009-51181-06028

(431) Novel Sources of Eastern Filbert Blight Resistance in 'Culpla' and OSU 495.072 Hazelnuts

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Eastern filbert blight (EFB), the fungal disease caused by the pyrenomycete *Anisogramma anomala* (Peck) E. Müller, is a significant disease of European hazelnut (*Corylus avellana* L.) in the U.S. Pacific Northwest. Disease progress can be slowed

by cultural practices and fungicide applications, but the disease significantly reduces productivity of infected trees and leads eventually to premature death. Genes conferring qualitative resistance (R genes) to EFB have been discovered and utilized in breeding to confer high levels of resistance to progeny. Accessions such as 'Gasaway', 'Ratoli' and OSU 408.040 have been used to introgress resistance into advanced selections. The cultivars 'Yamhill', 'Santiam', and 'Jefferson', developed by Oregon State University (OSU), have high levels of resistance conferred by a dominant allele from 'Gasaway'. There is concern that a single dominant gene resistance may break down under disease pressure, so it is desirable to identify novel sources of resistance and use them in breeding, eventually in gene pyramiding. Two hazelnut accessions, 'Culpla' (Spanish origin) and OSU 495.072 (Russian origin), have shown resistance to EFB. When crossed with susceptible selections, the progeny show a 1:1 segregation for resistance, indicating that each resistance is conferred by a dominant allele at a single locus. Two segregating seedling populations (OSU 675.028 x 'Culpla' and OSU 713.068 x OSU 495.072) were used to map the resistance genes. Greenhouse and outdoor structure inoculations were used to obtain a disease phenotype for individuals in the populations. Correlation of disease phenotype with simple sequence repeat (SSR) marker alleles indicates that resistance in both populations maps to linkage group 6. All known SSR markers from linkage group 6 were used to fingerprint the seedlings and map the resistance loci. The maps show that the resistance from 'Culpla' and OSU 495.072 is in the same region as 'Gasaway' resistance, and may represent a cluster of R genes. SSR markers linked to EFB resistance from these sources will be useful for introgressing resistance in the hazelnut breeding program.

(432) Ex Situ Conservation of Horticultural Plant Genetic Resources in the Genebank of Korea, National Agrobiodiversity Center

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The world-wide capacity of genebanks for ex-situ conservation of crop genetic resources has increased greatly since the 1970s, improving the access of crop breeders to landraces, and wild relatives (Wright, 1997). In south Korea, systematic seed germplasm management was begun at the Rural Development Administration (RDA) in 1985 and consequently genebank system was established in 1988. The RDA genebank, National Agrobiodiversity Center (NAC) of south Korea, preserve 173,217 accessions of plant seed germplasm and 10.7% (18,509 accessions) of whole preserved germplasm is occupied by horticultral PGR by 2011. Horticultural PGR preserved in NAC is composed with 67 genera of crops including pepper (3,817 accessions), tomato (2,040 accessions), cabbages (1,690 accessions) and etc. According to horticultural plant sub-group, fruit-vegetable is the biggest group with 60% of accession share and leafy vegetable (19%), root vegetable (10%), bulb vegetable (8%), and ornamental (3%) follow subsequently. In aspect of PGR status, landrace is dominant part of conserved accession and then developed cultivar, wild relatives, cultivated material, wild, and weedy type follow subsequently. Recently characterization and evaluation of horticultural PGR have been activated for 3 years in NAC, which are useful for breeders and users focused on disease-resistance or active ingredient. It will promote utilization of horticultural PGR and development of horticultural crop breeding program for both human being and sustainable agriculture in near future.

(433) Fatty Acid Profile in Seeds of Embrapa's *Manihot* Germplasm Collection

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Cassava (*Manihot esculenta;* Euphorbiaceae) is the only commercial species of the genus cultivated mainly for its starchy tuber roots. Cassava seeds are known to be rich in oils and fats. However, there are very few reports on the fatty acid profile in cassava seeds and its wild relatives. Wild cassava species usually produce higher numbers of seeds with large diversity in shape and size. Seeds of 12 *Manihot* species (75 accessions) from the Embrapa collection in Brazil were analyzed for fatty acid profile using gas chromatography. All species contained five predominant fatty acids. The concentration of the fatty acids was: palmitic (C16:0) 9.0–21.7%, stearic (C18:0) 1.9–11.2%, oleic (C18:1) 12.4–31.2%, linoleic (C18:2) 45.9–72.3%, linolenic (C18:3) 0.8–3.2%. The concentration of the fatty acids varied significantly within species and between accessions. The collection of Embrapa's *Manihot* germplasm contains a large source of variability for fatty acid composition, probably influenced

by the great diversity of wild species and accessions, and also by environmental factors such as year and location of seed harvest. The *Manihot* wild collection is a valuable source for cassava diversity and the data of this study will support cassava improvement programs.

(434) Improving Sweet Peppers for Fruit Qualities

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Genetic diversity in *Capsicum* species offers great opportunities to breed cultivars improved in levels of fruit antioxidant compounds, brilliant colors, and flavor with interesting shape and size. This research, performed in an innovative educational effort by undergraduate students, evaluated the inheritance of fruit shape, fruit size, fruit color, pungency, pericarp thickness,and flavor in several commercial cultivars and their crosses. In a cross involving two open-pollinated heirloom cultivars, 'Round of Hungary' and 'Bulgarian Carrot', the red mature fruit color and pungency were dominant traits over yellow fruit color and sweet taste, wavy pericarp was recessive over smooth pericarp and pericarp thickness was semi-dominant. Pericarp extracts of 'Bulgarian Carrot' had significantly greater antioxidant activity compared to those of 'Round of Hungary' using ferric reducing antioxidant power assay. However, total amount of extractable carotenoids were significantly greater in mature fruits of 'Round of Hungary' than those of 'Bulgarian Carrot'. Fruits of F_1 plants for 'Bulgarian Carrot' × 'Round of Hungary' had total carotenoid levels comparable to 'Round of Hungary'. Immature fruit color of cultivar Islander cultivar purple due to anthocyanin accumulation. This trait was dominant in crosses with yellow-fruited 'Bulgarian Carrot' and red-fruited 'Ladybug'. Inheritance patterns of fruit color, pungency and fruit size confirmed previous genetic studies in peppers. Further data on carotenoid levels, antioxidant activities and fruit anthocyanin coloration are valuable new information to build cultivars enhanced for high levels of pro-vitamiin A carotenoids, and anthocyanins combined with interesting fruit size and shape.

Specified Source(s) of Funding: College of Agriculture and Life Sciences, Univ. of Florida

(435) Genetic Relationships among the Vine Cacti *Hylocereus* Species Revealed by AFLP Markers

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Species of the vine cactus *Hylocereus* are increasingly being grown in Israel as new exotic fruit crops that are particularly suited to cultivation in semi-arid and arid lands. *Hylocereus* species are characterized by high genetic variability; in the current study, we investigated genetic similarity and distance, genetic relationships, allele frequency and polymorphic information content (PIC) of 15 accessions belonging to four commercially important *Hylocereus* species. As a first step in defining the above genetic characteristics of the investigated accessions, five amplified fragment length polymorphism (AFLP) primer combinations were used. These five sets of primer combinations amplified different subsets of restriction fragments. For each primer, 59 to 91 bands were identified that independently revealed similar patterns for relationships among the species under analysis. About 94.5% of the total number of bands developed were polymorphic, with the majority of the bands being small in size, i.e., between 50 and 250 bp. The highest similarity was found between accessions 96–664 and 96–680, and the lowest, between accessions 88–023 and 96–664, with all four accessions belonging to the species *H. megalanthus*. PIC varied between primers from 0.27 to 0.37 and between species from 0.40 to 0.50, revealing a high level of heterozygosity. Grouping of the accessions showing high similarity produced four main clusters. Two points of interest emerged: (i) The *H. undatus* accession 70–02–04 belonged to the cluster of *H. megalanthus* accessions, which suggested that this *H. undatus* accession is a putative natural hybrid, and (ii) *H. undatus* accession 89–024 and *H. megalanthus* accession 88–023 were clustered in the same node, showing a close association between them, with more than 50% of similarity. From the genetic distance analyses three clusters were obtained; one cluster including three *H. monacanthus* accessions, one *H. costaricensis* accession, and two *H. undatus* accessions (but not 89–024 and 70–02–04); one cluster comprising accession 89–024 (*H. undatus*) and accession 88–023 (*H. megalanthus*); and one cluster comprising six *H. megalanthus* accessions and *H. undatus* accession 70–02–04. The AFLP study thus confirmed the high genetic variability among *Hylocereus* species and showed that the technique provides an efficient means for assessing genetic relationships. The study also confirms the excellent prospects for conserving and domesticating these exotic fruit crop species.

Thursday, August 2, 2012 Grand Ballroom

Herbs, Spices, and Medicinal Plants

(073) An Evaluation of Shade Indices on Growth and Essential Oil Production of 'Italian Large Leaf' Basil

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Basil (*Ocimum basilicum* L.), a popular herb enjoyed by many home gardeners, can be used for cooking, as a source of essential oils, and as a fragrant ornamental. The objective of this study was to quantify the relationship between limited irradiance and the growth and essential oil production of 'Italian Large Leaf' basil. Basil plants were grown in a greenhouse under shade cloth that provided 0%, 30%, 50%, or 70% shade. Six pooled sub-sample plants with three replicate shade treatments were grown in a randomized complete-block design for 3 months and then harvested for dry weight and aromatic sampling. Peak areas for common basil aromatic compounds, including linalool, 1,8-cineole, eugenol, and methyl-cinnamate, were quantified from headspace samples derived from fresh shredded basil leaves and analyzed via gas chromatography. Plant growth increased with irradiance, resulting in highest dry weight under 0% shade. Basil plants flowered under 0% or 30% shade, while plants under 50% or 70% shade did not. Differences in essential oil aromatic compounds were not significant among shade treatments; however, there was considerable variability between samples suggesting a need for greater replication in future experiments. Our results suggest that higher irradiance allows for more photosynthetic activity to occur, resulting in greater dry mass accumulation. This is likely responsible for the differences in flowering between treatments as well.

Specified Source(s) of Funding: The Scotts-Miracle Gro Company

(075) Growing Hops in North Carolina: Variety Trials in the Central Piedmont and Southwestern Mountains of North Carolina

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North Carolina is home to more than 50 craft breweries, including several very large ones scheduled to be built within the next few years. North Carolina also has one of the strongest "buy local" movements in the U.S. These two factors have resulted in a high interest within the agricultural community to grow ingredients for locally produced beer. Small private hop (*Humulus lupulus*) yards exist across the state; with an estimated 50 currently in production. Since there is no regionally appropriate information available to support this industry, we initiated a multi-disciplinary hops research program. North Carolina is at the southernmost range of where hops can likely produce commercially. Due to it's unique climate and soils, proper variety selection for high yields and disease resistance is a top priority for growers. To help identify the best performing varieties, we established two variety trials; the first is located in the central piedmont region of the state and the second in the southwestern mountain region. The piedmont trial is in Raleigh where the summers are hot and humid and summer rainfall is heavy. The mountain trial is in Mills River near Asheville, where the summers are slightly cooler and drier. Ten varieties were planted in three replications at each location in .10 ha hop yards. The piedmont trial was planted in 2010 on a short-trellis system (3.7 m tall). The mountain hop yard was planted in 2011 on a high-trellis system (6 m tall). In 2011, 85% of the total yield from the piedmont hop yard was produced from just two varieties; 'Zeus' and 'Cascade', and the majority of the harvest occurred in mid-July. In the mountain trial, over 70% of the total production was harvested from four varieties: 'Cascade', 'Zeus', 'Galena', and 'Nugget', and the harvest was spread throughout August. These preliminary results demonstrate the importance of public variety trials, particularly on crops with significant startup costs and newly emerging markets. Many of the privately owned hop yards grow five or more varieties, many of which this research has identified as poor producers in North Carolina. These less productive varieties offer little opportunity for long-term success and sustainability and will likely need to be removed and replaced. This is a laborious, expensive, and time-consuming effort. Growers establishing hop yards in 2012 are benefiting from the results of our new research program through identification of varieties that perform well in our trials.

Specified Source(s) of Funding: NC Department of Agriculture & Consumer Services, USDA Specialty Crops Block Grant and the GoldenLEAF Foundation

(080) Seasonal Changes in Biomass of Wild Populations of Horsetail

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Horsetail (*Equisetum arvense* L.) is a perennial herb with segmented stem. The plant produces spring and summer stems. Sum-

mer stalks are 0.10 to 0.40 m high, green, ribbed, branched and barren. The plant is collected for production of dried medicinal known as a *Herba equiseti* or for production of commercially available capsules with powdered herb. Each plant species has its specific areas of distribution or habitats. Monitoring of selected species and populations was conducted during the period of 2009–11 on three different natural locations (L1, L2, L3) in Laborecká vrchovina in eastern Slovakia. The highest quantity of biomass was collected in 2009 and the lowest in 2011. The largest amount of the total biomass (131 ± 25 $g \cdot m^{-2}$) was obtained from the third collection from a total of six collections for the locality L2 in 2009. The lowest amount of biomass (33 ± 1 $g \cdot m^{-2}$) was obtained in the same locality in 2011. In 2009, the largest amount of collected biomass was obtained from the first three harvests. However, in 2010 and 2011 the largest amount of harvested biomass was obtained from the fifth and sixth collections. The locality L3 has the lowest amount of biomass, which ranged from 5 ± 1 $g \cdot m^{-2}$ to 42 ± 5 $g \cdot m^{-2}$ during the three experimental years. The main factors for statistical variability in the underground and aboveground biomass of horsetail (*Equisetum arvense* L.) were locality, year and collection. Location had the highest impact on underground and aboveground biomass.

Thursday, August 2, 2012 Grand Ballroom

Ornamental Plant Breeding

(391) Variable Fire Blight Resistance among 31 Species of Cotoneaster

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Cotoneaster is a diverse genus in the family Rosaceae, with approximately 400 species of highly variable plants from ground covers to trees. A limited number of species are available in the nursery trade. The common species commercially available are valued for their ability to flourish in difficult sites. Although cotoneasters are well adapted for abiotic stresses, many species are highly susceptible to fire blight (*Erwinia amylovora*, Burrill, Winslow et al.). Fire blight is a bacterial disease endemic to North America and has a wide host range in the sub-family Maloideae. The disease is vectored by floral and vascular feeding insects and also is spread by rain splash and mechanical injury. Symptoms result in flower and shoot necrosis and in severe infection the entire plant may be killed. Previous reports on disease resistance *Cotoneaster* spp. are conflicting and comprise a limited range of the genus. Our objectives were to clarify previous results and expand knowledge of disease resistance of unreported taxa. In this experiment, 31 species of cotoneaster were arranged in a glasshouse in a randomized complete-block design. Susceptibility to fire blight was determined by foliar assay with isolate EA153 at a concentration of 1.53×109 CFU·mL^{-1}. Lesion length was recorded over eight weeks and the percentage of shoot infection was calculated. Disease susceptibility varied among species. Susceptibility ranged from 0% to 100% shoot necrosis with a mean of 36% among species. Ten species fell below the 5% shoot infection that was used as the acceptable disease threshold. *Cotoneaster arbusculus*, *C. atropurpureus, C. dielsianus*, and *C. splendens* had no symptoms (0% shoot infection). Additionally, there were six species that exhibited symptoms below the disease threshold. Our results agree with previous reports that *C. franchetti* and *C. simsonii* exhibit fire blight resistance. We also report fire blight susceptibility level for eight other species, which have not previously been screened for fire blight susceptibility.

(392) Developing Molecular Markers for Development Rate of Petunia

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Petunia (*Petunia ×hybrida*) ranks first in wholesale value among bedding plant crops grown in the United States. Profitability of bedding plant production faces several economic challenges, including greenhouse heating and labor costs. Reducing crop production time is one strategy for addressing these challenges. Understanding the genetics of plant development rate offers the opportunity to breed faster developing cultivars, particularly under suboptimal conditions such as cool temperatures, short photoperiods and low irradiance levels. We previously determined that the progenitor species of cultivated petunia (*P. integrifolia* and *P. axillaris*) exhibited faster development (leaf unfolding) rates than any of a panel of modern cultivars. Two interspecific F_2 populations, *P. axillaris* × *P. exserta* and *P. integrifolia* × *P. axillaris*, exhibited transgressive segregation for many crop timing and quality parameters, including leaf number below first flower, time to flower, leaf unfolding rate, branch number, flower bud number, and flower size, indicating their potential utility as sources of novel alleles for commercial petunia breeding. To develop molecular markers, approximately 20,000 *P. axillaris* expressed sequence tags (ESTs) were mined for simple sequence repeats (SSRs), with 694 SSRs meeting the search criteria. Of these, 162 sequences were polymorphic between *P. axillaris* and *P. integrifolia*, and 113 sequences were polymorphic between *P. axillaris* and *P. exserta*. Seventy-four markers were polymorphic across both parental species combinations. The *P. integrifolia* × *P. axillaris* F_2 population was genotyped with 114 SSRs and 11 cleaved amplified polymorphic sequence (CAPS) markers. From this, a genetic linkage map comprising 101 markers assigned to seven linkage groups was generated. Utilizing this genetic linkage

An asterisk (*) following a name indicates the presenting author.

map and our preliminary phenotypic data for leaf unfolding rate, we identified three quantitative trait loci (QTL) for leaf unfolding rate, two on linkage group 1, and one on linkage group 5. Together, these three QTL explained 49% of the variability for leaf unfolding rate observed in this mapping population. We are currently developing recombinant inbred lines for these interspecific hybrid populations to evaluate the robustness of the identified QTL.

Specified Source(s) of Funding: USDA–Specialty Crop Research Initiative; USDA–Specialty Crop Block Grant; USDA–ARS Floriculture and Nursery Research Initiative; Western Michigan Greenhouse Association

(393) Discovery of a New Diploid Cytotype of *Fothergilla*

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Fothergilla (Hamamelidacea) is a small genus of uncommon, deciduous shrubs found exclusively in the southeastern United States. Two species of *Fothergilla* are currently recognized: *F. gardenii* and *F. major*. However, variation in the genus is considerable and as many as four taxa have been recognized in the past. *Fothergilla gardenii* is found in the coastal plains of North Carolina, South Carolina, Georgia, Florida, and Alabama and is tetraploid with $2n = 4x = 48$. In contrast, *F. major* is found on upland sites in the piedmont and mountains of North Carolina, South Carolina, Georgia, Alabama, Tennessee, and Arkansas and is hexaploid with $2n = 6x = 72$. No diploid cytotypes of *Fothergilla* have previously been known. The objective of this study was to survey DNA contents and ploidy levels of *Fothergilla* spp. from throughout its range. Samples from thirty populations were collected and tested. Flow cytometry was used to determine DNA contents and associated ploidy levels. As expected, tetraploid and hexaploid plants were identified, consistent with *F. gardenii* and *F. major*, respectively. However, populations of diploid plants were also discovered in a few locations. Considering that diploid plants differ morphologically and are isolated both geographically and cytogenetically from other *Fothergilla* spp., this cytotype may represent a new, distinct, and rare taxon. Additional work is continuing to reassess the systematics and phytogeography of *Fothergilla* in order to elucidate the diversity and evolutionary relationships among species, properly classify this new cytotype, and to help guide future conservation efforts.

Specified Source(s) of Funding: Mt. Cuba Center, USDA, Birmingham Botanical Gardens

(394) Effects of Oryzalin and Trifluralin in Polyploidy Induction in In Vitro *Cattleya walkeriana* Gardner (Orchidaceae) Seedlings

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Orchidaceae is one of the largest and most evolved families of flowering plants found especially in tropical and sub-tropical regions. Orchids are undoubtedly the ornamental elite because of their perplexingly complex flowers of exquisite beauty. Polyploidy induction is a common technique utilized to obtain plants with enhanced characteristics. Polyploid orchids might present larger flowers, larger number of flowers per inflorescence, enhanced vigor, and intensified coloration. The traditional polyploidy inductor used worldwide is colchicine, but this alkaloid is extremely toxic to human manipulation due to its high affinity to microtubules of animal cells. Oryzalin and trifluralin are herbicides recognized for their antimitotic activity and suitable plant polyploidy induction ability. They can be effective in very low quantities, present more affinity for plant tubulin dimers and consequently have reduced human toxicity. The objective of this study was to evaluate the effects of oryzalin and trifluralin in the induction of polyploidy in in vitro *Cattleya walkeriana* orchids. Seeds from *C. walkeriana* were germinated in vitro and 90-day-old protocorms were treated with different concentrations (0, 15, 30, 50, and 100 μM) of both antimitotic agents for 3 and 6 days. After that they were transferred to 180-mL flasks containing 50 mL of semi-solid ½ strength MS culture medium. The experimental design consisted of 20 treatments, 5 flasks per treatment and 10 protocorms per flask, with a total of 1,000 explants. The evaluation included biometrical responses (protocorm survival and number of shoots recorded at 8 weeks), and cytogenetic and flow cytometry analyses 22 weeks after the experiment establishment. Data were subjected to analysis of variance (ANOVA), and means compared using Tukey test ($\alpha = 0.05$). Treatments for both antimitotic agents decreased rooting and dramatically increased the number of shoots compared with controls. Trifluralin was significantly more toxic than oryzalin, particularly when protocorms were exposed to it for 6 days, and showed lower survival rates and high callus formation. The cytogenetic and flow cytometry analyses of regenerated plantlets confirmed the level of polyploidy induction. This study demonstrated that oryzalin showed more promising results and it was more effective in polyploidy induction as compared to trifluralin. Renegerated plants of *C. walkeriana* will be further evaluated for growth ex vitro and subsequently for floral characteristics.

Specified Source(s) of Funding: CNPq-Brazil

(395) Morphological Variations in Forsythia Induced by Gamma Ray Irradiation

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Forsythia × 'Meadowlark', released by North Dakota State University and South Dakota State University, in collaboration with the Arnold Arboretum and the North Central Regional Plant Introduction Station, Ames, IA, is an extremely hardy flowering shrub (flower buds have shown hardiness at –30 to –40 F) and widely planted for northern landscapes. It might be the first field flower in the spring in North Dakota and northern Minnesota. This shrub is very tolerant to drought and pests. It grows rapidly and can easily reach a height of 7 to 10 feet. However, the large stature is one of the concerns because it grows too big to fit in a limited space in residential areas. In this study, mutagenesis by gamma ray irradiation was employed to induce genetic variations. In vitro shoot tips of *Forsythia* × 'Meadowlark' was exposed to 0–100 Gy gamma rays and then recovered in MS (Murashige and Skoog, 1962) medium supplemented with 2.5 μM benzyladenine (BA). Shoots that survived from the gamma ray treatment were rooted in ½ MS medium containing 0.5 μM naphthalene acetic acid (NAA). An average of 80.3 % of shoots were rooted /recovered from the 25 Gy gamma ray treatment followed by 36.5, 5.4, and 2.1% from the 37, 50, and 70 Gy irradiation treatments, respectively. No shoots were survived when exposed to 100 Gy gamma rays. Rooted plants were transferred to potting mix and grown in the greenhouse for 3–5 months and then transplanted in the field. Morphological variations were first screened in the greenhouse and then in the field. Treated plants showed certain degree of reduced growth in the greenhouse. Various variations including characteristics of leaves (shape, size, hairs), stems (shape, internode length, branching), and plant stature were observed. These variations will be further screened in the field. This research demonstrates that in vitro mutation induction using gamma ray irradiation could be a useful protocol to develop new cultivars or genetic materials for further breeding of *Forsythia* or other related species.

(396) The Utilization of the Polyploid Nature of Roses

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Rose chromosome number ranges from 14 to 56 and understanding the dynamics of rose chromosome numbers can help improve the progress made in breeding programs and enhance the understanding of certain rose populations. A survey of the pollen size of 80 roses in a breeding collection suggested that 78% were tetraploid, 7% were triploid, and 14% were diploid. These results are currently being verified with flow cytometry. Of these roses, the presence of large pollen grains indicating non reduction during meiosis occurred in 10% of the roses. Triploid roses most commonly exhibited non reduction, but there were some diploid plants that had 2n gametes. The triploid rose 'Renny' had extremely large pollen grains with many measuring greater than 50 nm in diameter and a couple measuring over 70 nm in diameter. These large pollen grains were likely 3x, though these large sizes did not occur in the other suspected triploids. A common occurrence among the triploids was the presence of irregular and shrunken pollen grains that were likely aneuploids leading to pollen abortion. A series of interploidy crosses indicated that there were differences in set, seed yield and seed germination in crosses done between diploids or between tetraploids as compared to those done between either diploid or tetraploids and triploids. The ploidy level of the seedlings of these crosses is being followed to determine the frequency of haploid and diploid pollen from the triploid parent that results in a viable seedling.

(397) Breeding of an OTO Intersectional Hybrid Lily 'Flash Party' with Fragrance and Upward-facing Flower

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A OTO intersectional hybrid lily cultivar 'Flash Party' was developed in 2011 at National Institute of Horticultural and Herbal Science (NIHHS), Rural Development Administration (RDA), of Korea. The cross was made between female parents *Lilium* OT intersectional hybrid 'Avocado' and male parents *L.* Oriental hybrid 'Acapulco' in 2005. Preliminarily selection was done as 'OTO-08-03' in 2008. Multiplication and bulb formation, and characteristic tests were conducted from 2008 to 2010. The evaluation of this line was performed and named as 'Flash Party' (NIHHS line No:Wongyo C1-113) in 2011. 'Flash Party' flowers in the middle of June and grows average 131 cm. It flowers are fragrant, semi-upward-facing, red and light yellow color (RHS, R47A+Y8C) with the size of flower 21.5 cm. Mean outer-petal length and width is 15 cm and 4.7 cm, respectively. Leaves are

20 cm long and 3.3 cm wide, respectively. The weight and size of bulb is 65.3 g and 18 cm, respectively. Year-round flowering can be by storing the bulb under –1.5 °C conditions. For forcing culture, it is necessary to add calcium to the fertilizer or remove side scales to prevent leaf scorch. It is needed to control Botrytis disease in wet season.

(398) Cell Membrane Stability Provided Better Resolution for Screening Heat Tolerance in Garden Roses Than Did Chlorophyll Fluorescence

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Sales of garden roses in the United States have been declining over the last 20 years partly due to the impression that garden roses are difficult to grow. The lack of heat tolerant cultivars is one of the limiting factors for growing garden roses in sub-tropical conditions such as the southern U.S. Field evaluation of garden performance is crucial to a breeding program for landscape roses, but challenging due to yearly fluctuations in weather conditions. Development of a rapid screening technique to screen large amounts of rose germplasm which would enable accurate selection against the most heat susceptible material prior to field trials would be of great value to a breeding program. Both chlorophyll fluorescence and cell membrane thermostability (CMT) have been used as indicators of heat tolerance in other agricultural and horticultural crops. Detached leaf protocols, using chlorophyll fluorescence and CMT, were developed for screening heat tolerance in garden roses. To test whether chlorophyll fluorescence or CMT would provide the best resolution an experiment using four accessions, two identified as heat tolerant (J06-30-3-3 and J06-30-3-6) and two as heat susceptible ('Sweet Chariot' and 'Vineyard Song'); and two stress methods, water bath (45 °C for 45 min) and an oven (45 °C for 45 min) were used. Leaves from field grown plants were harvested within the first hour of sunrise and kept in the dark at high humidity until heat stress was applied to intact leaves. Chlorophyll fluorescence on dark adapted leaves was measured 30 minutes after the stress period, followed by CMT measurement on the same leaves. In both cases, CMT successfully separated the heat tolerant accessions from the heat susceptible accessions. CMT measurements resulted in a lower coefficient of variance when leaves were stressed in a water bath compared to chlorophyll fluorescence measurements on the same leaves. CMT was a more reliable indicator of heat tolerance in garden roses than was chlorophyll fluorescence.

(399) Characterization of Resistance Genes of *Rosa* spp. to Black Spot by Molecular Markers

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Black spot disease, caused by the fungus *Diplocarpon rosae* Wolf, is the most serious disease of landscape roses (*Rosa hybrid* L.) worldwide. Dominant genes for complete resistance to specific races of the pathogen were identified in roses as *Rdr*s. From a breeding perspective, a rapid screening of potential hybrid materials by molecular markers is beneficial for identifying the resistant germplasm. In this project, two microsatellite markers (155 at 0 cM and 69E24 at 0.1 cM distance) linked to *Rdr1* (resistance to race 3) were used to screen twenty cultivars for which the phenotypes are known and a rose collection consisting of the TAMU diploid breeding population, Earth-Kind® collection, Ralph Moore roses and various *Rosa* species. Up to four alleles of the locus 155 were amplified in 168 rose genotypes. The cultivars for which the phenotypes are known amplified fragments around 160 bp for the locus 155 and around 180 bp for the locus 69E24, indicating the presence of the *Rdr1* allele that conditions resistance to race 3. One hundred and twenty of the 147 plants with unknown phenotypes assayed had both the 160 bp band (locus 155) and the 180 bp band (locus 69E24) indicating that these possessed the *Rdr1* resistance gene. In addition one SCAR marker (ND5E) (9.1 cM distance) linked to *Rdr3* (resistance to race 8) was used to screen 51 rose genotypes of which the disease resistance phenotype with race 8 was known for 18. The one amplification product (around 80 bp) for the SCAR ND5E was only detected in the resistant roses and not the susceptible roses. Among the 33 roses with unknown resistance phenotypes, only one had the 80 bp band. The accuracy of these marker results among the roses with unknown resistance phenotypes will be verified by detached leaf assays with single spore derived cultures of the race 3 and race 8 of the black spot pathogen.

Specified Source(s) of Funding: Basye Endowment of Rose Genetics

(400) Ten-site Evaluation of Advanced Clonal Selections of *Taxodium distichum* (L.) Rich. Yields Data Aiding in Selection of Improved Trees for Built Environments in the Eastern and Central United States

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Baldcypress [*Taxodium distichum* (L.) Rich.] and its varieties, Montezuma cypress (*Taxodium distichum* var. *mexicanum* G. Gordon] and pondcypress [*Taxodium distichum* var. *imbricarium* (Nutt.) H.B. Croom], constitute an increasingly popular group of trees for challenging built environments and urban forests. In the nursery trade, these trees are largely seed propagated with minimal attention paid to provenance. Provenance trials of related seedling populations of *T. distichum* for growth and tolerance to alkaline soils, drought, soil salinity, and foliar salinity exposure were conducted. Clonal selections based on results from these experiments and phenotypic appearances were further screened for their propensity to root in sufficient quantities from shoot tip cuttings and to produce root systems of acceptable quality for commercial production. Replicates of all or some of the 23 advanced clonal selections from this work were sent to ten participating trial sites in an east–west transect in USDA plant hardiness zones 8 to 10 stretching from Balm, FL, Quincy, FL, College Station, TX, to El Paso, TX. A north–south transect from the USDA zones 8 to 10 Gulf Coastal sites through the central U.S. included Dallas, TX, Lubbock, TX, Fayetteville, AR, Haysville, KS, Columbus, OH, to Ames, IO in USDA zone 5a. Montezuma cypress tended to grow larger more rapidly than baldcypress or pondcypress on moderate to warm winter sites. Some Montezuma Cypress survived with minimal winter injury as far north as Kansas (–20 °C), while some species type baldcypress and genotypes from transitional populations between eastern provenances of baldcypress and Montezuma cypress from the Texas Hill Country survived –31 °C. Studies are needed to confirm longer term cold tolerances. Some clones of Montezuma cypress and the transitional Texas Hill Country populations had reduced foliar chlorosis compared to the species type baldcypress clones on high pH soils, but results were variable. Severe to moderate foliar damage from *Cercosporidium sequoiae* (Ellis and Everth.) W.A. Baker and Partridge infections limited the potential for use of all clones tested at the Florida sites.

Specified Source(s) of Funding: Tree Research and Education Endowment Fund.

(401) Interspecific Hybridizations in Flowering Cherries

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Flowering cherries belong to the genus *Prunus* L., consisting primarily of species native to Asia. Despite the popularity of ornamental cherry trees in the landscape, most ornamental *Prunus* planted in the U.S. are derived from a limited genetic base of Japanese flowering cherry taxa. A diverse collection of ornamental *Prunus* germplasm is maintained at the U.S. National Arboretum as part of an ongoing flowering cherry improvement program aimed at broadening the genetic base of cultivated ornamental cherries by developing new cultivars with disease and pest resistance, tolerance to environmental stresses, and superior ornamental characteristics. Controlled crosses carried out over the past 30 years have resulted in the creation of interspecific hybrids among many of these diverse taxa. We used SSR markers to verify over 100 hybrids created from over 35 parental taxa.

Thursday, August 2, 2012 Grand Ballroom

Produce Quality, Safety, and Health Properties

(040) Waste of Acerola Juice Processing as a Source of Antioxidant Dietary Fiber

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Despite many studies with acerola (*Malpighia emarginata*), showing the great benefits of this fruit to health mainly as an extraordinary vitamin C source, the research on antioxidants present in processing waste, its association with bioactive compounds and their role in food quality and health of the consumer is an emerging research area that has been little explored. This study aimed to evaluate the waste generated by the processing industry of juice as a natural source of antioxidant dietary fiber (ADF). The waste from the juice processing, pulping and refining steps, were provided by a industry and transported to Embrapa Tropical Agroindustry, Fortaleza, CE, Brazil. The samples divided into three replications were lyophilized and then, ground and stored at –20 °C. The determination of FD followed the method of indigestible fraction based on physiological conditions that mimics the human digestive process and involves of a series of enzymatic treatments (pepsin, pancreatin and α-amylase) which resulted in a residue (insoluble DF - IDF) and supernatant. The latter was subjected to incubation with amyloglucosidase followed by a dialysis system, resulting in soluble DF (SDF). The non-starch polysaccharides (NSPs Total) expressed by the sum of the results of Dinitrosalicylate, Antrona, and Uronic acids methods were determined in the SDF and IDF, and Klason lignin (LK), gravimetric weight, protein resistant (PR) and ash analyzed just in IDF. The total antioxidant capacity (TAC) associated with SFD (total extractable polyphenols - TEP) and FDI (TEP, hydrolysable tannins – HT, and condensed tannins CT) was determined by DPPH•. The results expressed in % of dry matter, in the pulping and refining wastes, were: FD Total - 83.50% and 77.81%; IDF - 92.35% and 84.96%; KL - 48.85% and 32.37%; NSPs Total - 29.20% and 33.81%, PR - 1.08% and 5.88%, Ash - 2.67% and 3.85%, TEP / FDS - 1.04% and 1.5%, TEP / FDI - 0.66% and 0.40%; HT / FDI - 0.58% and 0.63%, TC / IDF - 0.31% and 0.24%, TAC (TEP / FDS) - 68.32 and 77.62 g / g DPPH •; TAC (TEP / IDF) - 90.66 and 52.91 g / g DPPH •; TAC (TH) - 38.7 and 16.94 g / g DPPH •. The waste of juice processing present a high content of Total FD (> 70%) associated with a high CAT, which could be considered as a high functional raw material and consequently can add value to several byproducts.

Specified Source(s) of Funding: Capes, CNPq, EBBA, Embrapa, Funcap, UFC, and UNILAB

(041) Variability of Capsaicinoid and Capsaicinoid Analog Concentrations in Ají (*Capsicum baccatum* L.) Peppers

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Variability in the concentrations of capsaicinoids and capsaicinoid analogs which contribute to flavor and nutritional quality of *Capsicum baccatum* peppers is not well understood. Using reversed-phase liquid chromatography with ultraviolet absorbance and electrospray mass spectroscopic detection, we evaluated capsaicinoids and their analogs in mature green fruit from 224 non-cultivated and cultivated accessions of *C. baccatum* var. *baccatum, C. baccatum* var. *pendulum, C. baccatum* var. *umbilicatum* and *C. baccatum* var. *praetermissum* acquired from the USDA/ARS *Capsicum* genebank in Griffin, GA. Concentrations of total capsaicinoids and associated pungency scores among accessions ranged from 3 to 12,522 microg/g dry weight and 46 to 194,278 Scoville heat units (SHU), respectively, with median values of 3,165 microg/g dry weight and 47,667 SHU. Likewise, concentrations of individual capsaicinoids ranged from essentially none (< 2) to 8,323, 7,409, 996, 301, 293, 163, 126, 115, and 30 microg/g dry weight for capsaicin, dihydrocapsaicin, nordihyrocapsaicin, coeluting homocapsaicins, *N*-vanillyl decanoate, homodihydrocapsaicin II, *N*-vanillyl octanoate, homodihydrocapsaicin I and norcapsaicin, respectively, with associated median values of 1,918, 818, 151, 49, 35, 21, 7, 6, and 5 microg/g dry weight. Capsaicin was generally the most abundant capsaicinoid amongst accessions followed by dihyrocapsaicin and nordihydrocapsaicin. The total concentration of essentially non-pungent capsaicinoid analogs, capsiate, dihydrocapsiate, capsiconiate and dihydrocapsiconiate, ranged between non-detectable and 1,315 microg/g dry weight with a median value of 160 microg/g dry weight. Variability in the concentrations of capsaicinoids, and the capsinoid and capsiconinoid capsaicinoid analogs was sufficiently large that genetic manipulation may enable the development of improved *C. baccatum* cultivars with novel flavor and nutritional attributes and the introgression of these desirable attributes into pepper (*C. annuum*) breeding lines.

(044) The Scat/Track Guidebook for Desert Animal Identification

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Produce is perceived to be healthy and nutritious due to documented health benefits derived from consumption. Moreover, consumers also demand quality produce that has minimal risk of food-borne pathogens. However, over the years the number of outbreaks arising from the consumption of fresh vegetables has

increased exponentially. Vegetables commonly associated with outbreaks include leafy greens where sources of contamination can be variable and amplified due to open environment growing conditions. Microbial contaminations in fresh vegetables can occur at any stage of crop growth, harvest, or in transport to facilities; therefore the key to any effective food safety program is prevention of such contamination. Specifically in Arizona, vegetable growers, wholesalers, and food service buyers want to ensure that their fresh vegetables are being grown free of harmful pathogens and bacteria. Yuma, AZ, is considered a major player in the U.S. supply of winter grown vegetables, including leafy greens. As a fertile valley surrounded in a desert environment, a specific challenge for growers is wildlife intrusion within production acreage. Wildlife, such as birds, rodents, pigs, and deer, can be vectors for transmitting fecal pathogens to produce fields without growers' knowledge of intrusion. The ultimate goal for vegetable producers is to maximize food safety for the public while minimizing negative impacts on wildlife populations and habitats. Working in collaboration with the Arizona Game and Fish Department, Arizona Leafy Green Marketing Agreement, Arizona Department of Agriculture, and the Western Growers Association, the University of Arizona Yuma County Cooperative Extension developed a scat and track field guidebook to help identify signs of wildlife and domestic animal intrusion within production areas. In the development of the guidebook, constructive feedback was obtained from over 150 agricultural industry professionals at 3 quarterly food safety meetings during the growing season. Development of the field guidebook and contents will be discussed.

(045) Carotenoid Content of Raspberry and Blackberry Fruit

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Rubus fruits (raspberry and blackberry) generally contain high amounts of anthocyanins as the dominant pigment. Some yellow fruited raspberries contain little or no anthocyanin. Carotenoids are present in these fruits but only in tiny amounts. However, carotenoids may play an important role as precursors of flavor volatiles, especially the ionones. The purpose of our research was to determine the types and relative content of carotenoids in ripe fruit of cultivars and species of raspberry and blackberry. Freeze dried fruits were crushed and sieved to exclude seeds, then fruit tissue ground to a particle size of less than 40 μm. About 0.5 g dry tissue was extracted with hexane:ethanol:acetone, 6 mL of the hexane layer dried under nitrogen, and resuspended in 1 mL methanol. Aliquots were injected onto high performance liquid chromatography equipped with photodiode array. We found that the content of alpha carotene in red raspberry ranged from 20 to 80 and beta carotene ranged from 40 to 160 μg/g dw. In black raspberries, the content of beta carotene was much higher, exceeding 200 μg/g dwt. Yellow, pink, or red/yellow raspberries exhibited a range of carotenoids, with high levels of beta carotene; most of these had at least one-quarter *R. parvifolius*. Blackberry fruit were similar in carotenoid composition to black raspberry. Seeds of either blackberry or raspberry had detectable amounts of zeaxanthin and/or lutein. Alpha tocopherol and lutein represented large amounts of total carotenoids in raspberry and blackberry fruit tissue. Our results show that the carotenoid profile of raspberry is highly variable and depends on species background as well as phenotypic fruit color. In contrast, seeds had little carotene content but were high in zeaxanthin and lutein. Overall, the contribution of tochopherols, lutein, or carotenoids in raspberry or blackberry to dietary health is small. The relative role of carotenes to raspberry flavor remains to be determined.

Specified Source(s) of Funding: North American Raspberry and Blackberry Growers Association

(046) Methyl Jasmonate Application Enhances Glucosinolate and Phenolic Concentrations in Kale

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Previous research has shown that methyl jasmonate (MeJA) treatment increases the concentration of phenolics in radish and broccoli sprouts but has no effect in broccoli florets. This suggests that MeJA enhances phenolic concentrations in the vegetative tissues of brassica vegetables. To test this hypothesis, two kale cultivars, 'Dwarf Blue Curled Vates' and 'Red Winter' were sprayed with 0, 50, 250, and 500 μM MeJA 4 days prior to the harvest of apical and basal leaves from treated and control plants grown in the field during the summers of 2010 and 2011. Three replicate samples in each year were assayed for glucosinolates and flavonoid concentrations by HPLC and total phenolic concentration by the Folin–Ciocalteu assay. Antioxidant activity of 70% methanol extracts were also quantified using the 2,2-Diphenyl-1-Picrylhydrazyl (DPPH) and 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid) (ABTS) assays. Two hundred and fifty (250) μM MeJA maximized glucobrassicin and neoglucobrassicin in apical leaves of both 'Red Winter' and 'Dwarf Blue Curled Vates'. MeJA treatment significantly increased total phenolics and flavonoids in both cultivars in 2010. In contrast, no significant increase in total phenolic and flavonoid concentrations was observed in 2011 with any of the MeJA treatments, suggesting a year by treatment interaction. ABTS and DPPH antioxidant assays significantly correlated with total phenolics ($r = 0.96$, $P < 0.001$ and $r = 0.81$, $P < 0.001$, respectively). MeJA treatments can positively enhance health promoting bioactivity of kale by increasing indole glucosinolate

concentrations. Antioxidant activity in kale is closely associated with total phenolic concentrations and can be enhanced by MeJA treatments depending on environmental conditions.

(047) Antioxidants in Strawberry Cultivars and in Greenhouse-grown Tomatoes Subjected to Salinity

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The consumption of fruits and vegetables rich in neutraceuticals is encouraged in the prevention and treatment of illnesses such as cancer. Berries are rich sources of dietary antioxidants and hence plant breeders interested in improving fruit quality use antioxidant content as a selection criterion. In order to enhance neutraceutical content, vegetables such as tomatoes grown under control conditions are subjected varying degrees of salinity. In the present investigation we report the cultivar differences in strawberries with respect to antioxidant content as determined by oxygen radical absorbance capacity (ORAC) assay and the effect of salinity on neutaceuticals in tomatoes. Out of the strawberry cultivars examined Whonnock, Puget Reliance, Nisgaa and Cavendish had higher antioxidant content than Stolo and Totem. In tomatoes, in addition to total antioxidants, lycopene, β-carotene and lutein content were also determined. Salinity was increased by increasing concentrations of all macronutrients in hydroponic solution where electrical conductivity (EC) varied from 2, 4 and 6 mS/cm. When expressed on fresh weight basis increase in EC increased vitamin C, antioxidants, β-carotene and lycopene, but had no effect on lutein concentration. When expressed on dry weight basis increase in EC increased antioxidant content, but had no effect on vitamin lycopene and decreased lutein and β-carotene. Increase in EC however led to a reduction in fruit yield.

Specified Source(s) of Funding: Agriculture and Agri-Food Canada

(048) Whole Potato Tubers (*Solanum tuberosum* L.) Provide a Protective Matrix Effect That Stabilizes Antiproliferative Inhibitory Metabolites from Thermal Degradation, and Retains Inhibitory Properties against HT-29 Colon Cancer Cells In Vitro

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Our previous research revealed that two solid pigmented skin and flesh selections, a red selection (POTR) and a purple selection (POTP) inhibited HT-29 colon cancer cells in culture when harvested as immature tubers. Potentially bioactive classes of metabolites have been found in potato by others, to induce antiproliferative activity in cancer cells in vivo and/or in vitro. Included are dietary fiber, resistant starch, vitamin C, glycoalkaloids, flavonoids and polyphenolic acids. A primary objective of this study was to assess if heating degraded inhibition of HT-29 colon cancer cells in culture following extraction from raw immature tubers compared to heated aqueous extracts. Raw immature tubers, and extracts from immature tubers, were exposed to 22–24 °C, 37 °C, 45 °C, 55–60 °C, 72 °C ,and 96°C (boiling) for 20 minutes in a water bath. CellTiter 96 Aqueous Non-Radioactive Cell Proliferation Assay by Promega was used to measure the number of viable HT-29 colon cancer cells in all cell culture assays. The goal was to gain insight into what class of metabolites may be responsible for inhibitory activity and to evaluate if the tuber matrix serves to protect these inhibitory metabolites. Most significant differences in temperature sensitivity were detected at a 24% extract concentration in cell cultures. Heating purple pigmented POTP whole tubers had minimal impact on inhibitory properties, indeed heating to 60 °C increased inhibitory properties compared to heated tubers at room temperature. On the other hand, boiling red pigmented tubers of POTR, decreased antiproliferative activity by half compared to heated tubers at 45 and 60 °C. Heated extracts of POTP had weak antiproliferative activity and no significant differences upon exposure to six different temperatures at any extract concentration. Red pigmented heated extracts of POTR completely lost antiproliferative activity upon exposure to 72 °C and boiling. Higher antiproliferative activity was found in heated tubers when compared to heated extracts at all temperatures in POTP and at 45 °C, 55–60 °C, and 72 °C in POTR at 24%. Immature tubers stored at 4 °C for six months retained their inhibitory properties. Full to partial inhibitory activity retained at high temperatures may be a result of heat stable glycoalkaloids. The tuber matrix itself may also have served to protect and conserve additional heat sensitive inhibitory metabolites from thermal degradation whereas inhibitory metabolites alone in heated extracts did not have a tuber matrix to protect heat sensitive activity.

Specified Source(s) of Funding: USDA National Needs Crops for Health Fellowship

Thursday, August 2, 2012 Grand Ballroom

Production and Harvest Mechanization

(125) Development of Intelligent Spray Systems for Nursery Crop Production

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Two intelligent sprayer prototypes were developed to increase pesticide application efficiency in nursery production. The first prototype was a hydraulic vertical boom system using ultrasonic sensors to detect tree size and volume for liner-sized trees and the second prototype was an air-assisted spraying system using a laser scanning sensor to measure tree structure and foliage density for shade trees. Both sprayers had automatic controllers (computer program, a signal generation and amplification unit, and pulse width modulated solenoid valves, but different algorithms and circuit designs). The controllers manipulated nozzles to produce variable-rate spray outputs based on tree characteristics and plant occurrence in real time. Within the spray range, the sprayers had the capability to adjust spray outputs to provide the quantity of spray deposition and coverage as required by specific applications. Application qualities were field tested against industry standard application rates using multiple plant species. Spray deposition and coverage of the hydraulic boom sprayer were determined for five tree species with heights ranging from 2.8 to 8.1 ft, and were compared with 60 and 100 gpa constant-rate applications. Air-assisted sprayer performance was tested at three different plant phenological stages, and was compared with two conventional air-assisted spray systems at a 50 gpa application rate. Compared to the variable-rate boom sprayer, constant-rate applications of 60 and 100 gpa generally produced excessive spray deposition and coverage with unnecessary runoff. Conventional spray application rates estimated with the tree-row volume method were 131, 60, 40, 36, and 28 gpa, compared with variable rates of 38, 32, 25, 16, and 16, respectively. The variable-rate sprayer reduced spray volume up to 86.4% and 70.8% compared to a constant 100 gpa and tree-row volume estimated rate applications, respectively. Pest control for select insects and diseases was not different from conventional sprayers. Air-assisted intelligent sprayer coverage and deposition inside canopies were more stable over different growth stages at approximately 40% coverage compared to approximately 45–90% saturated coverage for the same air-assisted sprayer (non-intelligent control) and a conventional air-assisted sprayer. Compared to the constant application rate of 50 gpa (considered a half-rate), the intelligent sprayer reduced the application rate by 70%, 66%, and 52% in April, May, and June, respectively. Laboratory and field tests demonstrated that both variable-rate sprayers controlled spray outputs by continually matching canopy characteristics, which reduced off-target losses, and has potential to drastically decrease pesticide use and associated economic inputs, increase environmental quality, and enhance worker safety.

(126) Subsurface Application of Poultry Litter

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The common practice of spreading poultry litter on the surface of pastures and fields is being restricted near ditches and streams due to storm runoff. This collaborative proposal between UMES and USDA–ARS scientists has developed a new manure application technology for placing the material below the surface of the soil. Working with the Extension Service, the team has demonstrated a 30% increase in corn yields, 90% reduction in phosphorous runoff and ammonia-nitrogen emissions, and a 30% reduction in odor. A prototype machine has been manufactured and is currently being evaluated by shareholders to provide input and suggestions for commercial production of the "Subsurfer". Demonstrations are now being conducted with collaborators in Arkansas, Pennsylvania, and the local shareholder farmers in Maryland. It is expected this technology will help improve water quality by reducing nutrient runoff, decrease litter application rates by improving nutrient availability, and decrease runoff volume by increasing the water-holding capacity of the soil.

Specified Source(s) of Funding: 1890 USDA Capacity Building Grant

Thursday, August 2, 2012 Grand Ballroom

Propagation

(149) The Effect of Cutting Type and Auxin Treatment on Rooting of *Cupressus cashmeriana*

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Cupressus cashmeriana is an ornamental evergreen conifer with little information published on vegetative propagation. Two experiments were conducted to determine the effects auxin and cutting type on adventitious rooting. Experiment 1 evaluated three cutting treatments (softwood, hardwood, and mallet) and four auxin treatments consisting of 0, 2500, 5000, and 10000 ppm potassium indole-3-butyric acid (K-IBA). At 8, 12, 16, 20, and 24 weeks, cuttings were removed from the rooting substrate and evaluated. Experiment 2 evaluated the same cutting types as experiment 1 and auxin treatments consisted of 5000 ppm K-IBA, 5000 ppm naphthalene acetic acid (NAA), 2500 ppm K-IBA in combination with 2500 ppm NAA and zero auxin applied. After 140 d, roots were weighed. In experiment 1, softwood and hardwood cuttings had significantly higher rooting ratings than mallet cuttings. At weeks 20 and 24, cuttings treated with 0 ppm K-IBA had rooting percentages significantly higher than cuttings treated 10,000 ppm, while cuttings treated with 2,500 and 5,000 ppm were intermediate. The results of experiment 2 were similar to experiment 1 in that soft and hardwood cuttings had higher rooting percentages compared to mallet cuttings. The effect of auxin treatment was non-significant. Results indicate various rates or types of auxin may not be beneficial, and can even have a negative effect on rooting of *C. cashmeriana*. Additionally, successful rooting of *C. cashmeriana* occurs more often with soft and hardwood cuttings compared to mallet cuttings. This research suggests that the age of plant material from which cuttings are taken is one of the most significant factors for successful rooting *C. cashmeriana*.

Specified Source(s) of Funding: Longwood Gardens

(150) In Vitro Regeneration of Lettuce (*Lactuca sativa* L.) Shoot Buds Depends on Location, Size, and Shape of Explants

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The process leading to the development of new varieties involves the preservation of superior genotypes that perform well in the field. In vitro culture can regenerate important germplasm into a complete plant free of viral, bacterial or fungal diseases. An experiment was conducted to determine the effect of the size and shape of explants extracted from apical and axillary buds on their capacity to develop into plantlets following in vitro culture. A viable plantlet was defined as one with at least one root and one leaf, in both cases longer than 1 cm. The apical and axillary shoot buds were extracted, including some underlying tissue, and explants prepared using four types of cuts, namely, square, diametral, diamond, and transverse. With the exception of the transverse sectioning, for which length was 9 mm, each bud was left with underlying pith tissue measuring 3, 6, and 9 mm. Regardless of the size and shape of the explants, the plantlets derived from apical buds produced 4.2 times more leaves ($P < 0.0001$) and 2.7 times more roots ($P < 0.0001$) than those derived from axillary buds, resulting in 29% more explants producing viable plantlets ($P < 0.0001$) after 6 weeks on Murashige and Skoog medium. After two weeks of acclimation, the percentage of surviving, viable plantlets in relation to initial number of explants put into culture was higher (80%, $P < 0.0001$) from the 6-mm diamond-shaped explants than from the diametral-shaped (41% to 51%) and transverse-shaped (49%) explants, but not from the other diamond-shaped (71% to 76%) and the square-shaped explants (61% to 70%). Compared with other shapes, the reduced loss in viable plantlets during acclimation with diamond-shaped explants was associated with a higher root number to leaf number ratio prior to acclimation.

(151) Germination Characteristics of Water Sedge, *Carex aquatilis*, and Cotton Sedge, *Eriophorum angustifolium* from Arctic Coastal Wetlands, Prudhoe Bay, Alaska

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Well sites, roads, and buildings at Prudhoe Bay Oilfields, Alaska, are built on permafrost soils that surface-thaw in summer to form extensive wetlands. To prevent thawing and subsidence of subsurface, ice-rich soils, gravel pads 2 m or more thickness are built to support these facilities. As the oilfields age and are decommissioned, the gravel is removed, and sites must be revegetated. Since the 1970s, efforts to revegetate wetlands have included a variety of planting techniques and seed treatments mostly with native grasses. Water sedge, *Carex aquatilis* and cotton sedge, *Eriophorum angustifolium*, form large populations that spread vegetatively by rhizomes and often dominate these wetland environments. Despite their abundance, these species have not been considered for revegetation because vegetative methods are time consuming and expensive, and little is known about seed germination, seed development and viability. Germination experiments were begun to learn methods of seed germination of water sedge and cotton sedge for eventual use in direct-seeding or plug production for arctic wetland revegetation. Seeds of cotton sedge did not germinate more than 15% under a wide variety of conditions: 4 collection dates 30 July–23 Sept.), 30 harvest locations, light (*PAR* 99–108 μmol·m^{-2}·s^{-1}, 24 h) vs. dark, alternating (25/13 °C, 15/9 h) versus. constant (25 °C) temperatures, temperature ranges (10 to 30 °C, 5 °C intervals), prolonged cold dry storage (4 °C, 6 months); cold moist, stratification (4 °C, 30–150 days) and combinations of storage and stratification. These early results hint that early-season (30 July) harvest dates followed by cold stratification and then germination under alternating temperatures in light are important to overcome a physiological dormancy. Seeds of water sedge germinated best (up to 80%, mean 67% with dry storage, light, alternating temperatures). Dry-stored seeds germinated about 10% more than fresh seeds. Collection date and location did not have an effect on germination. For revegetation, the conditions for optimum germination of cotton sedge remain unknown. However, water sedge seeds have promise for commercial plug production or direct seeding of arctic wetland soils.

Specified Source(s) of Funding: BP Alaska

(152) Year-round Testing of Different Supplemental Lighting Treatments for Propagating Tomato Seedlings

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The industry is interested in cost-effective and energy-efficient sources of light to provide adequate growing conditions for greenhouse vegetable production. An experiment is being conducted to evaluated light-emitting diodes (LEDs) as an alternative lighting source for the propagation of greenhouse-grown tomatoes. Six tomato cultivars are grown monthly throughout a year for 3 weeks in a glass-glazed greenhouse. Five lighting treatments are being tested: natural light (control), natural + supplemental light from a 100-W high-pressure sodium (HPS) lamp, or natural + supplemental LEDs using either 80% red and 20% blue, 95% red and 5% blue, or 100% red. A variant solar daily light integral (DLI) occurs naturally for all treatments, and a constant DLI of 5 mol·m^{-2} per day is provided to the seedlings receiving supplemental lighting. Results for different growth parameters will be compared across seasons to determine when supplemental lighting is needed for acceptable plant growth and at what point of the year it is necessary to supplement with blue light. Shoot biomass production per kW-h of energy consumed will be compared for the different treatments. Preliminary findings from this experiment will be presented. This project is supported in part by NIFA SCRI grant 2010-51181-21369.

Specified Source(s) of Funding: NIFA SCRI grant 2010-51181-21369

(153) Grafting Techniques for Conservation of Endangered *Prunus geniculata* Harper and Other Native *Prunus* L. Species of the Southeastern U.S.

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The genus *Prunus* L. is economically important source of fruit such as plums, cherries, almonds, apricots and peaches. Grafting techniques are commonly used to propagate superior commercial cultivars. The desired scion genotype is grafted onto a rootstock. Native wild *Prunus* species have been previously used as rootstocks for grafting commercial cultivars. However, the use of grafting techniques for conservation, restoration, and maintenance of native wild *Prunus* species has been not previously reported. North America is a center of diversity for plum species. Several plum species are listed as endangered

with seeds being the primary means of propagation. The use of different grafting techniques for the nondestructive sampling, preservation and propagation of wild native *Prunus* species was the main objective of this study. A total of 94 *P. geniculata*, 20 *P. umbellata* Elliot, 14 *P. angustifolia* Marsh., and 5 *P. americana* Marsh. genotypes, native to southeastern US, were grafted using a modified-veneer and T-budding techniques. Two rootstocks, 'Sharpe' plum and *P. cerasifera* plum previously grafted onto Okinawa peach, were used and evaluated. Percentage bud take was measured for each genotype. 'Sharpe' rootstock had 36.71% and 27.96% bud take on average for modified-veneer and T-budding, respectively. *P. cerasifera* / Okinawa rootstock had 3.70% and 3.57% bud take on average for modified-veneer and T-budding, respectively. Grafting proved to be a feasible method for propagation and maintenance of wild *Prunus* species, particularly of *P. geniculata*, a federally endangered species with low seedling recruitment.

Specified Source(s) of Funding: Stone Fruit and Citrus Breeding and Genetics Program at the University of Florida, Gainesville, FL. and USDA–ARS grant 5306-21000-018-00D

(154) Complete Decapitation and Rootstock Culture In Vitro Are Efficient Methods for Shoot Regeneration from Eggplant Hypocotyls

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The complete decapitation method (CDM), in which main and all lateral stems were removed, promoted shoot regeneration in tomato plants grown in open fields (Harada et al., 2005). Here, the CDM was applied to eggplants, which show unstable shoot regeneration in in vitro culture. Seedlings of *Solanum melongena* 'Sisui' were cultured on Murashige and Skoog (MS) medium, and were cut at the center of the hypocotyl in vitro (CDM in vitro; CDM*i*). Hypocotyl explants were cultured on MS medium containing 1.0 mg·L^{-1} benzyladenine (BA) as the control. Calli formed at the cut end of hypocotyls 1 week after cutting in both the CDM*i* culture and the control hypocotyl culture. Adventitious buds regenerated 1 week earlier in the CDM*i* culture than in the control hypocotyl culture. The average number of adventitious buds was 10.3 in the CDM*i* culture and 3.1 in the control hypocotyl culture at 6 weeks after cutting. Shoots longer than 1 cm were obtained 2 weeks earlier in the CDM*i* culture than in the control hypocotyl culture. The average number of shoots per hypocotyl was 8.1 in the CDM*i* culture and 2.4 in the control hypocotyl culture at 6 weeks after cutting. These results indicated that CDM*i* is a simple and efficient method to obtain multiple shoots without determining optimal concentrations of plant growth regulators. We applied CDM*i* to three other eggplant cultivars; 'Senryou-2 gou', 'Kokuyou', and 'Shouya-oonaga'. The highest number of shoots was obtained from 'Sisui', followed by 'Senryou-2 gou', 'Kokuyou', and 'Shouya-oonaga'. This result indicated that there were different regeneration frequencies among cultivars of eggplant in the CDM*i*. To increase the number of shoots from 'Shouya-oonaga', hypocotyl explants of 'Shouya-oonaga' were grafted onto 'Sisui' rootstocks before CDM*i*. This method, i.e., rootstock culture of hypocotyl segments, increased the number of shoots obtained from hypocotyls of 'Shouya-oonaga' compared with direct application of CDM*i*. In contrast, when the hypocotyls of 'Sisui' were grafted on 'Shouya-oonaga' rootstocks before CDM*i*, we obtained fewer shoots from hypocotyls of 'Sisui' compared with direct application of CDM*i*. These results show that well-regenerated rootstock is the optimal material to obtain multiple shoots via CDM*i*. Rootstock cultures may be useful to regenerate plant material following genetic transformation.

(155) Adventitious Bud Formation Promoted by L-2-Aminooxy-3-Phenylpropionic Acid in Tomato Plants Treated with the Complete Decapitation Method In Vitro

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Organogenesis is unstable in tomato plants in vitro. Determinations of concentrations and valances in growth regulators for explants from various plant parts and cultivars are complicated. As recently-developed complete decapitation method (CDM), in which main and all lateral stems were cut to

eliminate shoot apex, regenerated lots of shoots without using growth regulators. And L-2-aminooxy-3-phenylpropionic acid (AOPP), a potent inhibitor of phenylalanine ammonia-lyase, promoted shoot regeneration. Therefore, we investigated the effects of CDM in vitro (CDM*i*), where hyocotyl was cut, and AOPP on shoot regeneration of tomato 'Micro Tom' plants grown with MS medium. Percentage of hypocotyls with adventitious buds was 73% in CDM*i* compared with 20% in control method, hypocotyl culture on a MS medium with BA at 1.0 mg/L. Number of adventitious buds on the hypocotyl was 3.9 in CDM*i* compared with 2.0 in control method. Efficiency of multiplication, calculated using the percentage and the number, was 2.9 fold in CDM*i* compared to 0.4 fold in control method. When AOPP was included in MS medium at 0 (control), 0.01, 0.1, 1.0 mM, percentage of hypocotyls with adventitious buds was highest 100% at 0.1 mM. Number of adventitious buds on the hypocotyl was largest 5.9 at 0.01 mM. Efficiency of the multiplication was highest 4.5 fold at 0.01 and 0.1 mM. When formed shoots were cut into MS medium, percentage of adventitious root formation was 93% and 87% at 0.01 and 0.1 mM AOPP, respectively, similarly to 87% at 0 mM 4 weeks after in vitro cutting. Number of adventitious roots on a cutting was 3.3 and 2.7 at 0.01 and 0.1 mM, respectively, similarly to 2.9 at 0 mM. It is concluded that CDM*i* promotes adventitious bud formation on hypocotyls compared with control tissue culture. AOPP at 0.01 mM in MS medium promotes shoot regeneration in tomato plants and does not retard root formation.Organogenesis is unstable in tomato plants in vitro, and it is difficult and complicated to determine the optimal concentrations and types of plant growth regulators to induce regeneration from various explant types and cultivars. The recently developed complete decapitation method (CDM), in which main and all lateral stems were cut to remove the shoot apices, regenerated many shoots from tomato without using plant growth regulators. In addition, L-2-aminooxy-3-phenylpropionic acid (AOPP), a potent inhibitor of phenylalanine ammonia-lyase, promoted shoot regeneration. Therefore, we investigated the effects of CDM in vitro (CDM*i*), where the hypocotyl was cut, and AOPP was applied to induce shoot regeneration in tomato 'Micro Tom' plants grown on Murashige and Skoog medium. Hypocotyls were cultured on MS medium containing 1 mg/L benzyladenine as the control. After CDM*i,* 73% of hypocotyls formed adventitious buds, compared with 20% in the control. The average number of adventitious buds on each hypocotyl was 3.9 in CDM*i* compared with 2.0 in the control. The efficiency of multiplication, calculated from the percentage of hypocotyls with adventitious buds and the number of buds per hypocotyl, was 2.9-fold in CDM*i* and 0.4-fold in the control. We included AOPP in the MS medium at 0 (control), 0.01, 0.1, 1.0 mM, and found that 100% of hypocotyls formed adventitious buds with 0.1 mM AOPP. The greatest number of adventitious buds per hypocotyl was 5.9 with 0.01 mM AOPP. The highest efficiency of multiplication was 4.5-fold at 0.01 and 0.1 mM AOPP. When the shoots were cut and transferred to fresh medium, the percentage of shoots that formed adventitious roots by 4 weeks after cutting was 93% with 0.01 mM AOPP, 87% with 0.1 mM AOPP, and 87% with 0 mM AOPP. The average number of adventitious roots per cutting was 3.3, 2.7, and 2.9 at 0.01, 0.1, and 0.0 mM AOPP, respectively. We conclude that CDM*i* promoted adventitious bud formation from hypocotyls compared with the conventional tissue culture method, and that addition of 0.01 mM AOPP to the MS medium promoted shoot regeneration in tomato plants without retarding root formation.

(157) Regeneration of *Lonicera japonica* L. through Somatic Embryogenesis from Zygotic Embryos and Cotyledons

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Honeysuckle (*Lonicera japonica* L.) is widely grown as an ornamental plant. Dried flowers and buds of *L. japonica*, called flos lonicerae in traditional Chinese medicine, are a popular herb. Flos lonicerae contains soluble phenolic acids such as chlorogenic acid and flavonoids such as luteolin, which have anti-inflammatory, anti-oxidant, and anti-cancer properties. With increased need for flos lonicerae, production hectares of *L. japonica* have been greatly increased, resulting in a high demand for starting materials. Cutting propagation and tissue culture through existing meristems cannot meet market needs for propagules. Regeneration via somatic embryogenesis has been considered the most efficient means of in vitro propagation, but methods for somatic embryogenesis of *L. japonica* have not been well developed. In this study, zygotic embryos derived from *L. japonica* seeds and cotyledons from seedlings were cultured on a MS basal medium supplemented with 4.4 and 8.8 μM BA respectively with 0.5 and 1.0 μM NAA. Callus appeared from zygotic embryos, and culture of callus pieces on the same medium as initially used for callus induction resulted in the formation of somatic embryos. Among the growth regulator combinations evaluated, 4.4 μM BA with 0.5 μM NAA resulted in 80% of zygotic embryos producing callus and subsequently 67% of cultured callus pieces produced somatic embryos. Culture of cotyledons on MS medium containing 4.4 μM BA and 0.5 μM NAA resulted in direct somatic embryogenesis. Somatic embryo conversion produced healthy plantlets, and plantlets grew well after transplantation into cell plugs.

(158) *Glacium* sp. Germination at Different Salinity Levels as Influenced by Growth Regulators

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In light of the continued increase in water usage and diminishing water resources in arid areas of USA, some states have implemented water conservation programs for lawns and gardens. It is therefore imperative that we seek more drought and salt tolerant plants so that we may maintain our colorful landscapes with less water usage. Plants that use lower quality water might also be used in place of potable waters. Horned poppy has been proposed by some as a potential new herbaceous perennial for the Rocky Mountain region. Studies have been initiated in order to determine the salt and drought tolerance of *Glaucium flavum*, *grandiflorum*, *acutidentatum* and *corniculatum*. Seed germination at 3 salinitiy levels (O, 15, and 30 dS/m) of all four species were determined as influenced by 4 growth regulators [ethephon (5.0 mM), fusicoccin (0.0 1 mM), thiourea (30 nM), and kinetin (1.5 mM)]. *G flavum* had the greatest germination with increasing salt levels followed by *corniculatum, acutidentatum,* and the least *grandiflorum*. Ethephon application resulted in higher levels of germination followed by thiourea as compared to kinetin and the control with increasing salinity.

Thursday, August 2, 2012 Grand Ballroom

Public Horticulture

(092) Scan, Link, and Learn: QR Codes and Readers Can Be Useful Tools for Learning in Arboreta and Botanic Gardens

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The Purdue University Campus Arboretum is implementing QR code technology to support and extend student learning. Smart phone users will now be able to use their personal handheld devices to access location based plant information through the use of QR codes displayed on plant signage. A QR code's ability to link the physical world with the virtual supports the type of experiential learning common to botanical gardens and arboreta. The codes offer expanded pedagogical value in applications that encourage students to create and contribute their own content to the learning experience. QR codes, short for quick response codes, and QR readers can connect users to location relevant educational content. The codes can be easily de-coded by any mobile camera phone that has a QR reader, which is freely available online for most devices. Once the code is read, the user is directed to a specified web page where they can learn about an object that has been tagged, a practice known as "mobile-tagging." In the arboretum, QR codes will direct students and visitors to the arboretum website where information about location specific plants will be available. Users will have immediate access to a plant's identification characteristics, landscape value, cultural requirements, and maintenance needs. In addition, students will be able to create their own location and time-relevant content through access to social networks, where they can post comments on virtual walls associated with locations. They can use such platforms to reflect on their experiences, document their observations, and connect with other learners in specific courses to share information as they study a particular plant. The idea of linking specific objects to information is not new, but QR codes combine simple and affordable creation with real-time, easy access. As a result, QR codes could inspire extensive thinking and innovation around the development of learning resources connected to locations and objects in informal learning environments like botanic gardens and arboreta.

(093) The Crosby Arboretum: Thirty Years of Native Plants in the Mississippi Piney Woods

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In late 1978 an idea was born from the death of Mississippi resident and entrepreneur, L.O. Crosby. A living legacy, which would not only give back to the community but provide educational opportunities for generations to come, was developed on Crosby-owned property in Picayune, MS. Established as a living memorial to Mr. Crosby, The Crosby Arboretum was the first ecologically designed arboretum. After years of developing and implementing a Master Plan and following the completion of the Pinecote Pavilion, The Crosby Arboretum opened to the public in 1986. The Arboretum joined forces with Mississippi State University Extension Service in 1997. Today the Arboretum encompasses more than 1000 acres at seven sites in two coastal Mississippi counties. "The Crosby Arboretum is a not-for-profit institution dedicated to educating the public about their environment by: Preserving, protecting, and displaying plants native to the Pearl River Drainage Basin in Mississippi and Louisiana, Providing environmental and horticultural research opportunities, and Offering cultural, educational, scientific, and recreational programs." In this mission, the Arboretum also meets the goals of the Mississippi State University Extension Service, which: "... provides research-based information, educational programs, and technology transfer focused on issues and needs of the people of Mississippi, enabling them to make informed decisions about their economic, social, and cultural well-being." With limited staff, the Arboretum relies on the hard work of a dedicated volunteer program, present since before the Arboretum opened to the public. While the site Master Plan is still being imple-

mented, the next major goal is the funding and construction of the Visitor/Education Center which would replace the current structure. Recent outreach efforts include an Arboretum blog, twitter account, updated website, and YouTube channel. Google Alerts, a free email alert monitoring system, is being used to track the Arboretum brand weekly. Data are being collected to determine the success of the website, social media outlets, and to evaluate the volunteer program.

(094) A 20-Year Survey of Conifer Survival at the Baker Arboretum, Bowling Green, Kentucky

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The Baker Arboretum is a private garden affiliated with Western Kentucky University. The garden emphasizes collections of conifers and Asian maples among its over 1100 taxa on 15 acres. Baker Arboretum is used as a living teaching and research laboratory. It was established in 1970 and a plant database began in 1991. A survey of the database over the past 20 years reveals trends in survival of over 100 conifer taxa representing over 1300 living specimens. Survival analysis of monthly planting dates showed a distribution in which the greatest deaths occurred in mid-summer with lesser amounts in early spring and late fall. Yearly analysis showed that the greatest deaths occurred during the dry, hot summers of 1994, 1998–99, and 2002. Utilizing the American Conifer Society's size classification there was a direct relationship between plant size and survival. Miniature plants (excluding groundcovers) died at 13.6% n = 128, while the greatest deaths occurred for large plants 29.6% n = 170. Plant shape was correlated with survival, as well. Bun or cushion-shaped plants experienced the greatest death rate, >40% (n = 205), while vase-shaped plants experienced the least death, 1% (n = 54). When plants were categorized as to their water needs, the greatest death occurred for those plants requiring the most soil moisture > 50% death (n = 145) while those requiring dry soils died about 7% of the time (n = 915). We believe that an examination of existing plant databases will reveal the strengths and weaknesses of such collections as well as unrecognized trends. These data may also reveal areas of cultural, procedural, or climatic deficiencies and corrective actions can be implemented and justified.

Thursday, August 2, 2012 Grand Ballroom

Viticulture and Small Fruit 3

(292) Organic Blueberry Production Systems: Management of Plant Nutrition, Irrigation Requirements, and Weeds

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A long-term systems trial was established to evaluate management practices for organic production of northern highbush blueberry (*Vaccinium corymbosum* L.). The factorial experiment included two planting bed treatments (flat and raised beds), source and rate of fertilizer (feather meal and fish emulsion applied separately at a low, 29–57 kg·ha^{-1} N, or high rate, 57–102 kg·ha^{-1} N, depending on planting age), weed management (sawdust mulch, compost topped with sawdust mulch, or weed mat), and cultivar ('Duke' and 'Liberty'). The planting was established in Oct. 2006 and was certified organic in 2008. Cumulative yield, over four fruiting seasons (2008–11) was 18% higher on raised beds than on flat ground. 'Duke' plants fertilized with feather meal had greater yield than those fertilized with fish emulsion, but yield of 'Liberty' was not affected by the source or rate of fertilizer applied. In both cultivars, fertilization with the high rate of fish emulsion (57 kg·ha^{-1} N, 2007–09; 102 kg·ha^{-1} N, 2010–11) increased fruit firmness and percent soluble solids, but reduced berry weight compared to the low rate of fish emulsion or the use of feather meal. Weed mat was the best option for weed management, while yard debris compost plus sawdust mulch resulted in the most weeds and the highest weed-control cost; yield however was similar between the two treatments and higher in two out of three years than when using sawdust mulch alone. Plants mulched with weed mat required additional irrigation to maintain the same soil water content as those mulched with sawdust or compost plus sawdust, especially when grown on raised beds. Growth and yield of the "best" treatment combinations have been similar to well-managed conventional production systems.

(294) Epidemiology and Control of *Blackberry yellow vein disease*

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Most modern cultivars of berry crops are often tolerant, asymptomatic, to single virus infection. It was thus a surprise, when fresh market blackberries in the southeast United States showed severe virus-like symptoms often associated with declining plants. The disease was named *Blackberry yellow vein disease* (BYVD) since the most common symptom is vein banding whereas chlorosis, mottling, and in severe cases, decline and plant death have also been observed. Originally and because of the geographic distribution of the disease, it was assumed that *Tobacco ringspot virus* was a major component of the problem. Test for this and other common *Rubus* viruses like *Raspberry bushy dwarf* and *Strawberry necrotic shock* failed to reveal any association with the disease, and thus, research was initiated to identify the causal agents of the disorder and study their epidemiology. In the last few years and as part of the SCRI project "Management of *Rubus* complexes in *Rubus*" we have identified more than 15 viruses associated with BYVD. Most of them are new to science whereas others are known viruses that have been identified in blackberry for the first time. None of the new viruses cause BYVD in single infections; the disease develops when two or more viruses infect plants. Symptoms are independent of the virus species infecting plants, whereas severity appears to be directly correlated to the number of viruses infecting the plants. Vectors of the new viruses include aphids, hoppers, whiteflies and mites, whereas some are seed and pollen-transmitted. Mite-transmitted viruses are of major concern as they are being discovered at an accelerated rate, and it is very difficult to identify the vectors in the field as they require microscopic examination. A group of pathologists, entomologists and breeders are working closely to understand the disease and implement measures that will its impact. Our approach, given the great number of new viruses and vectors, is to eliminate the vectors that are easier to control. This may not eliminate viruses but may eliminate BYVD if plants are infected with a defined number of viruses that do not cause severe symptoms. In areas where there are several viruses and vectors present this approach will prolong plant life to over the 5-year rotation, common now in severely affected areas, and sustain profitable yields for the growers.

(295) Crumbly Fruit Symptoms in 'Meeker' Red Raspberry Are More Severe with Mixed Virus Infections

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Raspberry crumbly fruit is a widespread disease most commonly caused by virus infections. In the last decade, crumbly fruit symptoms have become more severe in 'Meeker' red raspberry in the Pacific Northwest (PNW) of the United States and British Columbia (BC), Canada. The cause of crumbly fruit in raspberry has long been attributed to *Raspberry bushy dwarf virus* (RBDV), a pollen-borne virus. However, the identification of two new viruses, *Raspberry leaf mottle virus* (RLMV) and *Raspberry latent virus* (RpLV), both present at high incidence in northern Washington and BC, suggested the existence of a new virus complex responsible for the increased severity of the disease. A field experiment was established, consisting of 'Meeker' plants infected by single or mixed infections of RBDV, RLMV, and RpLV in all combinations along with healthy plants. During establishment in 2010, plants co-infected with RBDV-RpLV-RLMV and RBDV-RLMV had a 71% and 76% reduction, respectively, in primocane growth. Also in the first fruiting year, plants co-infected with RBDV-RpLV-RLMV and RBDV-RpLV had the lowest berry weights, firmness and number of drupelets. Comparisons of virus titers across treatments revealed that the titer of RBDV was increased approximately 400-fold in plants co-infected with RLMV or RLMV-RpLV relative to the titer in plants infected with RBDV alone or with RBDV and RpLV. The significant increase in titer of RBDV in presence of RLMV in the field was also found in greenhouse grown plants, suggesting that environmental conditions do not have an impact on this dramatic virus interaction. Neither RBDV nor RpLV had an impact on titers of co-infecting viruses. Taken together, these findings suggest that growth reduction and severe crumbly fruit disease in 'Meeker' are caused by a co-infection of RBDV and RLMV or RpLV. RLMV and RpLV are transmitted by the large raspberry aphid, *Amphorophora agathonica*. RLMV spreads rapidly in northern Washington and BC with the incidence approaching 100% four years after planting. Studies are underway to determine whether the enhanced titer of RBDV in the presence of RLMV also occurs in the pollen. If it does, then rate of pollen transmission will be examined in plants with single or mixed infections of these two viruses.

(296) Epidemiology of *Blackberry yellow vein associated virus* and *Blackberry chlorotic ringspot virus*, Two Major Components of Blackberry yellow vein disease

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Blackberry yellow vein disease (BYVD), is the most important virus disease of blackberry, especially in fresh blackberry production areas of the southern United States. BYVD is caused by virus complexes, where two or more viruses are needed to induce symptoms. More than 15 viruses are found associated with BYVD; however, *Blackberry yellow vein associated virus* (BYVaV) is the most prevalent virus in BYVD plants being detected in more than 50% of the samples exhibiting typical disease symptoms. *Blackberry chlorotic ringspot virus* (BCRV) is another virus frequently found in BYVD plants, and in addition to blackberry, can also infect rose and raspberry. Despite the importance of the viruses as major components of BYVD both are grossly understudied. This study was conducted to better understand the epidemiology of the two viruses that included population diversity, modes of transmission, and potential alternate hosts. The nucleotide sequences of four different genomic regions of 34 isolates of BYVaV were studied to determine the variability within virus population. RNA 3 of more than 30 BCRV isolates was used in this diversity study. Selection pressure on six coding regions of BYVaV and the coat protein and movement protein of BCRV was evaluated. Two whitefly species were tested for their ability to transmit BYVaV and seed transmission assays for BCRV were performed on three hosts. In addition, 25 plant species were tested as potential alternative hosts of the two viruses. The BYVaV population was fairly diverse, unlike BCRV US-isolates, but yet all coding regions for both viruses were under purifying selection. The greenhouse and banded-winged whiteflies were identified as efficient vectors of BYVaV and BCRV was found to naturally infect apple and be seed transmissible in all the three hosts tested.

(297) Three Viruses Contribute to the Raspberry Crumbly Fruit Phenotype

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Crumbly fruit in red raspberry has been observed wherever the crop is grown worldwide. In most cases, crumbly fruit has been attributed to virus infection, in most cases *Raspberry bushy dwarf virus* (RBDV) infection. Since the turn of the century, crumbly fruit in northern Washington (nWA) and British Columbia, Canada (BC) has become more severe and spreads more rapidly in new plantings. The same cultivars grown in Oregon that are infected with RBDV do not have the severe crumbly fruit and RBDV spreads more slowly in Oregon. In addition, it was observed that populations of the large raspberry aphid (*Amphorophora agathonica*) were much higher in nWA/BC than in Oregon. As a result of the difference in the spread rate of RBDV and severity of crumbly fruit between nWA/BC and Oregon we investigated the possibility that severe crumbly fruit may be caused by a virus complex. This led to the identification of two new viruses, *Raspberry leaf mottle virus* (RLMV) and *Raspberry latent virus* (RpLV) from symptomatic plants in nWA. As part of the SCRI project "Management of Rubus complexes in Rubus," RpLV was characterized and determined to be a novel reovirus. At the time all known plant infecting reoviruses were transmitted by hoppers. Leafhopper species from Rubus in nWA failed to transmit RpLV in greenhouse experiments, thus, aphids were tested as vectors. It was found that the large raspberry aphid could transmit RpLV, albeit inefficiently, and that RpLV replicated in the aphid. The same aphid was able to transmit RLMV quite efficiently. In field surveys in nWA/BC, RLMV was found to spread quickly in fields with incidence of infection approaching 100% in 4-year-old fields. In the same fields, the incidence of RpLV was less than 40%. In sWA and Oregon, the incidence of both viruses was much lower, usually less than 30% and 20% for RLMV and RpLV, respectively, in 8-year-old fields. At the same

time crumbly fruit was less severe in sWA/Oregon compared to nWA/BC. Field plots were established with each virus and all combinations of the RBDV, RLMV and RpLV as well as healthy plants. In these plots, RBDV plus RLMV had the greatest impact on plant growth, whereas RBDV plus RpLV had the greatest impact on fruit quality. Thus, mixed infections of these three viruses impacts plant growth, fruit yield, and fruit quality.

(299) Determining Nitrogen Fertilization Rates and Time of Application of Primocane-fruiting Blackberries

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Increasing production of blackberry (*Rubus* L. subgenus *Rubus* Watson.) and the development of new worldwide markets allows for important new opportunities in production. New genotypes such as primocane fruiting (PF) blackberries can extend the growing season and create benefits for both farmers and consumers. As new cultivars, there are some important cultural practices, including plants nutrition parameters, which need to be researched in order to optimize yield and financial returns. The objective of this research project was to determine the optimum rate and time of nitrogen (N) application. This study was conducted in 2011 at the University of Arkansas, Fayetteville. Prime-Ark® 45 blackberry plants were cultivated under high tunnel conditions. There were four N treatments: Trt. 1 (30 kg·ha^{-1}); Trt. 2 (40 kg·ha^{-1}); Trt. 3 (40 kg·ha^{-1} - 50% split application); and Trt. 4 (50 kg·ha^{-1}). Single applications of N were completed on mid May and the split application of 50% on mid May and 50% after bloom (last week of July). Ammonium sulfate $(NH_4)_2SO_4$ was utilized as source of nitrogen. A CRB design was used with four blocks and five plants per experimental unit. The following variables were measured: total and marketable yield, fresh weight of plant above ground, cane diameter; soil and foliar analysis for N content. Leaves for foliar analysis were collected on 11 July. Total fruit yields for Trt. 2 and Trt. 3 (2.52 and 2.49 kg, respectively) were the higher and significantly different than the other treatments. Although not significantly different, marketable yield had a similar trend as total fruit yield. Cane diameter and plant fresh weight were not significantly affected by the fertilizer treatments. Although there are not significant differences of N content in leaves among treatments, Trt. 3 had the highest concentration of N at the end of the season while the others showed a downward trend. No significant differences among treatments were found for the following elements: P, K, Ca, Mg, S, Na, Fe, Zn, and Cu while Mn and B were significantly different. Preliminary results indicate that either a single or split N application at rate of 40 kg·ha^{-1} can result in acceptable yields.

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Water Utilization and Management

(180) Water Use of Four Perennial Plants

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Rosemary (*Rosmarinus officinalis*), 'Pink Lanterns' columbine (*Aquilegia canadensis*), 'Bath's Pink' cheddar pink (*Dianthus gratianopolitanus*), and 'Rozanne' cranesbill (*Geranium* 'Rozanne') were grown at different substrate volumetric water contents (Θ = volume of water ÷ volume of substrate) to determine the effects of Θ on their growth and morphology. Two experiments were conducted; the first in the of Fall 2011 and the second in Spring 2012. Plants were grown at nine Θ: 0.05, 0.10, 0.15, 0.20, 0.25, 0.30, 0.35, 0.40 and 0.45 $m^3 \cdot m^{-3}$, which were maintained constantly using a capacitance sensor automated irrigation system. Generally, plants were visibly larger as Θ increased. Leaf count and leaf area of rosemary grown at higher Θ (> = 0.30 $m^3 \cdot m^{-3}$) were twice as high as those of plants grown at lower Θ (< = 0.15 $m^3 \cdot m^{-3}$). Shoot dry weight and fresh weight increased with increasing Θ. water availability impacted plant morphology, and thus the marketability of these perennial plants.

(181) Comparing Substrate Moisture-based Daily Water Use and On-demand Irrigation Regimes for Oakleaf Hydrangea Plants Grown in Two Container Sizes

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Independently controlled irrigation plots were designed to test two container nursery irrigation regimes on one and three gallon oakleaf hydrangea (*Hydrangea quercifolia* 'Alice'). Plants were automatically irrigated by one of two soil moisture probe-based regimes: 1) a daily water use (DWU) system that delivered the exact amount of water that had been lost in the previous 24 hours and 2) an on-demand (OD) irrigation system based on the relationship between substrate moisture level and photosynthetic rate. In this system, irrigation was applied when the substrate moisture level fell below 33% container capacity, which corresponded to 90% maximum predicted photosynthetic rate. Both treatments delivered the exact amount of water required to return the containers to container capacity by overhead irrigation. Photosynthesis rates, leaf water potential,

transpiration, and stomatal conductance were measured at the driest points throughout the experiment. Gas exchange was measured at the driest point prior to the next irrigation event. Biomass and growth index were measured after approximately 35 days in production. In plants produced in 3-gal containers, photosynthesis, stomatal conductance, and transpiration were not different for the two irrigation regimes. Leaf water potential, leaf temperature, and vapor pressure deficit were also not different for the two treatments. Also, total dry weight was not different, 161 g and 121 g for DWU and OD, respectively (P = 0.0623), however, growth index was greater for DWU than OD, 70.9 and 60.6, respectively. Water use efficiency per irrigation zone was greater for OD than DWU, 5.9 and 3.8 g/L, respectively. Season-long water use per zone was greater by more than 2-fold for DWU than OD, 351 and 164 L, respectively. For plants grown in 1-gal containers, total dry weight (22.9 and 24.1 g) and growth index (35.9 and 36.6) did not differ, for OD and DWU, respectively.

Specified Source(s) of Funding: UK Nursery Landscape Mini-grant

(182) Comparative Effects of Deficit Irrigation in Landrace and Commercial Chile Cultivars

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Chile (*Capsicum annuum*) is one of New Mexico's leading horticultural commodities. Communities in northern New Mexico have deep rooted traditions of cultivating landrace chile varieties including 'Chimayo'. The chile landraces are highly adapted to growing conditions in northern New Mexico and have been touted for greater ability to withstand stressful growing conditions compared to commercial cultivars. Recently the pressure on farmers to conserve water has intensified due to drought conditions in the southwest. There is also evidence that chile heat level (SHU) and extractable color (ASTA) may be impacted by water stress in plants. The objective of this experiment was to determine the effect of deficit irrigation on heat level and extractable color in two commercial chile cultivars (Big Jim and Sandia) and a landrace cultivar (Chimayo). The field was located in northern New Mexico at New Mexico State University's Science Center in Alcalde, NM. Seeds were planted in the greenhouse on 14 Mar. 2011, and transplanted to the field on 17 May. The field experiment was a block design with three replications with four treatments, three subplots (3 m by 2.7 m) per replication, and 30 plants per subplot. Irrigation stress treatments started on 20 June. Four treatments were applied: 7 days (optimal watering), 9, 11, and 13 days (drought stress watering). Armin poly-pipe (20.3 cm) with 7.6-cm gates was used to furrow irrigate each row, with a Samani measurement flume in place to measure and ensure uniform water applications. Plants were harvested on 12 Aug. and evaluated for extractable color, heat level, and other growth parameters. Results of this study did not support a correlation between deficit irrigation and extractable color. There was no significant difference in extractable color between the different irrigation treatments for either 'Chimayo' or 'Sandia'. ('Big Jim', a slower-maturing cultivar, was not tested for extractable color because no ripe fruit were available at harvest.) Heat level was not significantly different between the irrigation treatments for 'Chimayo' and 'Big Jim'. 'Sandia was significantly hotter at the 9 day treatment (14,927 SHU) compared to the 7 day treatment (5,362 SHU), but neither of these levels was significantly different compared to the 11 day (9,312 SHU) and 13 day (10,605 SHU) irrigation treatments.

Specified Source(s) of Funding: NM EPSCoR and New Mexico State University's Agricultural Experiment Stations

(183) Estimating Water Use by Green Industry Activities in Texas

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Green industry (nursery, greenhouse, sod, landscaping) in Texas rank as the second most important agricultural activity, with an estimated (in 2008) economic output of $1.99 billion at the farm, and a total of $14.9 billion (including all associated services, goods and products) and $8.4 billion in value-added impacts, plus the generation of >170,000 jobs. It is a fact that the production and landscape maintenance of ornamental plants is characterized the use of massive inputs of water, fertilizers, chemicals and labor. Dwindling water supplies, severe droughts, water competition and pollution concerns significantly challenges the future of these activities. In order to appreciate the potential impact of these water issues on green industry activities, federal and state census data and statistics, as well as pertinent irrigation literature were consulted to estimate the acreage and potential water use by ornamental plant production (nursery, greenhouse, sod) and managed golf courses and landscapes in Texas. There are 24,300 hectares of ornamental plant production, 60,700 hectares of golf courses and 486,000 hectares of managed landscapes/lawns. With irrigation rates averaging 2,134 mm, 914 mm and 914 mm per year for ornamental plant production, golf courses and landscapes, respectively, all these activities sum a total annual water use of 555,000 hectare-meter. As a point of comparison, the state has 2,226,000 hectares of irrigated (agronomic) crops (significantly dwindling over time), which represent an annual water use of 987,000 hectare-meter (432 mm per year). This information could serve as a baseline reference to set goals when drawing best management and water conservation practices that increase water use efficiency, and minimize pollution potential, while helping sustaining these green industries and their overall economic and societal benefits.

Specified Source(s) of Funding: Rio Grande Basin Initiative, Texas AgriLife Research

(184) Soil Moisture Mapping of Potato Farms Utilizing Four Irrigation Practices: Seepage, Subsurface Drip, Tile Irrigation, and Surface Drip

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Alternative irrigation practices are being investigated for potato production in Northeast Florida to reduce fresh water consumption and increase soil moisture uniformity. In this region, potato is traditionally supplied water though seepage irrigation by pumping water through furrows spaced 60 ft apart, allowing water to flow down into the soil profile and raise the water table up from an impermeable clay layer to the root zone. Excess water is drained into ditches at the end of a field and directed out of the agricultural system. The average potato irrigation requirement was estimated to be 457 to 508 L/m^2/yr. The seepage system commonly results in uneven soil moisture at root zone across the field including the areas furthest from the furrows, leading to uneven growth and yield of potato plants, especially during dry periods. Commercial potato growers have implemented alternative irrigation methods on their farms with the objective to reduce irrigation water volume application and increase water distribution efficiency in comparison to previously established seepage irrigation systems. The objective of this study was to investigate the soil moisture spatial pattern obtained from spot measurements carried out in different irrigation strategies for potatoes. These alternative methods included: a) subsurface drip irrigation, using 2–4 drip tapes installed between furrows 12 inches below the soil surface; b) tile irrigation, using a network of 4-inch pipes buried 24 inches below the soil surface to supply water; and c) surface drip irrigation, using one drip tape per potato row placed above the planted seed piece. Seepage irrigation sites located beside the alternative irrigation systems were also evaluated for comparison. Soil moisture was measured throughout the fields at the root zone, 20 cm below the soil surface using a time domain reflectometer (TDR-300) in conjunction with a mounted GPS and repeated three times throughout the season. Soil moisture variability was evaluated using geostatistical analysis based on the empirical semivariogram. Contour maps were created of each irrigation method to describe the distribution of soil moisture. Spatial soil moisture patterns were found to be correlated with the slope and the distance from the furrow irrigation and drainage ditches. The field water table was raised quickly and more uniformly using subsurface drip irrigation and tile drainage than seepage at determined points of the area, especially the central area between furrows. Drip irrigation showed the greatest uniformity of soil moisture at the root zone compared to other irrigation methods.

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Fruit Breeding 2

(383) A Postharvest Quality Study of University of Florida Strawberry Cultivars and Advanced Selections

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Strawberries are highly perishable fruits and have postharvest handling requirements including initial pre-cooling to temperatures near 0 °C and holding at 5 °C thereafter to reduce decay and water loss during storage. It is important to approximate the performance of University of Florida (UF) strawberry advanced selections for their postharvest qualities to determine their potential as cultivars. The objectives of this study were to compare strawberry cultivars and advanced breeding selections from the UF breeding program for some postharvest attributes, evaluating the effect of storage at 4 °C and 90% to 95% RH on weight retention, soluble solids content (SSC), fruit appearance and calyx appearance across three harvest dates in 2011. Due to availability and interest several genotypes were evaluated: 'Bish', 'Galleta', 'Florida Radiance', 'Strawberry Festival', Winterstar™ , and selections UF2, UF3, UF4, and UF5. Five marketable fruit were packed into each of four replicate clamshells per genotype. The weight (g) and SSC (%) were recorded on the day of harvest and on the 8th day after harvest. Appearance evaluations were done the day of harvest and again on the 4th and 8th days after harvest by three separate panelists using a non-structured 10 cm scale where overall appearance was anchored from 0 = old, dull to 10 = fresh, glossy and calyx appearance was anchored from 0=wilted, brown to 10=turgid, green. Storage at 4 °C for 8 days differentially affected the fruit quality of strawberry cultivars and advanced breeding selections from the UF breeding program. 'Strawberry Festival' and Winterstar™ had the highest weight retention of 95% and 94%, respectively. 'Galleta' and 'Strawberry Festival' obtained the highest increase in SSC by 27% and 25%, respectively. UF5, 'Bish', 'Florida Radiance' and Winterstar™ had increased SSC of 3% to 8% after 8 days. UF4, 'Strawberry Festival' and UF3 obtained the highest overall fruit appearance ratings after 8 days of storage. 'Strawberry Festival', Winterstar™ , and UF3 were graded by the panelists as having calyxes that were more turgid and green compared to 'Bish', 'Florida Radiance', and UF2. The study indicated that multiple advanced selections have quality after storage that is comparable to commercial standards.

(384) Mandarin Improvement using Interploid Sexual Hybridization

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Interploid sexual hybridization of mandarins, via 28 (diploid × tetraploid) and 2 reciprocal (tetraploid × diploid) crosses was carried out during the 2011 season on different locations in central Florida. The main breeding objectives were: seedlessness, easy-peel fruit, and extending the season of availability (early and late); also, improved juice quality, shelf life, cold hardiness, and disease resistance. In diploid × tetraploid (2X × 4X) crosses, the female (seed) breeding progenitors were the following diploids: 'Ellendale' tangor, 'Fortune' mandarin, 'Marisol Clemenetine' mandarin, 'Nules Clementine' mandarin, 'Monreal Clementine' mandarin, 'Lee' tangelo, 'Fallglo' tangelo-tangor, 'Sugar Belle' tangelo, and 'Ambersweet' tangor. The pollen progenitors were the following allotetraploid somatic hybrids: ['Page' tangelo + 'Ortanique' tangor], ['Page' tangelo + ('Clementine' mandarin × 'Satsuma' mandarin)], ['Succari' orange + 'Murcott' tangor], ['Succari' orange + 'Changsha' mandarin], ['Succari' orange + 'Page' tangelo], ['Murcott' tangor + 'LB8-8' tangelo], ['Rhode Red' orange + 'Dancy' mandarin], ['Hamlin' orange + 'Dancy' mandarin], ['Valencia' orange + 'Page' tangelo], and ['Valencia' orange + 'Minneola' tangelo]. Two allotetraploid somatic hybrids ['Page' tangelo + 'Ortanique' tangor] and ['Murcott' tangor + 'LB8-8' tangelo] were also included as female parents in tetraploid × diploid (4X × 2X) crosses while diploid 'Furr' tangor was the pollen progenitor in both crosses. Immature fruits were collected 100–120 days after hand-pollination. No fruits were observed in six (2X × 4X) crosses, as well as two (4X × 2X) crosses. In other 26 (2X × 4X) crosses, zygotic embryos were recovered from seeds using an embryo rescue method (embryos were carefully excised under the stereomicroscope and plated on a modified MT medium for 1–3 months to induce germination). Germinating embryos were cultured on different growth media (B+, DBA3, and RMAN) for 4–6 months, and ploidy levels of fully developed seedlings were determined by flow cytometry. The analysis of nuclear DNA content in the progenies revealed variation in ploidy level among produced seedlings. From the total number of generated plants (747), majority were sexual hybrids (582 - 77.9%). Triploids (3X) represented the highest percentage of sexual hybrids (557 - 95.7%); 24 seedlings (4.1%) were found to be tetraploids (4X), and only 1 (0.2%) to be hexaploid (6X). All sexual hybrids that survived in vitro manipulation were grafted on citrus rootstocks for subsequent field evaluation.

(385) Evaluation of Muscadine Genotypes for Storage Ability

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Storage trials were conducted on 10 muscadine grape (*Vitis rotundifolia*) cultivars and selections. Ripe berries were washed in 100 ppm chlorine and packed in 0.94-L vented clamshells. Clamshells were packed with and without UVASYS SO_2 emitting sheets and stored at 1 °C for 2 or 4 weeks. Berries were removed from cold storage and berry firmness was measured after 1 and 4 days at room temperature. Berries were then evaluated for rot or bleaching damage and stem scar integrity. There was a large amount of variation in berry firmness initially, but differences declined after storage. 'Supreme' and 'GA 1-1-48' were firmer than all other genotypes initially. Day 14 firmness rankings largely reflected day 0 rankings, with 'GA 1-1-48' and 'Supreme' markedly firmer than all other genotypes. Day 17 showed differences among genotypes, but only 'Supreme' was dramatically firmer than all others. At day 28 'GA 1-1-48' and 'Supreme' were significantly more firm than all other genotypes, but by day 31 only 'Supreme' was markedly more firm. These results demonstrate that berry firmness varied widely over cultivars but differences largely disappeared after storage, especially after storage for four days at room temperature. The one notable exception to this was the cultivar 'Supreme' which maintained a firmer berry than the other cultivars. The presence of wet scars significantly reduced berry firmness at all storage periods except for 17 days. Interestingly berry firmness was reduced by the presence of a wet scar even during the initial measurements. The reduction in firmness with wet scars may be more a result of mechanical relaxation of firmness rather than an increase of decay or loss of turgor pressure. Several cultivars showed no improvement in berry firmness with the addition of SO_2 generators, and no cultivar showed improvement over every storage period tested. Taken together these results suggest that the SO_2 generators only have a very modest effect on controlling berry rot and improving berry firmness. No bleaching or other ill effects were observed with the SO_2 generators. This study indicates that retention of berry firmness after storage is a relatively rare trait. The cultivar 'Supreme' was superior to all other selections and should be considered the standard to compare to when testing new selections for storage ability. In addition, this cultivar is being used as a parent in the breeding program with the goal of improving storage ability.

Specified Source(s) of Funding: Southern Region Small Fruit Consortium

(386) Evaluation of Fruit Rot Disease Resistance in Muscadine Grapes (*Vitis rotundifolia* Michx.)

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Musacadine grapes (*Vitis rotundifolia* Michx.) are truly a sustainable fruit for the southeastern United States. Although far more resistant to many fungal and bacterial diseases and pests than most of the bunch grapes (*V. vinifera, V. labrusca,* or their derivatives), muscadine grape suffers considerable economic losses every year due to berry rotting diseases such as black rot (*Guignardia bidwellii f. muscadinii*), bitter rot (*Greeneria uvicola*), and macrophoma rot (*Botryosphaeria dothidea*), which could significantly decrease yield and affect their marketability. The objectives of this study were to evaluate commercial muscadine grape cultivars for fruit rot resistance in order to identify promising muscadine germplasm for use in the breeding program and to make cultivar selection decisions for grape growers. Among the cultivar evaluated, bitter rot was the most prevalent fruit rot disease that occurred on 38 muscadine grape cultivars, followed by black rot, and the incidence of macrophoma rot was relatively low. The most susceptible cultivar to bitter rot was 'Early Fry', while cultivars 'Pride', 'Noble', 'Albemarle', 'Sothern Home', and 'Cowart' showed some degree of resistance to the bitter rot disease. In addition, ripe rot is also commonly found on the muscadine berries, especially at the late harvesting season, which often makes the identification of bitter rot more difficult.

(387) Simple Sequence Repeat (SSR) Markers Associated with White Flower in Peach [*Prunus persica* (L.) Batsch] Identified using Bulked Segregant Analysis (BSA)

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White flower color is controlled by a recessive allele *w* in peach. To map the *W* locus, open pollinated seed were collected from two different F_1 hybrids. The first hybrid was an F_1 between 'White English' *ww* (white flower) and 'UFSun' *WW* (pink flower). The second a hybrid was an F_1 between 'Brooks' *ww* (white flower) and 'UFBeauty' *WW* (pink flower). Open pollinated seed were collected from both F_1 hybrids to produce a segregating F_2 population. 'Brooks' × 'UFBeauty' and 'White English' × 'UFSun' F_2 populations consisted of 37 and 110 individuals, respectively. The F_2 populations did not deviate significantly from a 3:1 pink to white phenotypic segregation ratio ($c^2 \leq 0.01$). White flower phenotypes were identified to be homozygous recessive, as previously described. Bulked samples of white and pink flower phenotypes from 'White English' × 'UFSun' F_2 population were used to identify the genomic region linked with white flower *ww* locus using a total of 41 simple sequence repeat (SSR) markers. A linkage map was created with the SSR markers closely linked with white flower *ww* in peach and the locus placed on the *Prunus* reference genome map.

Specified Source(s) of Funding: Stone Fruit and Citrus Breeding and Genetics Program, University of Florida, Gainesville, FL.

(388) Polyploidy of Cells in Sweet Cherry Fruit

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Cell flow cytometry was used to investigate cell activity of sweet cherry (*Prunus avium* L.) cultivars during fruit development. The nuclei of 'Chelan', 'Bing' and 'Sweetheart' sweet cherry fruit became highly polyploid during early, rapid fruit growth, compared to small-fruited wild cherry (*Prunus* sp.) and choke cherry (*Prunus virginiana*). Polyploidy was observed only in fruit; flowers at full-bloom and leaf tissues were largely 2-C (>90%). For all cultivars, there was a rapid increase of the 4-C, 8-C and 16-C levels of DNA content during the "stage-I" growth phase. DNA content stabilized during "stage-II" (pit hardening) to approximately 30%, 45%, 20% and 5% of the 2-C, 4-C, 8-C, and 16-C levels, respectively, and remained largely unchanged throughout "stage-III" development. Polyploid differences among cultivars were not observed. Development of polyploidy demonstrated that cell divisions cease soon after full bloom. Bagged fruit (unpollinated and unfertilized) showed a much smaller increase in polyploidy. 'Sweetheart' spur cropload level (high and low) did not affect ploidy number of cells. A survey of small to large sweet cherry fruit (diverse genotypes) is underway to determine if a correlation exists between fruit size and polyploidy. Results from these studies could be useful in breeding programs focused on improving fruit size, and for early detection of fruit set.

(389) Developing New Sources of Resistance to Fire Blight for Use in Apple Scion Breeding Programs

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Fire blight, caused by the bacterium *Erwinia amylovora*, is a devastating disease of apple (*Malus)* that can kill young trees outright or result in permanent structural damage. Several sources of resistance to fire blight have been described in apple (*Malus*),

however most are from wild species or cultivars with inferior fruit quality. The goal of this project is to identify and characterize additional sources of resistance from both *M. sieversii* and *M.* ×*domestica* with fruit quality traits suitable for use in scion breeding programs. What distinguishes *M. sieversii* from other wild *Malus* species as an excellent source of disease resistance for scion breeding is its large and palatable fruit. All data available within the USDA–ARS, Germplasm Resources Information Network (GRIN) database was used to select 200 *M. sieversii* accessions with a predicted 1:1 ratio of fire blight susceptible to resistant accessions and superior fruit quality traits for flavor, firmness, juiciness, and soluble solids, harvest date (favoring later dates) and resistance to apple scab. Replicated plantings of the accessions and control cultivars have been established at the WSU–TFREC, Wenatchee, WA and USDA–ARS–AFRS, Kearneysville, WV, and will be phenotyped for resistance to fire blight following inoculation with *E. amylovora*. The accessions will also be genotyped using Genotyping By Sequencing for marker development. 'Splendour' is a commercial apple cultivar from New Zealand with excellent flavor that has been observed to be fire blight resistant under conditions of natural infection. To evaluate 'Splendour' as a potential donor of fire blight resistance, replicate plants of a subset of a 'Honeycrisp' × 'Splendour' population were bench grafted and evaluated for resistance to fire blight following inoculation with *E. amylovora* in the greenhouse. Six of 21 plants appeared resistant suggesting resistance to fire blight was segregating within the population. Two additional populations of 'Gala' × 'Splendour' (500 individuals) and 'Splendour' × 'Cripps Pink' (Pink Lady) (250 individuals) were created and will be used to determine if a QTL for resistance to fire blight can be identified within 'Splendour'. Plans are also underway to phenotype the RosBREED *Malus* Crop Reference Set and Washington State University Breeding Pedigree Sets to facilitate pedigree mapping of resistance to fire blight and marker development. After validation, molecular markers developed in the project will be made available to tree fruit breeding programs to facilitate the development of fire blight resistant apple and pear cultivars by marker assisted breeding.

Specified Source(s) of Funding: USDA–ARS, Washington Tree Fruit Research Commission, State Horticultural Association of Pennsylvania

(390) Clonal Propagation of Dragonfruit (*Hylocereus* sp.) Hybrids

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Long overlooked outside its native range in Central America, the dragonfruit (*Hylocereus* sp.) has become an increasingly popular specialty fruit item in markets spanning the globe from Asia to Europe. In the last 10 years the United States has joined in the excitement generated by this vining-type cactus, known for its striking fruit color and its large nocturnal inflorescences, with small commercial plantings having been established in both California and South Florida. Currently limitations to expanded commercial production are due to a lack of cultivars with improved flavor, a relatively small pool of flesh and floral colors, and need to develop additional self-fertile varieties. To overcome these limitations, the objectives of this project were to develop new hybrids of dragonfruit and a system for their clonal propagation using in vitro tissue culture techniques. This will enable the rapid introduction of plant material when new selections are ultimately made. Selections of *H. guatamalensis* and *H. stenoptera* where chosen for their differing flesh and flower colors, and hybrids were created by reciprocal crosses between them. The resulting fruit were harvested, and the seeds removed, cleaned and sterilized, before establishing in vitro for germination. Seeds were placed in magenta G7 boxes containing MS medium, 5 per box, for a total of 50 seedlings per cross. For each cross, five seedlings displaying the greatest hybrid vigor were chosen to represent individual lines after attaining a minimum shoot length of 6 cm. Shoots from these selections were then dissected into 3–4 mm sections containing at least one node and placed 3 per box in MS medium modified with different combinations of 1-naphthaleneacetic acid (NAA) and thidiazuron (TDZ), representing 8 treatments, with 6 boxes per treatment. Cultures were monitored weekly for growth and evaluated for percentage of explants per treatment showing shoot formation, root formation, and number of shoots and roots per explant. Shoot formation was observed for all treatments, including the control, however the best results for multiple shoot formation were achieved with a combination of NAA (0.05 µm) + TDZ (0.5 µm), TDZ (2.27 µm), and NAA (0.05 µm) + TDZ (2.27 µm). Plantlets were regenerated and transferred to greenhouse. In the present study we demonstrated a feasible technique for the clonal propagation of hybrid dragonfruit. Additional studies should evaluate the field performance of hybrids, fruit yield, visual appearance of flesh and flower colors, °Brix levels, and the ability to self-pollinate.

Thursday, August 2, 2012 Grand Ballroom

Nursery Crops

(216) Development of an Oxygenation System for Nursery Crop Irrigation Water

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Root zone oxygen is essential for root respiration. Rhizospheric oxygen concentration is largely determined by diffusion rates with the atmosphere and is affected by substrate moisture level, temperature, and physical properties, as well as respiration rates and atmospheric O_2 concentrations. Plants growing in suboptimal rhizospheric oxygen levels undergo anaerobic respiration, which generates toxic by-products. Suboptimal oxygen levels can reduce yield and growth, and increase root rot susceptibility. Non-permeable containers may limit gaseous diffusion. Elevated CO_2 levels associated with global warming could further deplete

rhizospheric oxygen levels. Determining dissolved oxygen (DO) requirements for optimal container plant production is critical to understanding how agricultural systems will respond to elevated CO_2 and increased temperatures. The objectives of this research were to: 1) evaluate a commercial oxygenation system (Water D.O.G.™ Iron Hunter HD) (WD) for elevating DO levels in irrigation water and 2) conduct preliminary investigations into response of woody species to elevated DO level in irrigation water when grown in a heavy or light substrate. The DO concentration for W.D.-treated water and the municipal, river-based water supply (control) was measured to establish a consistent increase in DO due to WD treatment. Experiments with plants used a CRD in a 2 (substrate) × 2 (water treatment) factorial arrangement with 8 blocks. *Forsythia ×intermedia* and *Cornus florida* were potted into 1-gal containers with a heavy or light substrate, bulk density 0.53 and 0.16 g/cc, respectively. Experiment duration was 83 and 56 days for *Forsythia* and *Cornus*, respectively. W.D. DO was 4.1 mg/L greater than the control throughout the experiment. DO had no effect on *Cornus* or *Forsythia* height. *Forsythia* in the light substrate had greater height than in the heavy substrate. For both species, there was no effect due to water treatment on dry weights although *Cornus* in the heavy substrate had 60% greater root dry weight with DO-treated water. Substrate did influence root growth. *Cornus* root dry weight was greater in the light substrate. *Forsythia* growing in the light substrate had greater shoot, root, and total dry weight than those in the heavy substrate. The Water D.O.G.™ consistently increased DO levels above the municipal water control. Substrate influenced biomass for *Cornus* and *Forsythia*. Future work will examine the effects of elevated DO in irrigation water on growth of multiple species over a longer production period, less extreme environmental conditions, and using a typical nursery water supply (well water) rather than municipal water source.

Specified Source(s) of Funding: J. Frank Schmidt Charitable Foundation

(217) Seed Source Significantly Influences Growth Rates and Disease Resistance of *Abies lasiocarpa* Grown for Ornamental Nursery Stock and Christmas Trees

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Trees from six corkbark fir (*Abies lasiocarpa* var. *arizonica*) and 10 subalpine fir (*Abies lasiocarpa* var. *lasiocarpa*) seed sources were grown at the University of Idaho (SREC) and three commercial nurseries in northern Idaho and northeastern Oregon. Post transplant mortality was highest during the first two years and was very high at two of the unirrigated nurseries. For the three plantings evaluated through 2006, survival averaged 76% and 80% for corkbark and subalpine fir, respectively. In SREC irrigated plots, survival averaged 96% and 99%, respectively. Spring frost damage occurred on 74% to 100% of trees during 2002–2006. In SREC plots, damage was minor and did not adversely affect tree appearance. Initial tree heights and growth rates varied significantly between seed sources. In general, corkbark fir grew faster than subalpine fir. After nine years, SREC mean corkbark tree heights ranged from 2.08 m [Santa Fe National Forest (N.F.)] to 2.89 m (Apache-Sitgreaves N.F.). Subalpine fir mean heights ranged from 1.31 m (San Isabel N.F.) to 2.27 m (Kaibab N.F.). Through 2006, tree heights at the nurseries were about 30% less for corkbark and 39% less for subalpine fir than for corresponding SREC trees. Corkbark fir proved moderately resistant to resistant to a *Phoma*-type fungal blight that affected current-season laterals. Three corkbark seed sources appeared suitable for ornamental landscape applications and Christmas tree production. Subalpine trees were more susceptible to Phoma blight and are questionable for general landscape applications. Two fungicide programs (Pageant or Pageant plus Bravo Weather Stik) provided control of the blight. Six subalpine fir and 25 corkbark fir at the SREC were selected for testing as possible cultivars for landscape use.

Specified Source(s) of Funding: Idaho Department of Agriculture Nursery Advisory Committee and the University of Idaho

(218) Use of Fiber Containers Does Not Affect Water Use or Plant Growth Compared to Plastic Containers for Pot-in-Pot Production of Birch

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Growth and water use during pot-in-pot production of birch (*Betula nigra*) was compared between two fiber containers (Kord® Fiber Grow and Western Pulp) and a standard black plastic container (GL2800, Nursery Supplies®, Inc.). The experiments were conducted in KY, MI, MS, and TX. Birch bare root liners were planted in mid-June 2011 into 7-gal contain-

ers filled with 85 pine bark: 15 peat (vol/vol). The containers were arranged in a completely randomized design with eight replications. A GL6900 (15 gal) container served as the socket pot. Bubble wrap was used to fill the gap between the production and socket pot for all the container types. Copper-treated paper or fabric was placed between the production and socket pot to prevent roots from escaping the production container. Substrate moisture content was determined with a theta probe (ML2, Dynamax, Inc.). Irrigation was applied to replace 100% of daily water use. Irrigation was delivered with one Tornado ray jet emitter, ~6 gph (Plastro Irrigation Systems, Ltd.) per container. Depending on location, there was a two- to three-fold increase in plant height during the 4 month study period. Plant caliper was found to increase by approximately 6 mm in all locations. The increase in plant height, caliper and/or plant growth index was not influenced by container type in any location. Daily water use was similar among the container types with an average water use of 2350 ml/day in Kentucky and 1480 ml/day in Michigan during Aug. 2011. Water usage responded more to daily weather conditions than to container type in all the locations. Inspection of the fiber containers in Mar. 2012 did not show any root outgrowth and the visual and tactile evaluation indicated that the side wall and bottom of the containers were intact and appeared to be suitable for use in the second year of the study. In conclusion, our initial findings indicate that there was no impact of fiber containers on plant growth and daily water use compared to standard plastic containers in pot-in-pot production. A second growing season will evaluate these same parameters under greater t ranspiration demand and root intrusion as the birch plants develop. The physical characteristics of the containers will also be evaluated at the termination of the study in October 2012.

Specified Source(s) of Funding: USDA–SCRI

(219) Do Shrubs in Mediterranean California Differ from Their Eastern Congeners in Drought and Flood Resistance?

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Numerous woody genera are distributed in both eastern North America and in portions of California characterized by the dry summers of Mediterranean climates. As part of a broader survey of how these taxa have evolved under conditions of disparate moisture availability, our objective was to compare the effects of flooding and drought on relative growth rate (RGR), photosynthesis, and measures of biomass among seedlings of *Ptelea* and *Sambucus* from the San Francisco Bay Area (*Ptelea crenulata* and *Sambucus nigra* ssp. *caerulea*) and from more mesic deciduous forests in the East (*Ptelea trifoliata* and *Sambucus nigra* ssp. *canadensis*). Seedlings in pots were subjected to six treatments of root-zone moisture that comprised three extents of inundation and three severities of drought (root zones irrigated when soil moisture by volume decreased to 5%, 10%, and 20%). After 5 weeks, *Ptelea* and *Sambucus* from western provenances showed more deleterious effects of flooding than did their congeners from the East. For example, RGR of western and eastern *Sambucus* was reduced 116% and 25%, respectively, when root zones were completely inundated. Although all western and eastern *Ptelea* died when root zones were fully inundated, inundating half the root zone killed all western plants but caused only a reduced RGR among eastern plants. Photosynthesis of *Sambucus* from the West was lowest with complete inundation (4 $\mu m \cdot m^{-2} \cdot s^{-1}$) but was similar across the remaining treatments (11 $\mu m \cdot m^{-2} \cdot s^{-1}$). In contrast, photosynthesis of eastern *Sambucus* was lowest under severe drought (1 $\mu m \cdot m^{-2} \cdot s^{-1}$) but otherwise similar (4–6 $\mu m \cdot m^{-2} \cdot s^{-1}$). Photosynthesis of *Ptelea* was sensitive to both drought and flooding; both western and eastern plants showed the greatest photosynthesis (14 $\mu m \cdot m^{-2} \cdot s^{-1}$ and 4–8 $\mu m \cdot m^{-2} \cdot s^{-1}$, respectively) under moderate root-zone moistures. For both genera, maximal photosynthesis was greater among western than eastern plants. Leaf area and biomass of eastern plants exceeded those of western plants regardless of genus and treatment. Root-to-shoot ratios of western *Sambucus* were greater than ratios of plants from the East after all treatments, whereas western *Ptelea* had greater root-to-shoot ratios than eastern *Ptelea* only under severe drought. These findings suggest that plants from Mediterranean provenances of taxa distributed across North America are less resistant to flooding but not necessarily more drought resistant than their eastern congeners.

(220) Irrigation Based on Plant Daily Water Use Conserves Water without Affecting Plant Growth

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Container-grown woody ornamentals were irrigated with 4 treatments based on daily water use (DWU) to study the impact of irrigation regime on plant growth, leachate electrical conductivity and pH, and runoff water volume and nutrient content. *Hibiscus syriacus* 'Bricotts', *Euonymus alatus* 'Select', *Weigela florida* 'Alexandra', and *Spiraea japonica* 'Yan' were grown in 10.2-L (#3) containers and subject to four overhead irrigation treatments: 1) irrigation scheduled to replace 100% DWU per application (100DWU); 2) irrigation alternating every other

application with 100% replacement of DWU and 75% DWU the following application (100–75); 3) irrigation scheduled on a three-application cycle replacing 100% DWU followed by two applications replacing 75% DWU (100–75–75); and 4) irrigation scheduled on a four-application cycle replacing 100% DWU followed by three application replacing 75% DWU (100–75–75–75). Container substrate consisted of 85% pine bark: 15% peatmoss (vol: vol). Plants were fertilized on 5 July 2011 with 26 g per container of a 17.0N–3.5P–6.6K control released fertilizer with micronutrients with a nutrient release period at 27 °C of 4 months (Harrell's, Inc., Lakeland, FL). The substrate moisture content was determined by 10 HS soil moisture sensor (Decagon Devices, Inc., Pullman, WA 99163). Plant DWU was calculated as moisture content after irrigation minus moisture content before irrigation the following day. The irrigation amounts were scheduled by a programmed data logger (CR3000, Campbell Scientific Inc., Logan, UT) based on the highest DWU reading from the sensors in each zone. Irrigation applications were separated by at least 24 hrs. The average daily irrigation amount applied for 100–75, 100–75–75, and 100–75–75–75 were 424 mL, 473 mL, and 423 mL, respectively, and less than 513 mL in 100DWU. There were no differences in final plant growth, electrical conductivity, or runoff nutrient content between treatments, and only a small difference in pH between treatments. These results suggest that irrigation water could be reduced without affecting plant growth.

Specified Source(s) of Funding: MSU GREEEN

(221) Effects of Fertility on Sedum Green Roof Module Production and Maintenance

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The effect of fertility on sedum green roof module production and maintenance was studied. Three starting proportions of cuttings and three fertility rates were evaluated for six popular green roof module sedum species. In only 8 weeks, 80% of modules were at least 95% vegetated and ready for sale using a moderate controlled-release fertilizer rate of 78 g/ft2. Final proportions of species may not be the same as initial proportions of species depending on which species are combined in modules. In a second study, the ability of inorganic and organic fertilizers to maintain green roof aesthetics was compared. Two different organic fertilizers (4N–0.9P–1.7K and 8N–2.2P–4.5K) were compared to an inorganic granular fertilizer (10N–4.4P–8.3K) and an inorganic controlled-release fertilizer (14N–6.1P–11.6K, 6-month formulation). Fertilizers were applied once at a rate of 2 lb N per 1000 ft2 or twice at a rate of 1 lb N per 1000 ft2 except for the controlled-release fertilizer which was applied only once at a rate of 2 lb N per 1000 ft2. Fertilizer treatments were rated visually based on foliage color and coverage. The single application inorganic granular fertilizer treatment performed the best, followed by the double application inorganic granular fertilizer treatment. The no fertilizer control and the controlled-release fertilizer performed the worst and the organic fertilizer treatments were intermediate. The single application of organic 8N–2.2P–4.5K fertilizer produced better results than the other three organic fertilizer applications.

Specified Source(s) of Funding: UConn Research Foundation

(222) Seed Production of Japanese Barberry Cultivars and Their Establishment in Deciduous Woods

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Japanese barberry (*Berberis thunbergii*) is an invasive shrub across most of the northeastern and central United States, but it is also an important landscape shrub. Using a replicated field planting we evaluated the fruit and seed production of 46 cultivars. A subset of popular cultivars was evaluated to determine how well their seeds would germinate and survive in a dry deciduous woodland. Cultivars produces as many as 12,000 seeds per plant and the number of seeds per fruit ranged from 0.1 to 1.8. Five cultivars produced fewer than 100 seeds per plant and two cultivars failed to produce fruit. In general, yellow-leaved and dwarf purple-leaved forms produced less seed than green-leaved cultivars or standard-sized purple-leaved cultivars. Fruit production increased to as much as 35,000 fruit per plant when plants were allowed to mature for 4–5 additional years. The two cultivars, which appeared sterile at the initial evaluation, produced small numbers of fruit when they were more mature. It is clear that sufficient time must be provided for woody plants to mature and establish before they can be useful in accurately assessing cultivar reproductive potential. Cultivar seeds germinated between 12.5% and 31% when sown in a deciduous woodland and exhibited survival rates between 5.6% and 29.3%. We combined germination data with survival data to generate a predicted establishment rate for each cultivar tested. The predicted establishment rate was then used in combination with seed production data to estimate the number of seedlings that each cultivar has the potential to contribute to a natural area annually. Even cultivars producing as little as 100 seeds annually have the potential to contribute a few seedlings each year to a natural area. Since barberry is a long-lived woody perennial, the number of seedlings an individual plant could contribute to a natural area could be quite high, even for cultivars producing low numbers of seeds.

(223) Seed Production of Winged Euonymus Cultivars and Their Establishment in Natural Areas

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Winged euonymus [*Euonymus alatus* (Thunb.)] is an important landscape shrub that has a demonstrated potential to be invasive in numerous states across the central and northern United States. Nine cultivars were evaluated for their potential to produce fruits and seeds in a randomized, replicated field planting. Seed from 'Compactus' was evaluated in five natural environments (full sun meadow, edge of woods, moist woods, dry woods, pine woods) to determine which types of environments would support germination and establishment of winged euonymus cultivars. Seeds from all cultivars were evaluated for their ability to germinate and survive as seedlings in a deciduous woodland. Seed production for medium to large plants of cultivars varied from 981 to 6090 seeds per plant. The dry deciduous woods and pine woods environments were the only two that supported significant germination rates, which could be over 30%. Seedling survival was at least 77% in the deciduous dry woods and at least 55% in the pine woods. In the first time replication, establishment rates for cultivars in the dry deciduous woods ranged from a low of 6.5% for 'Odom' Little Moses™ to a high of 42.5% for 'Monstrosus'. In the second time replication all cultivars achieved over 30% establishment and most exceeded a 40% establishment rate. By combining seed production data with establishment data, the annual seedling contribution per plant of different cultivars was predicted. Annual seedling contribution from individual landscape plants of different cultivars was predicted to range from 588 to 3763. None of the nine cultivars evaluated should be considered to be non-invasive based on our findings. Because germination and seedling survival rates are high for *E. alatus*, cultivars will likely have to be completely seed sterile to be considered non-invasive. Furthermore, *E. alatus* cultivars typically live multiple decades in the landscape and this must be considered when estimating their overall potential to contribute seedlings to natural environments.

(224) Using DNA Fingerprinting to Confirm Identity and Correct Labeling of Japanese Barberry (*Berberis thunbergii*) Cultivars in the Market

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Japanese barberry (*Berberis thunbergii* DC.) is a popular ornamental shrub appreciated for its hardiness and ornamental attributes. Currently over 60 cultivars of barberry are sold across the United States and Canada. These cultivars are identified using their botanical descriptions such as leaf color and plant habit. Since plants are sold when young, differentiating between cultivars with closely similar traits can be difficult and mislabeling can occur. In addition, the nursery industry has long suspected the widespread presence of subclones, or variants, in some cultivars such as 'Crimson Pygmy'. DNA fingerprinting is a reliable technique that can be used for barberry cultivar identification. At the University of Connecticut, AFLP profiles of 52 cultivars have been developed using seven primer combinations. These profiles were used to confirm the identity and check for correct labeling of barberry cultivars in the market. We screened 274 plants representing 20 different cultivars to determine the extent of mislabeling or presence of subclones. These plants were obtained from different nurseries and retail outlets across the United States. A total of 263 plants were accurately identified and confirmed as correctly labeled while 11 plants were determined to be mislabeled. Almost half of the 'Crimson Pygmy' plants tested exhibited some genetic variations from the reference cultivar and other same named plants. However, these plants contained cultivar specific markers and were still designated as 'true-to-name'. The profiles of four 'Crimson Pygmy' plants were substantially different from the reference profile and these plants could not be considered 'true-to-name'. The intra-cultivar genetic variations observed in 'Crimson Pygmy' could be due to random genetic mutations that can occur in clonally propagated plants especially those that have been propagated repeatedly over a long period of time. Overall, these AFLP profiles could be utilized to develop a 'true-to-name' barberry certification program for the industry.

(225) Growth of Containerized Nursery Crops in a Cedar Amended Substrate

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Eastern redcedar (*Juniperus virginana;* ERC) has recently proven to be an encouraging avenue for alternative substrate research for nursery crops. To date, several species have been grown in substrates composed partially or entirely of ERC with varying success. The objective of this study was to evaluate the growth of six species in pine bark (PB)- and ERC-based substrates. Three substrates were used (each contained 20% sand): 80% PB, 80% ERC, and 40% PB : 40% ERC (by vol.). On 2 June 2011, individual liners of lacebark elm (*Ulmus parifolia* 'Emer II'), compact inkberry holly (*Ilex glabra* 'Compacta'), double pink knockout rose (*Rosa* 'Radtkopink'), dwarf maiden grass (*Miscanthus sinersis* 'Little Kitten'), blanket flower (*Gaillardia* ×*grandiflora* 'Goblin'), and autumn joy sedum (*Sedum* × 'Autumn Joy') were planted into each of the three substrates. Plants were grown on an outdoor gravel container pad near Wichita, KS and irrigated by overhead sprinklers (2.54 cm daily). Stem caliper of lacebark elm was greatest in the PB:ERC substrate. Shoot (SDW) and root dry weights (RDW) of lacebark elm grown in ERC were smaller than those grown in PB and PB:ERC at 120 DAP. There were no differences in plant growth index (GI), SDW or RDW of plants grown in any treatment of knockout rose. Sedum plants had greater GI when ERC was part of the substrate. However, maiden grass was generally larger (GI and SDW) when PB was part of the substrate. There were no

differences in RDW for sedum. Although inkberry holly RDW was unaffected by substrate, above ground (GI and SDW) were larger when PB was a component of the substrate. There were no differences in GI, SDW or RDW of blanket flower. Plants evaluated in this study were successfully grown in a PB:ERC substrate, thereby expanding the list of species adapted to production in ERC-based nursery crop substrates.

Specified Source(s) of Funding: USDA NIFA Floriculture and Nursery Research Initiative

(226) Using Effluent Volumes to Control Leaching in Container Nursery Crops

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Over-irrigating container-grown crops can lead to increased nutrient leaching and negatively impact water quality. Leaching is implemented to reduce substrate salt concentrations within the container. The term, "leaching fraction" (effluent volume/irrigation volume) has historically been described by best management practices to monitor irrigation efficiency. Recommendations for leaching fraction for container crops and methods for controlling leaching fraction can greatly vary. Therefore, a study was conducted to determine predicted leaching fraction versus actual leaching fraction with parameters for container water-holding capacity and antecedent substrate moisture content included. Three replications for three container sizes (2.7 L, 11.6 L, and 22.7 L) with coarse pine bark substrate were dried to 95%, 80%, and 70% of container capacity following saturation. Containers were subsequently irrigated to achieve targeted leaching fractions of 0.0, 0.2, 0.4, and 0.6 of applied irrigation. At termination of leaching, effluent was collected and actual leaching fractions were calculated. Actual leaching fractions were found to be higher than treatment targets, and varied according to antecedent substrate moisture content. When irrigation and effluent volumes were compared to container capacity, a linear relationship was found between percent of container capacity leached at irrigation termination and total percent of container capacity leached, regardless of antecedent moisture content. Soluble salt concentrations were measured on leachate samples collected from volumetric intervals after commencement of leaching, and compared to total effluent salt content. The proportion of salts leached was highest in the initial volumetric samples. Container water-holding capacity and antecedent substrate moisture can greatly affect the volume of irrigation needed to produce target leachate volumes. Measuring leachate as a percent of container capacity can provide a more standardized method for achieving targeted leaching volumes.

Specified Source(s) of Funding: Louisiana State University AgCenter

Thursday, August 2, 2012 Grand Ballroom

Ornamental/Landscape and Turf 3

(244) Landscape Management Cost Comparison Before and After Implementation of Sustainable Landscape Practices

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Sustainable landscape practices address issues of water management, air quality, resource use, wildlife habitat and human well-being. Some widely used practices include water conservation in the landscape known as xeriscaping, on-site storm water management using rain gardens and green roofs, water harvesting through various systems designed for the landscape, use of trees for energy conservation in buildings, restoration of native plant communities, and creation of wildlife habitat on golf courses and residential properties. Sustainable landscape practices were implemented on this residential property in western Illinois beginning in 2004. Prior to that, the property landscaping included mostly turf as a groundcover, some yews as foundation plants two shade trees and some weedy growth along a creek that runs through the property. The property has a 112-ft-long curved slope that was covered with turf. The creek that runs through the property originates from farm field run-off and feeds into the Lamoine River, which run into the Illinois River and then the Mississippi River. The primary practices implemented on the property were removal of turf and replacement with native plants, creating plant communities, and increasing diversity of the riparian plant community. To estimate management costs, maintenance activities were recorded on an annual basis. Labor, equipment, and material costs were summed for all activities over the course of a year. In the process of implementing the sustainable practices a total of 16,804 square feet of turf was removed. It was mainly replaced with plants and mulch, although two sets of steps were installed on either end of the slope. Labor required for mowing was reduced by 13 hours over the period of one season. As weed control in turf decreased over the course of the season, it increased in shrub and flower beds. Pest problems were minimal before and after implementation of the changes.

Specified Source(s) of Funding: Ecoplace

(245) Sustainable Landscaping Issues and Trends as Discussed in the Academic Literature

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The term sustainable landscaping has come into increasing usage in recent years. Regional differences in the definition and

meaning of what constitutes sustainable practices exist. There are also differences among disciplines that share some of the terminology of sustainable landscaping. The term "landscape" is used by the urban planning community, in agriculture, by landscape architects, and horticulturists. It is also used in to refer to a nature scene, or to an overview of a topic. Sustainable is also used in various ways. Thus, research and developments occur across disciplines using common terms that sometimes have different meanings. In this study, a survey of the literature was conducted with the goal of examining issues and trends that comprise sustainable landscaping. Literature searches were conducted using Agricola and Google Scholar. The journals published by ASHS were also searched. Search terms used were "sustainable landscape" and "sustainable landscaping." Searches were conducted in 10 year increments to identify whether publications on the topic were changing over time. Results indicate an increasing number of publications in the four decades from 1970 to 2010. Both books and academic journals were published on the topic. Some of the issues discussed included pest control, use of disease resistant plants, on-site water treatment, proper tree care, the carbon cycle, nature conservation and restoration, water conservation, and ecological management of landscapes. Types of publications were far more varied using Google Scholar than Agricola. In the latter, books and academic journals were the primary listings. With the former, dissertations and articles intended for the lay audience were also included.

(246) Organic Amendment Effects on Soil Carbon and Microbial Biomass in the Root Zone of Three Landscape Tree Species

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There is increasing interest in amending degraded soils with organic matter to improve soil quality and increase capacity to support tree growth, especially in urban areas where rehabilitation of damaged soils may enhance tree growth and provision of ecosystem services. To assess the potential of such organic amendments for producing a sustained alteration in soil biological characteristics, we studied the effects of three organic amendments incorporated into the root zone of three tree species on root development, soil carbon dynamics, and soil microbial biomass over one year beginning 20 months after amendment application. Soil amendment with leaf-based and, to a lesser extent, biosolids-based composts increased root length within the amended root zone of red maple (*Acer rubrum*), but not of pin oak (*Quercus palustris*) or chestnut oak (*Q. montana*). There was a concomitant increase in microbial biomass carbon for red maple. Across all species, sphagnum peat moss amendment reduced microbial biomass carbon by 47% compared to unamended root zones and suppressed maximum seasonal soil respiration relative to composts. Carbon/nitrogen ratios remained stable throughout most of the year except in the root zones of chestnut oak and pin oak amended with peat, where it declined 44% to 85%. Total soil carbon was stable in all treatments, although unamended soils averaged about 40% lower than amended soils. We conclude that soil microbial activity can be increased by compost amendment of the root zone and that this increase is mediated to some degree by tree roots. In addition, stable C/N ratios suggest this alteration in the root zone may be sustainable. Further research may clarify whether compost amendment combined with tree planting can accelerate soil restoration.

Specified Source(s) of Funding: ISA Tree Fund

(247) Morphophysiological Dormancy in Seeds of *Thalictrum rochebrunianum* var. *grandisepalum* (H.Lev.) Nakai Native to Korea

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The Ranunculaceae is a family reported to have morphological dormancy (MD) or morphophysiological dormancy (MPD), with rudimentary or linear embryos. *Thalictrum rochebrunianum* is a perennial plant within the Ranunculaceae family. There are few reports on embryo growth, morphology, and germination in *Thalictrum* (Ranunculaceae) species. The aims of this study were to determine the requirements for dormancy break and germination, and to characterize the type of seed dormancy of *T. rochebrunianum* seeds. Ripe seeds (achenes) were collected in late September. To determine the temperature requirements for embryo growth and germination in the field, the seeds were sown to the field soil. Every 2 weeks, seeds were exhumed, and phenology of embryo growth and germination was studied. Temperature requirements for embryo growth and germination were also determined by incubating seeds under controlled laboratory conditions. Additionally, the effect of GA_3 on dormancy break was tested to characterize the type of seed dormancy. Seeds had underdeveloped embryos that were about 0.5 mm, which was about 22% of those of fully matured seed. Since embryos in seeds of this species had to grow to critical length (1.5–2.2 mm) before germination was possible, seeds seemed to have morphological dormancy. When tested at the time of dispersal, no fresh seed germinated after 4 weeks of incubation at 20 °C. Therefore, the seed dormancy type for *T. rochebrunianum* seemed to be morphological and physiological, i.e. morphophysiological. In natural conditions, embryo growth and germination occurred in early March 2012 and late March 2012, respectively. In laboratory experiments, after 4–8 weeks of cold stratification at 1 or 5 °C embryos grew rapidly during incubation at 25/15 °C (warm temperature). It seemed that embryo dormancy was broken by cold stratification when stored for more than 4 weeks, and then

the embryos started to grow by warm temperature. GA_3 substituted for cold stratification to break dormancy in seeds of *T. rochebrunianum*. After 1,000 mg·L^{-1} GA_3 treatment, 86.7% of the seeds germinated after 3 weeks of incubation at 25/15 °C. Consequently, seeds of *T. rochebrunianum* can be characterized as having non-deep simple morphophysiological dormancy.

Specified Source(s) of Funding: Korea Institute of Planning and Evaluation for Technology of Food, Agriculture, Forestry and Fisheries

(248) Choice and No-choice Feeding Preferences of the Southern Pine Sawyer Beetle on Four Species of Pine

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For the past 30 years, North and South Americas, Europe, and Asia have experienced an increased loss of landscape and forest pines due to pine wilt disease. Pine wilt is a fatal disease caused by the pinewood nematode (*Bursaphelenchus xylophilus*) and its vector, the pine sawyer beetle (*Monochamus* spp.). The objective of this study was to determine if southern pine sawyer beetle (*Monochamus titillator*; SPSB) feeding preference could partially explain tree species susceptibility to pine wilt and provide non-preferred pine species alternatives for the landscape. Choice and no-choice feeding preferences of SPSB were evaluated using four species of pine as a preliminary investigation to determine the potential of pine wilt tolerant/resistant pine species. In May and June 2011, one newly emerged beetle (less than 24 hours old) was placed into each 90 L feeding arena containing one shoot of current season growth for four pine species (*Pinus sylvestris,* Scots; *P. ponderosa*, ponderosa; *P. strobiformis*, southwestern white; and *P. taeda,* loblolly) for the choice study and only one shoot southwestern white pine for the no-choice study. Shoot samples were fed on for 48 hours and assessed for feeding site area and feeding area percent [(feeding site area ÷ total shoot surface area) × 100] using a leaf area scanner system (WinFolia, Regent Instruments Inc., Ottawa, Ontario). Choice feeding area and percent feeding data revealed that Scots, ponderosa, and loblolly pines were preferred feeding hosts for SPSB while southwestern white pine was not preferred. However, no-choice feeding area and percent feeding data did measure feeding on southwestern white pine. No-choice feeding indicated that while southwestern white pine was not a preferred feeding host for SPSB in choice feeding tests and when faced to starve or subsist by feeding on a non-preferred species, non-preferential feeding may occur and potentially spread pine wilt. The preliminary results from both the choice and no-choice studies will be used for further evaluations determining pinewood nematode susceptibility of evaluated pines to pine wilt. Further investigations to assess pine sawyer beetle feeding preferences and pinewood nematode pathogenicity may result in identifying pine wilt tolerant/resistant pines or other conifer selections for use as windbreaks, forestry, and/or landscape use.

(249) *Cryptodiaporthe corni*, a Latent Pathogen in Asymptomatic Stems of Pagoda Dogwood (*Cornus alternifolia*)

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Golden Canker is a common disease that frequently attacks pagoda dogwood (*Cornus alternifolia* L.) causing branch dieback, diffuse cankers, and occasionally stem mortality. The causal agent, *Cryptodiaporthe corni* (Wehm.) Petrak, is commonly found throughout much of the northcentral and eastern United States. An evaluation of 40 asymptomatic stems of pagoda dogwood from five natural stands and managed landscapes across Minnesota was completed. Surface sterilization was used to eliminate contamination of microorganisms on the stem surfaces. Results indicate that the fungus lives as an endophyte before becoming pathogenic. When all sites were combined, the fungus was found in 62.5% of the asymptomatic stems studied. A positive correlation between stem diameter and presence of the fungus was found. Discovery of a high percentage of asymptomatic stems, which were infected in the managed landscape (44%), suggests controlling the disease will be difficult. Furthermore, these results suggest that removal of infected tissue may simply reduce the visual impact of the disease without impacting the future disease incidence of the pathogen on the infected plant. Factors inciting a change in the fungus from a latent to active form of infection need to be investigated.

(250) The Effects of a Controlled Burn on Native *Aureolaria grandiflora* Populations Existing on an Ozark Savanna and Glade Habitat

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Prior to settlement in the early 1800's, the Ozark Highland ecosystem relied on disturbances to maintain the diversity of flora and fauna. Periodic wild land fires preserved a mosaic of open oak savannas and glade habitats, which early journal accounts in the 1800s suggest contained robust meadows covered in a range of wildflowers and grasses. Due to the suppression of fires in the Ozark region, most of these savannas and glades today are overgrown in invading species not tolerant of periodic burns. *Aureolaria grandiflora* (Benth.) Penn., also called large-flowered false foxglove, is a parasitic plant of *Quercus* spp. (oaks) within the white oak group, and has been deemed a strong indicator plant of a remnant savanna and glade complex.

This study evaluates if *Aureolaria grandiflora* established plants or seed germination will respond favorably to controlled burns by increasing seedling populations and perennial caudex stem growth the following spring. In Oct. 2010, a 2.4-acre rocky wooded slope, in Ozark County, Missouri, was slashed. An assortment of trees, mostly within the white oak section were maintained and spaced to allow at least 50% light penetration to the forest floor. The land rested for one year, and on 27 Oct. 2011, populations of *Aureolaria grandiflora* were charted in twenty 2.74 m × 3.05 m plots. Each plant's stem count was recorded for comparison in spring 2012. Twelve of the 20 test plots were burned once on 2 Dec. 2011, and again on 19 Feb. 2012. Eight of the 20 test plots were not burned. In May 2012, perennial stem counts and seedling numbers will be collected and compared to the data collected prior to the burn. Data and analysis of the *Aureolaria* population differences and relative growth in response to burning will be presented.

(251) Ornamental Attributes of 16 Selections of Rhizoma Peanut (*Arachis glabrata* Benth.) in Response to Sun and Shade

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Rhizoma peanut (*Arachis glabrata* Benth.) has received little attention for its potential use as an ornamental groundcover although it has been used almost exclusively as a forage crop since the 1970s. This study represents the first attempt at characterizing attributes of rhizoma peanut for ornamental use. These attributes include low stature, high visual quality, flower production, drought, pest, and disease resistance, and no need for nitrogen inputs. Additionally, variable rates of cover and mature heights among selections warrant a comparison to quantify ornamental attributes of new and previously released rhizoma peanut selections. Furthermore, successful cultivation of rhizoma peanut in a shaded environment would allow a greater diversity of landscape habitats to be utilized. Individual plots of 16 cultivars were replicated four times in a completely randomized block design at two Florida locations. A split-plot design was chosen, with cultivar as the main plot and shade treatment as the sub plot. Shade treatments were created by covering half of each plot with 30% shade cloth. Plots were evaluated bi-weekly over two growing seasons for coverage, canopy height, number of flowers, and visual quality. Locations were not directly comparable due to differences in planting year. During the first (establishment) year, mean height was less than that of established (second year) plots. Mean height was affected more by rhizoma peanut selection than by shade treatment or location. Rate of cover was much greater for established plots (over 1 year old) than establishing plots. Rhizoma peanut selection had a strong effect on rate of cover and total coverage. Shaded plots were slower to achieve full coverage compared to full sun plots and they were also slower to exhibit low temperature induced defoliation and die-back. After 2 years of establishment, well-drained sandy soils reduced coverage more than clay soils with greater water holding capacity. Flower number was most influenced by selection and was significantly reduced in shade. Flower number was greatest during the establishment year, and was reduced in the second year due to increased height which obscured flowers. Visual quality was influenced more by selection than shade treatment, location, or year. Generally, cultivar performance was not significantly different between sun and shade, suggesting rhizoma peanut is adaptable to a wide range of shade environments. This study provides evidence that several selections of rhizoma peanut are suitable for ornamental use, evidenced by a fast rate of cover, low height, high visual quality, and prolific flowering.

(252) Impacts of Broadleaf Mistletoe Infestations on Native Trees Used in Urban Environments

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Trees are a main component of urban landscapes, parks and roadways, and along with turfgrasses are usually the major users of water in these settings, with mature trees consuming potentially as much as 400 L in a summer day. The use of native and adapted tree species is strongly promoted as a way to save water in Texas urban landscapes. Unfortunately several of the recommended and widely planted native tree taxa (i.e., *Ulmus, Celtis, Prosopis, Maclura*) are susceptible to broadleaf mistletoe (*Phoradendron* spp.) infestations, whose severity and impact on the growth, health and water economy of the trees are undocumented. We are investigating aspects related to the spread and biology of broadleaf mistletoe in urban landscapes and rights-of way, and in particular evaluating the use (extraction) of water and nutrient by mistletoes in Texas-native trees. Results from these efforts would be used to draw viable recommendations for landscape horticulturists, arborists and homeowners to effectively monitor and manage mistletoe infestations in urban trees and forests, improving overall tree health and water use efficiency.

Specified Source(s) of Funding: Rio Grande Basin Initiative, Texas AgriLife Research

(253) Four Levels of Flooding Alter Soil Oxygen Concentrations and Growth and Survival of *Taxodium distichum* (L.) Rich

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Development of vertical protuberances from the roots of baldcypress [*Taxodium distichum* (L.) Rich.], commonly known as knees, often occur on various taxa of baldcypress in the proximity of wet soils. Various explanations have included functions in mechanical stability, as well as movement of oxygen to root tissues in low oxygen soils or water. Although baldcypress has become a popular tree for built environments, development of knees can hinder turfgrass maintenance and present trip hazards for pedestrians. A study was undertaken to determine if in specially constructed flooded cells could induce rapid induction of knee development on selected genotypes derived from trees exhibiting strong or weak tendencies for knee development? This could then potentially be used as a screening tool in cultivar selection. This study would also provide additional information related to variable genotypic responses of *T. distichum* to flooded conditions. Cells 1.2 m wide × 2.4 m long × 0.3 m deep were constructed in which 15 cm of sandy loam soil was placed in raised beds containing pond liners and then maintained in four levels of flooding: 1) well drained conditions in which water was allowed to drain immediately upon irrigation sufficient to maintain soils in a moist, but not saturated condition (control); 2) soil was saturated at approximately weekly intervals by flooding then allowed to drain after 3 d; 3) soil was maintained in a saturated condition with water just visible at the soil surface (boggy conditions); and 4) soil was maintained in a flooded state with approximately 7.6 cm of stand water. Although noted for its flood tolerance, across six genotypes baldcypress had greater survival (100%), grew taller, had greater trunk diameter, and had greater shoot, root, and total plant dry masses under well drained conditions than in any of the flooding treatments. Periodic flooding resulted in statistically similar survival (89%), but reduced height, trunk caliper, and dry mass accumulation. Saturated soil (28%) and standing water (17%) reduced survival substantially and also reduced shoot and root growth. Growth of genotypes in the cells was greater for seed propagated genotypes than those propagated from rooted cuttings. Flooded soils exhibited reduced oxygen concentrations, particularly during late summer.

Specified Source(s) of Funding: J. Frank Schmidt Family Charitable Foundation and Tree Research and Education Endowment Fund.

(254) Mississippi State Extension Horticulture Outreach: A History of Southern Gardening

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One of the most visible outreach efforts produced by the Mississippi State University Extension Service is the Southern Gardening program. Though television, radio and newspaper columns, Southern Gardening has been providing garden and landscape information to Mississippians for 27 years. The goal of Southern Gardening is to introduce new plants, educate gardeners about plant uses and celebrate the fun of gardening. Seeing new plants or learning how other home gardeners use plants in the landscape is of interest to the home gardener. The newspaper column and radio program were first produced in 1985, followed by the television program in 1996. All have been produced 52 weeks a year since 1996. In the beginning the newspaper column was called "In Mississippi Gardens" and the radio program was called "Gardening Mississippi Style. Both featured topics of vegetable gardening and landscape horticulture interest. In 1996 with the addition of the television program the name was changed to "Southern Gardening" for all three products. The Southern Gardening products are distributed to appropriate outlets across Mississippi. The potential consumption of Southern Gardening makes this effort one of the most visible outreach efforts for Mississippi State University Extension Service. Twelve television and cable outlets air the 2-minute Southern Gardening television segments as a regular weekly feature with an audience of up 500,000 viewers. Southern Gardening is also a weekly feature of the "Farmweek" television program on Mississippi Public Broadcasting and satellite nationwide on RFD-TV. The newspaper column is a regular weekly feature in as many as two dozen newspapers. It is also published on an intermittent basis in many others. The total weekly readership is more than two million. The daily 2-minute Southern Gardening radio programs are a regular feature on 11 stations across the state.

(255) Determining the Minimum Growth Substrate Depth Needed for Plants in Arid Climate Green Roofs

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Green roofs are a popular technology used to address the environmental challenges of society, but their use in arid climates is claimed unsupportable due to the lack of precipitation charac-

teristic of such regions. The current perception is that, without adequate precipitation, the thin green roof growing substrates will desiccate in the extreme heat of arid climates making plant growth untenable. As a result, the misconception that arid climate green roofs are theoretical concepts must be overcome without the luxury of thinner and lighter weight profiles of growth substrates. The objective of this study is to determine a minimum growth substrate depth that will support growth of traditional green roof taxa *Sempervivum* spp. (hens and chicks) and *Delosperma nubigenum* (hardy iceplant) in arid climates. Plants were grown in a greenhouse located at the Fabian Garcia Science Center in Las Cruces, NM. The plants were grown at depths of 7.5, 10, and 12.5 cm in a 6:3:1 heat-expanded clay: washed sand: worm castings (Hydroton, Willich, Germany; Quikrete Playsand, Atlanta, GA; Wiggleworm Soil Builder, Racine, WI) growing substrate by volume. The growing substrate had a bulk density of 0.8 g·cm^{-3}, an air-filled porosity of 42%, and a pH of 7.3. The experimental design was a split-plot with four replications. The whole plot was growing substrate depth and the sub-plot was plant taxa. Four plants from each species were randomly selected and harvested destructively to assess initial plant growth characteristics. Plants were evaluated every 15 days for survival, coverage, and visual quality. Initial results revealed that *Delosperma* had a mean canopy area of 130 ± 7 cm^2, which was greater than that of *Sempervivum*, which had a mean canopy area of 66 ± 1 cm^2. In addition, *Sempervivum* had a mean root weight of 0.8 ± 0.2 g and a shoot weight of 3 ± 0.5 g, which was less than *Delosperma* which had a mean root weight of 4.6 ± 0.9 g and a mean shoot weight of 4.1 ± 0.3 g. While the growing substrate is adequate to support growth, a lighter formulation is being developed for further tests. Data collection is ongoing, but at day 15 substrate depth had no effect on plant growth.

Thursday, August 2, 2012 Grand Ballroom

Plant Biotechnology (Poster)

(127) Somatic Embryogenesis and *Agrobacterium*-mediated Transformation of *Epipremnum aureum* 'Jade'

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This study established an efficient system for regeneration and transformation of *Epipremnum aureum* 'Jade'. Leaf and petiole explants were cultured on a Murashige and Skoog basal medium supplemented with N-(2-chloro-4-pyridl)-N'-phenylurea (CPPU) or N-phenyl-N'-1,2,3-thiadiazol-5-ylurea (TDZ) in combination with α-naphthalene acetic acid (NAA). Somatic embryos appeared directly from explants after 4–6 weeks of culture; TDZ at 9.08 μM with 1.07 μM NAA was the best medium for somatic embryo induction from both leaf and petiole explants and subsequently embryo conversion. Based on this established regeneration method, an *Agrobacterium*-mediated transformation procedure was developed. Leaf discs and petiole segments were inoculated and co-cultivated with *A. tumefaciens* strain EHA105, carrying the binary vector pLC902 which contained the hygromycin phosphotransferase (HPT) selectable gene and the enhanced green fluorescent protein (EGFP) reporter gene. The leaf discs and petiole segments were cultured on MS medium supplemented with 9.08 μM TDZ and 1.07 μM NAA as well as cefotaxime, carbenicillin and hygromycin. Somatic embryos formed from leaf and petiole explants, and embryo conversion resulted in healthy plantlets. A total of 237 putative transgenic plants were obtained, and all of them expressed EGFP fluorescence throughout the entire plant, including roots. Results also showed that the co-cultivation period significantly affected transformation efficiency. Five-day co-cultivation led to 100% of leaf explants showing transient EGFP fluorescence and 23.8% of leaf explants producing somatic embryos expressing stable EGFP fluorescence. Seven-day co-cultivation resulted in 100% of petiole explants showing transient EGFP fluorescence and 14.3% of petiole explants producing somatic embryos expressing stable EGFP fluorescence.

(128) QTL Mapping for Fire Blight Resistance in Apple

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Fire blight, caused *by Erwinia amylovora*, is a major threat to apple and pear production world-wide. To identify genomic regions conferring resistance to fire blight in apple, we searched and identified Single Nucleotide Polymorphisms (SNPs) from publicly available apple EST database, and custom-synthesized a 1536 GoldenGate™ SNP genotyping assay (Khan et al. 2012). SNPs were genotyped using an apple mapping population consisting of 90 F1 individuals derived from a cross between Co-op 16 × Co-op 17. A total of 583 SNPs segregated in the mapping population, and these were used to construct a linkage map. A well-saturated consensus genetic map for both parents using the Haldane's mapping function was constructed. The genetic map consisted of 17 linkage groups with an average of 34 ± 6 markers per linkage group. Overall, the average interval

between markers was 2 ± 4 cM. In addition, progeny of this mapping population was grafted onto Bud-9 rootstock, grown in the greenhouse, and artificially inoculated the with a suspension culture of *E. amylovora*. Lengths of necrotic shoots were measured, and percent infected shoots was calculated. These data were used for QTL mapping together with the newly constructed apple genetic linkage map. We identified a QTL with moderate effects on one of the linkage groups, and explaining 13-17.5 % of the observed phenotypic variation. The marker is an EST-based SNP with an LOD of ~4. This interval is being investigated to identify underlying candidates genes associated with fire blight resistance.

Specified Source(s) of Funding: This project was supported by funds from USDA–NIFA–SCRI grant AG 2009-51181-06023.

(129) The Regulatory Role of an Apple Transcription Factor, *MdMYB3*, in Anthocyanin Biosynthesis

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Coloration of apple fruit is attributed to accumulation of anthocyanins, a class of plant flavonoid metabolites. Flavonoids are ubiquitous in plants, and play important roles throughout plant growth and development, and contributing to pigmentation of flowers and fruits. MYB transcription factors (TFs) are highly abundant in plants, and play important roles in regulation of several pathways such as cellular morphogenesis, cell cycles, and secondary metabolism. Previous efforts on characterization of structural and regulatory genes involved in fruit coloration in apple (*Malus* ×*domestica* Borkh.) have elucidated roles of some genes in the anthocyanin biosynthesis pathway that contribute to accumulation of anthocyanin in skin of apple fruit. Moreover, three transcription factors, *MdMYB10*, *MdMYB1*, and *MdMYBA* have been isolated and characterized in apple, although these are likely to be allelic. In this study, a novel apple MYB TF, designated as *MdMYB3*, has been isolated, characterized, and mapped to an apple linkage group. Transcripts of *MdMYB3* transcript have been detected in all various tissues in apple, including leaves, flowers, and fruits. Moreover, transcripts of this transcription factor have been compared in red- versus yellow-colored fruit. Functional analysis of *MdMYB3* gene in tobacco (*Nicotiana tabacum*) revealed interesting variations in flower color pigmentation as well as other morphological characteristics. The regulatory role of this transcription factor has been further elucidated in these studies.

Specified Source(s) of Funding: This project was supported by funds from USDA–NIFA–SCRI grant AG 2009-51181-06023 and the University of Illinois Office of Research Project no. 65-325.

(130) Improving Diploid Strawberry Yellow Wonder Genotype 5AF7 as a Functional Genomics Resource

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Cultivated strawberry (*Fragaria* ×*ananassa* Duch.) is a valuable crop in United States and Florida. Molecular-genetic and genomic studies in the cultivated strawberry are complicated by its octoploid genome. An alternative is to investigate strawberry biology using diploid strawberry (e.g., *Fragaria vesca*), which shares a common ancestor with the cultivated strawberry. Diploid strawberry is fully sequenced, grows quickly from seed to seed, and has a simple and remarkably small genome. We have developed protocols for the Yellow Wonder *F. vesca* genotype 5AF7 (YW5AF7) which is a seven- generation inbred diploid strawberry that has been well phenotyped. The optimization of in vitro growth for seedlings and regeneration from leaf disks has been performed. It was determined that MS media with B5 vitamins and 1% sucrose supported healthy in vitro plant growth. Plant growth regulators (PGRs) were tested to obtain robust, high regeneration efficiency. A combination of 1.5 μM IBA with 15 μM BA gave the highest percentage of shoots, (about 70% of explants) and 5 shoots per explant within the same period. These concentrations of plant growth regulators were selected after a comprehensive test with three different types of cytokinins and auxins over a range of concentrations. We have also identified light conditions that best support adventitious shoot formation, increasing the efficiency of the system. Transformation protocols have been optimized, testing the effect of dark pre-incubation periods. Validamycin A is also being tested in selection media to obtain more rapid and reliable generation of transgenic plants. The optimization of transformation efficiency makes the diploid strawberry a useful tool for functional genomics.

Specified Source(s) of Funding: Higher Ministry of Education (MOHE) Malaysia, University of Florida.

(131) A Transcription Factor Complex Regulates the Anthocyanin Biosynthetic Pathway in Eggplant (*Solanum melongena*)

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Eggplant, *Solanum melongena,* fruit color is an important determinant of fresh product quality. Marketable fruit color varies from white to green through varying shades of violet to black.

The genes responsible for the biosynthesis of anthocyanin compounds in eggplant that contribute to fruit color are not well characterized. Model systems support the interaction of biosynthetic and regulatory genes for anthocyanin biosynthesis. Anthocyanin structural gene transcription requires the expression of at least one member of each of three transcription factor families - MYC, MYB and WD40. These transcription factors form a complex that binds to structural gene promoters, thereby modulating gene expression. In order to determine the genetic basis for tissue pigmentation in eggplant fruit, we utilized real-time PCR to evaluate the expression of anthocyanin biosynthetic (*Chs, Dfr, Ans*) and regulatory (*Myc, Myb, Wd*) genes in *S. melongena* genotypes that produce dark violet pigmented and white non-pigmented fruit. Gene expression was evaluated in fruit from respective genotypes at various stages of development ranging from small post-anthesis fruit to full-size marketable fruit. Biosynthetic gene transcript levels were significantly higher in anthocyanin pigmented tissue than in non-pigmented tissue with greatest differences observed for *Ans* transcript levels. *Myb* and *Myc* transcript levels were also higher in anthocyanin pigmented tissue in developing fruit with *Myc* levels exhibiting much greater fold increases in comparison to those observed for *Myb*. No differences were observed in expression of the *Wd* gene between anthocyanin pigmented and non-pigmented fruit. Differences observed in gene expression for eggplant versus related Solanaceous species will be discussed. The results are important for elucidating the genetic control of pigment biosynthesis and development of new plants with enhanced fruit quality and nutritive value.

(132) Examining the Role of Arabinogalactan-Proteins in *Agrobacterium*-mediated Transformation of Citrus

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A possible role of arabinogalactan proteins (AGPs) in control of shoot regeneration and cell transformability in stem explants of two *Citrus* cultivars, 'Carrizo' citrange (*Citrus sinensis* L. × *Poncirus trifoliata* L.) and 'Duncan' grapefruit (*Citrus paradisi*) was investigated. The regeneration potential (RP) of both 'Carrizo' citrange and 'Duncan' grapefruit was suppressed by the treatment of explants with the βGlcY reagent (a dye with high specificity for binding to AGPs). In the case of 'Carrizo', decreased RP of βGlcY-treated explants was the result of both lower number of shoots on the explants that had shoots and decreased percentage of explants with shoots. For 'Duncan', treatment with βGlcY reduced RP only by lowering the percentage of explants with shoots but it did not affect number of shoots on the explants with shoots. Treatment of *Citrus* explants with αManY reagent, which does not bind AGPs, did not affect their ability to regenerate shoots significantly. The amounts of AGPs measured in stems were comparable for both cultivars. Exposure of dark-grown seedlings for 7 days to white light resulted in a 50% increase in tissue concentration of AGPs. White light treatment of plants also resulted in higher RPs in explants obtained from those plants compared to etiolated explants. Cell transformability of white light-irradiated explants of both cultivars was higher when compared to etiolated explants. Our data suggest that AGPs play important role in processes controlling differentiation and genetic transformation of Citrus cells by *Agrobacterium*.

Specified Source(s) of Funding: Citrus Research and Development Foundation

(134) Construction of an Intron-hairpin RNAi Vector Using the Cp Cistron of Papaya Ringspot *Potyvirus*-P

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Since its discovery, RNA silencing and specifically strategies for dsRNA production has become an attractive molecular tool to confer specific plant resistance against *Potyvirus*, one of the largest and agriculturally most important genus of plant viruses. With this in mind, we report here the construction of an RNA silencing-trigger (dsRNA producer) vector commonly known as intron-hairpin RNAi (ihRNAi) using 217 bp of coat protein (*cp*) cistron amplified from PRSV-P infected papaya plants and cloned in pCR® 2.1-TOPO®. Our strategy consisted of construction (cloning) of sense and antisense versions of this *cp* fragment into restriction sites *Xho* I/*Kpn* I (for sense arm) and *Xba* I/*Cla* I (for antisense arm) included in pHANNIBAL plasmid. Correct ligation was confirmed by means of restriction analysis (with both aforementioned pair of enzymes), real-time PCR (using a LightCycler®1.5 thermal cycler and a Taqman probe labeled with 6-FAM and TAMRA as reporter and quencher dyes, respectively) and DNA sequencing (with BigDye® Terminator method and an ABI PRISM® 310 Genetic Analyzer, Sequencing Service at Institute of Neurobiology-UNAM, Juriquilla, Qro., México). Results indicated that this construction is available for subcloning into binary vectors

for plant transformation experiments. Fund FRABA-Colima University, agreement 771/11 and SEP

Specified Source(s) of Funding: Universidad de Colima-Secretaría de Educación Pública

(135) Cryopreservation of *Dendrobium* Hybrid Mature Seeds by Vitrification Using Cryoprotectant Additives

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Orchids represent one of the most important ornamental crops and sales have increased for the past 15 years. Cryopreservation is a biotechnology tool that plays an important role in international plant conservation programs and in preservation of the world's genetic resources. Vitrification has been the most common method used in orchid seed cryopreservation. The beneficial use of phloroglucinol and Supercool X-1000® has been reported to enhance the recovery of protocorms and shoots vitrified in cryopreservation protocols. The objectives of this study were to evaluate the effect of the PVS2 vitrification solution at different exposure times either alone or combined with phloroglucinol and Supercool X-1000® for cryopreservation and subsequent in vitro germination of the hybrid *Dendrobium* Dong Yai seeds. The experiment was divided into two phases. The first phase aimed at finding the best exposure time for PVS2 by exposing seeds to 30, 60, 120, 240, and 360 minutes. The second phase aimed at analyzing the effect of cryoprotectants solutions in enhancing seed survival and germination using the best PVS2 exposure time. About 2,000 mature seeds of *Dendrobium* Dong Yai were surface disinfected and placed in Petri dishes containing P-723® culture medium. Treatments consisted of the absence or presence of the vitrificant solution PVS2, with or without 1% phloroglucinol (w/v) and 1% Supercool X-1000® (w/v). Protocorm germination was evaluated under a stereoscope 4 weeks after treatments were initiated. Five treatments with five replicates were used in each experiment and the second experiment was repeated. Seed germination data was normalized using square root transformation and subjected to analysis of variance (ANOVA), with means compared using Tukey test ($\alpha = 0.05$). The use of PVS2 during 60 minutes resulted in germination percentage of 51%, while the addition of 1% phloroglucinol increased germination to 79.3%. Antioxidant properties of phloroglucinol may have contributed to seed survival by reducing oxidative stress in *Dendrobium* Dong Yai embryos during the PVS2 exposure. Therefore, the use of PVS2 during 60 minutes with 1% phloroglucinol is recommended for ultra low temperature seed conservation of this commercial hybrid orchid.

Specified Source(s) of Funding: CNPq - Brazil

(136) Cryopreservation of *Salix* sp. Dormant Winter Buds

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In cryopreservation, using dormant winter buds (DB) as source plant materials is economically advantageous over tissue culture options (TC). Processing DB does not require aseptic conditions and elaborate cryopreservation procedures. However, the DB approach is only feasible for cryopreserving a select number of temperate tree species. The objective of our study was to evaluate cryotolerance of 14 *Salix* germplasm accessions that represent seven different species in the USDA–ARS National Plant Germplasm System. One-year-old twigs harvested in December or January were cut into either 7- or 10-cm segments. A part of the twig segments was slow cooled to –35 °C and exposed to the vapor phase of liquid nitrogen (LNV) for at least 7 days and the other part was stored in –4 °C. After cryoexposure, LNV exposed and –4 °C twigs were warmed and direct-rooted in plastic containers (sterile peat moss, vermiculate, sand) in a cold greenhouse. Six weeks later, the material was evaluated for shoot and root development. Twig segments that developed a shoot were considered viable. For the 7-cm-long budwood segments, between 50% and 100% of the –4 °C and 0% to 100% of the LNV treated materials were viable. The 10-cm-long segments had viability that ranged from 68.5% to 100%. The higher survival of the 10-cm-long segments indicates that longer twig segments may be better suited for cryopreservation of *Salix* DB.

(137) Development of Comprehensive Medium for Micropropagation of Cultivated Cassava Accessions

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Cassava is one of the most important foods in the human diet in the tropics, where it ranks fifth as a source of energy, after rice, sugar cane and maize. Since it is a vegetative propagated crop, the use of in vitro propagation is very important to preserve germplasm free of pest and diseases. Micropropagation protocols published so far indicate large differences in shoot and root development for different accessions in response to a specific medium. The establishment of a culture medium efficient for a large number of genotypes remains one of the great challenges. The objective of this study was to evaluate the performance of different cassava genotypes under different culture media in order to establish a comprehensive protocol. Six contrasting cassava genotypes were cultured on 10 different media, with different combinations of hormone concentrations (IAA 0 and 1 mg/L; NAA 0, and 0.02 mg/L; BA 0.1, 0.01, and 0.05 mg/L; GA 0, 0.1, and 0.05 mg/L) and the addition of adenine sulfate (50 and 100 mg/L). For each genotype and medium, apical and axillary node explants from approximately 2-month-old in vitro cultures were placed in six magenta vessels; three vessels with apical nodes and three vessels with axillary nodes. The cultures were evaluated for different phenotypic characteristics after six week. The genotypes showed different performance with significant growth differences among the different media. The apical explants grew faster and produced more biomass in the roots and shoots than the axillary explants. The different behavior of genotypes can be attributed to their origin, different genetic structure (native and improved accessions), contrasting levels of hormones (NAA, BA, and GA), and absence or presence of adenine sulfate. Two different medium compositions appeared to produce similar numbers of roots and shoots in all six accessions used in that study. The suitability for other genotypes will be tested in future experiments.

(139) Adventitious Shoot Regeneration of Oriental Lily (*Lilium orientalis*) and Genetic Stability Evaluation Based on ISSR Marker Variation

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A regeneration system was developed for oriental lily (*Lilium orientalis*) based on leaf and bulb scales. Adventitious shoots were regenerated from leaves and bulbs of in vitro cultures using a MS medium containing thidiazuron (TDZ) or 6-benzylaminopurine (BA), and naphthaleneacetic acid (NAA). The highest percent regeneration from leaf explants was 74.2% grown in a medium containing 10.8 μM TDZ and 0.54 μM NAA. The highest mean number (4.4) of shoots generated from bulb scale explants was obtained using a medium containing 0.54 μM TDZ and 0.54 μM NAA. Adventitious shoots from both leaf and bulb sources were successfully rooted at rates ranging from 79.2% to 100%. The rooted plantlets survived after acclimatization in the greenhouse. Eighteen ISSR markers were employed to determine the genetic stability of the regenerated shoots in comparison to their mother plant. Eleven primers in total produced 70 clear and reproducible bands. Genetic similarity indicators among the clonal derivatives and the mother plant ranged from 0.92 to 1.0. Using this marker approach we were able to successfully group 15 micro-propagated progenies and the mother plant in a single major cluster with a similarity level of 92%. The somaclonal variation rate across the plantlets was estimated at 4.2%, indicating that direct shoot formation from explant regeneration is a safe method for multiplication of 'true-to-type' plants.

Thursday, August 2, 2012 Grand Ballroom

Plasticulture

(099) High Tunnel Strawberries: Potential New Crop for Small Acreage Growers in West Texas

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Adverse weather, particularly high winds and hail have prohibited strawberry production on the Texas High Plains. However, consumer interest in fresh, locally available produce, and the potential for higher grower profits have revived interest in growing them in the region. High tunnels have been utilized in other regions for season extension and climate modification, and increased production of highly sensitive crops like strawberries. Five strawberry varieties were evaluated under high tunnel culture versus the open field at the Texas AgriLife R&E Center in Lubbock, TX, for yield and quality as part of a three-state experiment with funding provided by NIFA—SCRI, SREP. Plugs of 'Strawberry Festival', 'Chandler', San Andreas, 'LCN' and 'Albion', plus bare root 'Albion' plants were transplanted during Oct. 2010. The beds, previously laid with drip tape and black plastic, were arranged in two staggered rows at 30 cm apart. Ripe berries were first harvested on 21 Feb. and 5 Apr. in high tunnels and open field plots, respectively, and harvests terminated in mid-June. Marketable yields in high tunnels were 7.5 times greater (avg. 332 g/plant) and significantly higher

($P < 0.0001$) compared to yields in the open field (avg. 44 g/plant). Highest yields were found with high tunnel-grown 'Strawberry Festival' which produced 520 g marketable fruit/plant, while lowest yields were observed with 'Chandler' and 'San Andreas' (both 11.0 g/plant) in the open field. 'Albion' plugs produced significantly more ($P < 0.0001$) yield than bare root plants in both the high tunnel and open field plots. Though more research is needed, especially regarding methods to reinforce structures against weather extremes, these results suggest a potential for strawberry production on the Texas High Plains using high tunnel culture.

(100) In Situ Changes to Soil Microbial Community Structure and Function Following Degradation of Potentially Biodegradable Mulch Films

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Mulch films that are biodegradable are desirable alternatives to black plastic polyethylene mulches in agriculture. Although degradation is generally initiated by abiotic factors such as UV radiation, wind, temperature, and moisture, biodegradation by soil microorganisms ultimately transforms biodegradable material into biomass, CO_2, and H_2O. Little is known about the soil microbial community involved in these transformations. This study determined soil microbial community structure using phospholipid fatty acid (PLFA) profiles and function via two enzyme activities involved in chitin and cellulose degradation as affected by different biodegradable mulches across contrasting climate and soil types during 1.5-year in situ incubation. Four replications of both high-tunnel (HT) and open-field (OF) sites were established in three eco-regions of the United States (Southeast TN; Northwest WA; and Northwest TX). Mulch treatments used at each site included: no mulch (NM) control; experimental spunbond polylactic acid (SB), BioAgri and BioTelo (starch-based films; BA and BT); and WeedGuardPlus (cellulose-based mulch; WG). Following the 2010 tomato harvest, used mulches were removed and 161-cm^2 nylon mesh bags, each containing 103 cm^2 of each mulch and ~400 g of resident soil were reburied into each mulch's corresponding plot. The mesh bags were extracted at 6- and 12-months following burial, and an 18-month sampling is underway. A distance-based MANOVA (perMANOVA) was run to determine the effect of SITE (HT vs. OF), TREATMENT (mulch films), and interaction at each region for the 6-month samples. There were significant main effects but no significant interaction. In general, total PLFA content was higher under HT compared to OF at each region. In WA and TN, HT had greater relative abundance (mol%) of fungi compared to OF, whereas in TX, the fungal mol% was greater in OF. The most consistent trend among mulches was that fungal mol% was greatest under WG. In TN, the average fungal mol% for WG was 10.4% compared to 8.9% for all other mulches. The fungal mol% of WG for TX and WA were similar (average 15%) and higher than all other mulches (average 11%). Trends among the bacterial markers were less consistent between regions; however, at all regions, the mol% of Actinomycete markers were lower and the fungal:bacteria ratio was highest under WG compared to all other mulches. There were no significant differences for enzyme activities due to mulch treatments. However, there was significantly greater chitin-degrading activity in HT compared to OF at each region. Twelve-month samples are now being processed.

(101) High Tunnels, Cultivars and Plant Types Influence Disease Incidence and Severity in Organically Managed Strawberries

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Consumers desire organically produced strawberries, but concerns about disease and pest management prevent many berry growers from adopting organic practices. One common strawberry disease is Botrytis gray mold, which reduces marketable yields and decreases the shelf life of harvested fruit. Strawberry plants are also susceptible to Verticillium wilt, which reduces yields by causing plant collapse. Plug plants of cultivars 'Albion', 'Strawberry Festival', 'LCN' and 'Chandler', and bare root plants of 'Albion' and 'San Andreas' were evaluated in high tunnel and open field locations in western Washington. The experiment was a split plot, with locations as main plots, and cultivars/plant types as subplots. The losses due to Botrytis in the tunnels were approximately 20% less than those in the open field (1.1% and 5.4%, respectively; $P = 0.0042$). The effect of cultivar/plant type on Botrytis incidence was highly significant ($P < 0.0001$): 'Strawberry Festival' and 'Chandler' had less Botrytis than 'Albion', 'San Andreas' and 'LCN'. Plants grown under high tunnels had numerically, but not significantly, greater Verticillium incidence and area under the disease progress curve (AUDPC) values compared with those grown in the open field.

'Albion', 'San Andreas' and 'Chandler' had lower Verticillium incidence and severity than 'LCN' and 'Strawberry Festival' ($P < 0.05$). Bare root 'Albion' plants had lower Verticillium AUDPC values than those grown from plugs ($P < 0.05$). Marketable yield was not influenced by production in high tunnels or the open field, but cultivar had a profound effect on yields. In high tunnels and in the open field, marketable yield of the dayneutral cultivars 'Albion' and 'San Andreas' was over three times that of the junebearing cultivars 'Chandler', 'LCN' and 'Strawberry Festival' ($P > 0.05$). This work confirms earlier results from this project, indicating that high tunnels can effectively reduce Botrytis, which is one of the major barriers to organic production. However, in the absence of crop rotation or other control measures, high tunnels may worsen Verticillium wilt. Cultivar choice is also critical to minimizing disease pressures, and to establishing productive plantings.

Specified Source(s) of Funding: USDA–SCRI

(102) Evaluation of Winter Production of Leafy Greens in High Tunnels: A Comparison of Results for Mild and Cold Winters

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Studies was conducted over 2010 to 2012 assess the productivity of different cool season leafy green crops under high tunnel culture at 4 locations across the central and eastern region of Oklahoma. The objective was to determine the feasibility of small scale commercial production during fall, winter and spring. The four locations were Ardmore, Lane, Oklahoma City and Tulsa. Each site used high tunnels covered by a single layer of clear polyethylene film. Nine different cool season greens were included: spinach, Swiss chard, romaine lettuce, collard, kale, mustard, spinach mustard (mild type mustard), turnip and broccoli raab (2010–11) or leaf lettuce (2011–12). Raised soil beds were utilized at three sites and planting was on-grade at the 4th location. Soils at all sites were prepared for planting by soil testing to determine the levels of nitrogen, potassium, and phosphorus and soil pH. Fertility levels were targeted at 120 lbs. of nitrogen and 150 lbs. per acre for each of phosphorus and potassium. Plots were direct seeded in late September and early October with hand push precision planters using rows spaced 4.5 inches apart and approximately 8 to 9 seeds/linear foot. In the 2011–12 trial lettuce was established using transplants. Crops that bolted were replanted in some cases. Treatments were randomized with either 3 or 4 replications per site. Harvest began late in October and continued through June. The winter of 2010–11 can be described as being colder than normal for the region (January and February) while the following winter was milder than normal. Comparisons will be made of performance of specific greens crops across the two seasons of trials. Trial results may be viewed in MP-164 "Vegetable Trial Report" at: http://www.hortla.okstate.edu/industry/vegetables/pdf/11vegreport.pdf

Specified Source(s) of Funding: Oklahoma Cooperative Extension Service Oklahoma Department of Agriculture Food and Forestry

(103) Temperature Moderating Effects of Low Tunnels Over Winter in Cool Climates

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The objective of our study was to determine the temperature moderating effects of low tunnels for the potential of overwintering hardy vegetable crops in New England. Six experimental sites were selected in New Hampshire, Massachusetts and Rhode Island, spanning USDA hardiness zones 4b through 7a. Low tunnels were constructed of 10 ft lengths of plastic PVC spaced 2.5 ft. apart. Each low tunnel was 3 ft. wide, 3.5 ft. high, and 40 ft. long. Orientation of the tunnels varied depending on the site, but shading was avoided. Temperature data were collected throughout the fall and winter months under three types of coverings: two layers of 1.25 oz./yd.^{2} spunbonded polyethylene rowcover (2XRC), one layer of rowcover covered with one layer of 2-mL perforated plastic (RC+perf), and one layer of rowcover covered with one layer of 6 mil IR greenhouse film (RC+GH). In each site, an uncovered control was included. Within each tunnel and adjacent to the tunnels, temperature was recorded every 2 hours. Each temperature logger was shielded from direct sunlight with a ventilated box or radiation shield. Similar patterns in temperature were observed in all six sites. At some sites, the outdoor logger and/or the low tunnels were covered with snow during some parts of the winter. Snow provided excellent insula-

tion, preventing daily temperature fluctuation almost entirely. The daily maximum and minimum temperatures reached inside the low tunnels were usually, but not always, higher than the temperatures measured outside the low tunnels. The RC+GH tunnel provided the greatest gain in temperature, followed by the RC+perf and 2XRC tunnels. For example, over the 2011–12 season in Durham NH, the daily minimum temperatures were, on average, 5.5 °F, 2.4 °F, and 2.7 °F warmer in RC+GH, RC+perf, and 2XRC tunnels, respectively, than outdoor temperatures. The daily maximum temperatures during the same period were, on average, 19.8 °F, 10.0 °F, and 5.8 °F warmer than outdoors, respectively. The degree of temperature protection offered by RC+GH low tunnels was negatively correlated with the daily minimum outdoor temperature ($r = -0.7693$); greater temperature gains occurred on coldest days. Our results demonstrated that low tunnels can raise the absolute minimum winter temperature by greater than 20 °F, offering the potential to effectively modify climate by four or more hardiness zones.

Specified Source(s) of Funding: Northeast SARE, NH Agricultural Experiment Station

Thursday, August 2, 2012 Grand Ballroom

Postharvest 4

(033) Samples of Intact Açaí (*Euterpe oleracea* Mart.) Fruit Belonging to Different Batches Affect Model Performance for Total Anthocyanin Content Prediction using Near-infrared Spectroscopy (NIR)

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Açaí (*Euterpe oleracea* Mart.) fruit has a dark-purple skin colour due to the presence of anthocyanins which have excellent functional properties, high antioxidant capacity. The standard methods to quantify anthocyanin are destructive, time consuming, generate chemical residues and sometimes require specialized procedures. Therefore non-invasive and/or nondestructive techniques have been used to determine quality parameter of fruits and vegetables e.g. the near infrared spectroscopy (NIRS). Although the apparent simplicity of NIRS the use of fruit samples from different batches is probably the most important factor that may affect model performance, as the fruit matrix may be subjected to within-tree, within-orchard, fruit age and seasonal variability. This study describes the model performance of total anthocyanin content prediction of intact açaí fruit (*E. oleracea* Mart.) using NIR diffuse reflectance spectroscopy based on different validation procedures. The models we have developed were obtained from açaí fruits samples collected during 2010–11 at 3 harvest periods and at 4 growing regions. The spectra were pretreated using standard normal variate (SNV), de-trend transformation and first derivative (Savitzky-Golay). Calibrations were developed using partial least squares (PLS) regression. Model performance was evaluated based on the values of root mean square error for prediction (RMSEP) and coefficient of determination (R^2) obtained from different validation fruit samples, as such: i) random cross validation method; ii) one-third of used spectra dataset; iii) external validation of an independent dataset; and iv) external validation of an independent dataset of fruits coming from Pará State. The model constructed using random cross validation method lead to a RMSEP of 0.46% with 5 latent variables (LVs). More robust model was obtained when one third of the spectra dataset was used (RMSEP 0.15%, R^2 0.96), but the LVs increased to 15. Independent dataset resulted in a less robust model (RMSEP 0.23%, R^2 0.90, 12 LV) compared to one third of the dataset. Course model performance was obtained when fruits from Pará State independent dataset was used as test matrix (RMSEP 0.77%) as the R^2 was not adjusted (0.04). The NIRS can be successfully used to predict anthocyanin in açaí fruits as a nondestructive method, however more dataset of fruits from different batches is necessary to reduce RMSEP and improve calibration model prediction accuracy and robustness.

Specified Source(s) of Funding: FAPESP proc. 2008/51408-1 and 2009/18602-1

(034) The Effects of Storage and Harvesting Method on Anthocyanin Content of Southern Highbush Blueberries (*Vaccinium corymbosum* L.)

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Secondary plant metabolites, like flavonoids, have been shown to have beneficial effects on human health. Anthocyanidins, a class of flavonoids, have been linked with decreasing cancer risks and improving cardiovascular health. Blueberries (*Vaccinium* spp.) are a rich source of multiple types of anthocyanins. Anthocyanin levels within blueberry fruit may be influenced by horticultural production practices as well as postharvest storage conditions. The objective of this study was to determine the effects of two different harvesting techniques and four different storage durations on six blueberry cultivars and advanced selections. Six genotypes (Sweetcrisp, Farthing, Meadowlark, Scintilla, Star, and FL 01-248) grown in Florida were either hand or machine harvested. After manual sorting, the fruit were stored at 0–1°C and 90–95% relative humidity. Two clamshells of fruit were removed every week for 3 weeks after harvest and analyzed either immediately or after 3 days at room temperature. The total anthocyanin measurements were made by identifying the concentrations of cyanidin, delphinidin, malvinidin, peonidin, and petunidin, the predominant anthocyanins found in blueberries. Anthocyanin measurement was performed using HPLC. Genotype and harvest method were the two most significant factors affecting anthocyanidin content. Genotypes FL 01-248 and Scintilla averaged 112 mg/100 g and 88 mg/100 g

fresh weight, respectively, over the duration of the study while cultivars Farthing and Star had concentrations of 65 mg/100 g and 60 mg/100 g fresh weight, respectively. Machine harvested fruit generally had 20% less total anthocyanins than the hand harvested fruit. The storage duration did not affect anthocyanidin content; however, time spent at room temperature did. Fruit left at room temperature for 3 days after removal from storage had about 10% higher levels of anthocyanins than fruit analyzed immediately after removal from storage. Hand harvesting may result in the selective harvest of fruit at the optimum stage of harvest while mechanical harvesting typically results in the non-selective removal of fruit at various stages of ripening. The variability in the stage of ripening may partly explain the differences in anthocyanidin content between the two methods of harvesting. Additionally, mechanical impact sustained during mechanical harvesting may reduce the amount of anthocyanins produced and enhance the production of other defense or repair-related compounds. Room temperature incubation following removal from low temperature storage may result in the induction of anthocyanin production leading to the higher content of these compounds. Together, data from this study indicate that harvesting method, genotype, and storage protocol can affect anthocyanidin content in blueberry.

(036) Site Specific Fertilization Affects Yield, Fruit Size, Quality, and Shelf-life of 'Kent' Mango

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Site specific fertilization (SSF) defines the type and rate of fertilizer needed for individual orchards. This study presents preliminary results (2010–11) of a medium term project to quantify the effects of SSF on yield, fruit size, quality, and shelf-life of 'Kent' mango. Two orchards are used for the study and are located in Acaponeta (irrigated) and San Blas (rain fed) counties, Nayarit, Mexico, respectively. Planting distance in both orchards is 10 × 10 m, about 100 trees/ha. At each orchard, three fertilization treatments were evaluated: 1) Normal rate, which considers the demand of the tree to produce 20 tons/ha; 2) High rate (normal rate + 50 %); 3) Control (no fertilization). The elements supplied in the fertilizer mixture were N, P, K, Ca, Mg, Fe, Mn, Zn, and B. They were applied in July and Sept. 2010. A factorial design with 20 tree-replications per treatment was used. At full bloom 20 panicles per tree were tagged. Fruit were harvested when they reached 1,800 thermal units (Base temperature = 10 °C). At harvest, yield (kg/tree), fruit size (length, diameter, weight, and caliber), and initial quality (external appearance, skin color, pulp firmness, pulp color, and total soluble solids content) were recorded. Another set of fruit was stored at market simulation conditions (22 ± 2 °C; 75 ± 10% RH) until reaching the consumption ripeness stage. Shelf-life was evaluated periodically and quality was assessed again at consumption time. Significant differences were found for fertilizer treatments, especially for yield and fruit size. The normal dose resulted in bigger fruit when compared to high and control treatments. For initial quality, significant differences were detected for pulp firmness and total soluble solids content, while at consumption differences were detected for pulp color and total soluble solids content, all of them in favor of the normal dose. Fertilization treatments did not affect shelf-life.

Specified Source(s) of Funding: INIFAP, CONACYT–FORDECYT, GOBIERNO DEL ESTADO DE NAYARIT–SEDER

(037) Reflectance Spectroscopy to Determine Dry Matter Content in 'Hass' Avocado Fruit

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Avocado fruit maturity is usually assessed by measuring its pulp dry matter (DM) content, a destructive and time-consuming process that could only be performed on harvested fruit. An alternate non-destructive method that could be used in situ to determine avocado DM content would therefore be beneficial to producers and other stakeholders. The objective of this investigation was to assess the potential of reflectance spectroscopy to determine DM content in 'Hass' avocado fruit. In a first experiment, fruit from three avocado lots from the same orchard were analyzed weekly in Nayarit, Mexico. Individual intact fruit were used for spectra data acquisition by two methods: a) without changing the fruit between sampling; and b) changing the fruit. Ten spectra were obtained for each fruit in the dorsal or ventral position in the top, middle, and bottom part using an Ocean Optics USB 4000 spectrometer in the 345–1047 nm spectral region. The DM content of each fruit was also determined using the microwave method. Spectra and DM were correlated. In the second experiment, 10 trees were selected from an orchard located in Tepic county, Nayarit. Thirty fruit per tree were tagged when they were 2–3 cm in length. Harvests were performed from 5 July to 15 Sept. 2011. At harvest, 20 fruit were analyzed with the same spectrometer as in the first experiment. Five readings were taken in the dorsal-middle part of each fruit. Also, DM content was considered and data were correlated. For the first experiment, significant differences were detected for getting

the spectra without changing the fruit or changing the fruit, being the first one better. In addition, significant differences were detected for dry matter content among harvest dates, sides and positions of fruit. Furthermore, a significant ($P < 0.0001$) but negative correlation ($R^2 = –0.469$) was detected between reflectance and dry matter content. For the second experiment, reflectance at 820 nm was weakly correlated with DM. Results suggest that it is not possible to predict avocado maturity using reflectance spectroscopy in the spectral window used in these experiments. Reflectance spectroscopy measurements further in the near-infrared (1000–2500 nm) will be investigated to assess avocado maturity.

Specified Source(s) of Funding: INIFAP–IICA PROCINORTE

(038) Shelf Life and Composition of Organically Grown North Carolina Blackberries

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The composition and storage life of blackberries produced organically in North Carolina was determined for shiny (SB) and dull black (DB) ripeness stages. Subjective ratings, soluble solid content (SSC), titratable acidity (TA), total anthocyanin and phenolic contents, and antioxidant activity (FRAP) were determined in 'Natchez', 'Ouachita', and 'Navaho' blackberries held for 0 or 15 days at 1 °C and compared to fruit held for 13 days at 1 °C followed by 2 days at 20 °C. Weight loss was higher when berries were held at 20 °C for the last two days of storage. 'Navaho' had less leaky berries than 'Ouachita' or 'Natchez' at both storage temperatures. Decay incidence and softness were higher in 'Natchez' than in 'Navaho' and overall rating was highest for 'Navaho' blackberries. Lower leakage, decay incidence, and softness and higher overall rating were observed in SB than in DB fruit held at both storage temperatures. Storage condition, ripeness stage, and cultivar affected the composition of organic blackberries. SSC and TA were lower when berries were held at 20 °C for the last two days of storage compared to those held constantly at 1 °C. The TA was higher in SB fresh or stored berries compared to DB berries. SSC, TA, and SSC to TA ratio were not different among cultivars before storage. However, SSC and TA were highest, and SSC to TA ratio was lowest, in 'Navaho' blackberry after storage. Total anthocyanin and phenolic contents and antioxidant activity of all berries were highest before storage. Neither ripeness stage or storage temperature greatly affected total anthocyanin, total phenolic content, or FRAP values. In this study, 'Natchez' had highest amounts of total phenolics and anthocyanin and 'Ouachita' lowest amounts (2609 vs. 2197 mg gallic acid equivalents/kg and 1284 vs. 944 mg cyanidin-3-glucoside equivalents/kg, respectively). The results suggest that organically grown 'Natchez', 'Ouachita', and 'Navaho' blackberries had excellent storage life and retained antioxidants when they were at the SB ripeness stage or stored constantly at low temperature.

(039) Effect of Gamma Irradiation on Different Enzymatic Activities in Spongy Tissue Development of Mango Fruit 'Ataulfo'

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The hot water treatment (46.1 °C for 75–110 min.) is a mandatory process to export mango fruit from Mexico to the United States and others countries in order to prevent the spread of Mexican fruit fly (*Anastrepha ludens*), but this process affects the fruit sensory quality. Radiation with gamma rays into 0.15 to 1.0 kGy range is a safety alternative to this treatment which is approved by FDA and APHIS offices. Previous data indicated that mango cv 'Ataulfo' irradiated at doses ≥ 0.84 kGy developed spongy tissue and internal color changes but its origin is unknown. The aim of this work was to determine changes in the microstructure, weight loss (WL), total soluble solids (TSS), total starch (TS), total sugars (TSU), and α and β activity-amylase, phenylalanine ammonia lyase (PAL) and polyphenol oxidase (PPO) in mango cv. 'Ataulfo' from Oaxaca, Mexico, in maturity ¾ stage irradiated at 0, 0.6, and 1.0 kGy, stored for 19 days at 10 °C, 20 °C, and transferred from 10 °C to 20 °C. Spongy tissue development was observed at ≥ 0.6 kGy dose, indicating higher susceptibility respect of previous reports. At 10 °C, the variables values were statistically lower than 20 °C except α and β activity-amylases. At 1 kGy and 10 °C, the TSS and TSU values were lower (9.2 °Brix and 8.43 mg/100 g) in fruits with spongy tissue respect to control fruit (13.2 °Brix and 22.08 mg/100 g, respectively); the β-amylase activity was higher for the same temperature and irradiation dose (12.53 mg maltose/mg protein min) than control fruits (10.57 mg maltose/mg protein min). TS content gradually decreased (10% to 1.6%) while TSU increased over the time. Fruits at 20 °C and 1.0 kGy, showed maximum α and β-amylase activities and spongy tissue development in comparison to control fruit (36.89 and 20.60 mg maltose/mg protein min, respectively). The activities of PPO and PAL did not explain the color changes. The behavior of amylases activities did not explain completely the spongy tissue development and although there were micro

structural changes in the tissue there was not a clear relationship with the dose applied.

Specified Source(s) of Funding: National Mango Board

Thursday, August 2, 2012 Grand Ballroom

Root Growth and Rhizosphere Dynamics

(185) Root Morphology of *Vaccinium* spp. in Response to Iron Concentration

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Vaccinium corymbosum L. is the major contributor to the southern highbush blueberry gene pool. Anecdotal evidence describes this species' root system as thin, fibrous roots oriented parallel to the soil surface. In contrast, *Vaccinium arboreum* Marsh. is a wild *Vaccinium* species native to the Southeastern United States that has not been extensively utilized for blueberry breeding but has been reported to have deeper and thicker roots than *V. corymbosum*. Here we describe the root morphology and architecture of *V. arboreum* (*VA*), *V. corymbosum* (*VC*), and an interspecific hybrid between the two species (*F1*) grown in a hydroponic system with high (90 μM) or low (10 μM) iron concentrations. Two-year-old clonal plants rooted from softwood cuttings were grown in a hydroponic system for 110 days before they were destructively harvested. Roots were scanned and analyzed with WinRhizo Pro 2008a. Average root diameter, total root volume, total root length and specific root length were measured. Root length was classified into different categories according to root diameter, and length in each category was expressed as percent of total root length. *VC* had significantly greater total root length and volume than *VA*. Although the *F1* had significantly higher total root length than either parent, root volume was intermediate between the two. Average root diameter was similar between *VC* and *VA,* while the *F1* exhibited significantly smaller root diameter. Fine roots (diameter ≤ 0.3 mm) accounted for a significantly higher percentage of root length in *VA* than *VC*, while root diameters > 0.4 mm were more abundant in *VC* than in *VA*. Root diameters in the *F1* generally resembled those of *VA*. Iron deficiency significantly increased the abundance of very fine roots (diameter ≤ 0.1 mm) but not other root diameters. When grown in high iron concentration, the three genotypes had no significant differences in specific root length. However, when grown in low iron concentration, the *F1* exhibited significantly higher specific root length than either parent. Using specific root length as a diagnostic of the morphological response to low iron concentrations, we found that both parents responded by increasing nutrient uptake efficiency (intensive adaptation) while the *F1* responded by increasing fine root biomass (extensive adaptation). These findings show that *VC*, *VA* and *F1* plants of similar age have considerable differences in root morphology and that these differences are the product of genetic and environmental factors.

Specified Source(s) of Funding: USDA–NIFA Specialty Crop Research Initiative Award Number 2009-51181-06021

(186) Effect of Pervious Pavement on Soil CO_2 Efflux and Root Growth

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There are numerous benefits to preserving existing mature trees in urbanizing areas, such as larger amounts of shade, greater transpirational cooling and greater air pollution removal. However, covering root zones of mature trees with gas and water impervious materials often leads to rapid death of mature trees in urbanizing areas as result of anoxia and drought stress. Pervious pavements may improve gas and water exchange with the underlying soil and thus provide a more favorable environment for root growth. We studied the potential use of pervious concrete as a way to preserve mature trees after development. We monitored soil CO_2 efflux, root production and death, and tree diameter growth over a 2-year period in plots with 20-year old *Liquidambar styraciflua* that were exposed to three soil covering treatments: 1) no pavement (control); 2) impervious concrete and; 3) pervious concrete. We found higher soil CO_2 concentrations and soil CO_2 fluxes in both concrete treatments when compared to the control. Soil O_2 concentration was lower in the impervious plots compared to the control and pervious plots at high soil water contents, but never was lower than 15%. There was a strong negative effect of both concrete pavements on standing root length, but no difference between pervious and impervious pavement. Both concrete pavements reduced root lifespan compared to the control. Overall tree diameter growth was not significantly affected by any of the pavement treatments. We conclude that in our system, where pervious concrete was used on a heavy clay subsoil with low permeability, there was no measurable tree growth or root production benefit of using pervious concrete over impervious concrete.

Thursday, August 2, 2012 Grand Ballroom

Vegetable Crops Management 3

(313) A Transdisciplinary Approach to Developing an Eastern Broccoli Industry

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Current economic, social and scientific situations have made it attractive to establish a substantial and profitable broccoli industry in the eastern US, where several obstacles have prevented that from happening previously. Because many barriers must be overcome simultaneously, we assembled a transdisiplinary team of public and private sector participants in to ensure a well-coordinated effort. The project began with SCRI funding in Summer 2010. The scientific breakthrough that made the effort possible was the development of broccoli breeding lines that continue to make uniform buds despite temperatures that normally arrest that process. The first component of the project is to move that trait into varieties sold by seed companies. In concert with Bejo Seed USA, Seminis Vegetable Seed, Syngenta Seeds and Johnny's Selected Seeds, new crosses are being made to achieve this goal. Second, regional trials have been established across the east coast to assess wide and specific adaptation of new materials, discover genetic and environmental bases for improved nutritional quality, guide further breeding efforts, and select the best materials for release. Third, the seed companies will identify new varieties for release and develop procedures for seed production and marketing. Fourth, we are building and strengthening grower networks that can market sufficient product for year-round supply regionally, using cost-of-production benchmarking for profitability, the most competitive production and post-harvest practices, and GAPs compliance for food-safety. Finally, we are working with distributors and retailers to build acceptance of the new product source. The integration involves feedback to the breeders from the regional trials and from eastern buyers' and consumers' acceptance of any variation from the western norms; to extension on crop budgets and optimal post-harvest technologies; and to distributors and extension on optimal regional distribution channels. The whole project is designed so that each commercial participant sees improved profit, has access to raw materials and has a strong market for their product. That must be true for each step in the chain from the seed companies to the growers, distributors and retailers. Society will benefit from reduced fuel use for transportation, a stronger rural economy in distressed areas, and a stronger regional food system.

(316) A Comparative Evaluation of EM on Soil Quality and Fresh Yield of *Brassica oleracea* var. *acephala* Grown on Orangeburg Loamy Sand Soil

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Effective Microorganisms (EM) is a microbial inoculant designed to improve soil condition and to increase production while reducing the use of chemicals and other synthetic compounds. A field study was conducted to comparatively examine the effects of EM and traditional nutrient sources on fresh leaf yield of collard greens (*Brassica oleracea* var. *acephala*) and postharvest soil chemistry. The study, a 4 × 4 RCBD was conducted on the Research and Extension Center Farm of Florida A&M University, Quincy, FL, during Fall 2011. The treatments were 202 kg/ha of N as ammonium-nitrate fertilizer, mushroom compost, EM at 0.1% per hectare, and control. Seedlings were planted on raised beds covered with black plastic, and drip irrigated. The crops were harvested approximately 12 weeks after planting. Data collected includes plant height, plant weight, leaf length, leaf width, root length, and root weight. The fresh yield in kilograms per hectare was derived using aboveground plant weight. Approximately 2 weeks after harvesting, soil cores were removed at 0–15.24 cm and 15.24–30.5 cm and were processed and subjected to physical and chemical analyses. All data were statistically analyzed using SAS 9.3. Results showed fresh leaf yield was significantly higher in plots treated with ammonium-nitrate fertilizer and mushroom compost than those treated with EM and control. Preliminary analysis of soil chemistry showed no significant differences among the treatments in concentrations of P, NO_3, TKN; pH, OM, and CEC. This study will be continued to establish more accurate information.

(317) High Tunnels in Maine: Production Practices and Challenges

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In 2011 and 2012, three interviews or visits were conducted with 31 Maine high tunnel owners to identify common practices, benefits, and challenges. Basic data was collected on 52 tunnels and detailed data was collected on 31 tunnels. Soil samples were collected in mid-summer and analyzed for nutrients using

standard soil test methods, saturated media extract, and other measures of soil quality. Twenty-four tunnels were a year or less old at the start of the project. Eight farms were certified organic, 23 were not. Forty-five houses were gothic-style, reflecting the design needed for a 4-season house in Maine's winter. Seven houses were Quonset-style and some were managed as 3-season structures. Most tunnels were oriented E–W (59%); 37% were oriented N–S; 4% were NE–SW (n = 51). Tunnels were most often 17 ft (19%) or 30 ft (29%) wide and 48 ft (21%) or 96 ft (33%) long (n = 52). At construction time, 11 farmers made specific efforts to improve drainage. An additional 5 reported drainage problems with a new tunnel. The primary crop grown was tomatoes (81%), followed by greens (56%), cucumbers (47%), and peppers (44%) (n = 31). Compost and/or manure was used prior to planting in 94% of the tunnels; 32% received additional nutrients as sidedress or fertigation (n = 31). Elevated organic matter (>8%) and salt levels (> 2mmohs/com) were found in 54% and 30% of tunnels respectively. In addition, soil test results showed pH below the recommended minimum of 6.5 in 70% of tunnels (n = 37). Primary irrigation methods were drip (61%), overhead (17%), or hand watering (12%) (n = 41). Twenty-six percent of tunnels had no mulch within crop rows and 29% had no mulch between crop rows (n = 42). Farmers reported that growing in high tunnels allowed early and late crop production and higher crop quality. This led to some farmers relaxing their early-season planting schedules or shifting production of certain crops (such as tomatoes) entirely to high tunnels. Differences in labor requirements and pest pressure were also reported.

Specified Source(s) of Funding: NRCS Agreement Number 69-1218-0-28

(318) Effect of Grafting on Root Permeability of Dutch and Japanese Tomato Cultivars

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In our previous report [Kakita et al. Supplement to HortScience 46(9):S327, 2011], we found that the root permeability was changed when Japanese cultivar 'Reiyo' (R) was grafted on 'Receive' (r), but not Dutch cultivar 'Dundee' was grafted on 'Maxifort' (m). In this study, we investigate the physiological differences when plants were grafted on different Dutch and Japanese tomato cultivars. We used Dutch tomato 'Starbuck' (S) and (R) as scions, and (m) and (r) as rootstocks. Grafted plants were obtained each combination (i.e., S/m, R/r, S/r and R/m) and grew hydroponically until flowers on first-truss bloomed. We measured the fresh weight of the aerial parts, the surface area of roots, the root permeability and the water potential of exudates. The fresh weight of the aerial parts and the surface area of roots for S/m were the highest among 4 combinations. The root permeability and the water potential of exudates had no significant difference. We found that root growth was influenced by a scion, but the root permeability was not. These results indicate that the root permeability of rootstock was not influenced by scion, but the root area was. Because the total amount of absorbed solute might be different, the fresh weight of the aerial parts was different at S/m and the other grafted plants.

(320) Do Tunnels Enhance Earliness and Quality in Muskmelons for Local Market?

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Plasticulture techniques allow growers to enhance the growing environment and expand the selection of crops market growers are able to produce. Muskmelon (*Cucumis melo* L. var. *reticulates*) has the potential of being a specialty, high-value crop for New England market growers, as new hybrid varieties and tunnel production ease local climate constraints of unpredictable weather and inconsistent summer temperatures. This study evaluated six cultivars of muskmelon (grown in organic production) for yield, quality and earliness in three production systems: high tunnels, low tunnels and conventional production. The six cultivars tested were: Athena, Lil Loupe, Sivan, Sarah's Choice, Sweet Granite, and Tasty Bites. The gothic-design high tunnels measure 7 m × 24 m and have a unique feature in having ridge vents along with side vents. To investigate location effect in the high tunnels, each cultivar occupied a center and edge plot. Low tunnels measured 20 m long and were made of perforated clear, 1.1-mil plastic stretched over wire hoops. The low tunnels remained in place for 3 weeks. Conventional production (control) consisted of protecting the crop with lightweight, spunbonded rowcover until flowering. Data was collected on days-to-harvest, marketable and cull yields, fruit quality (°Brix), and insect and disease damage. Total yields differed significantly between cultivars, but not between treatments. Location within the high tunnel significantly affected yield in some cultivars. For all cultivars, °Brix levels were highest in the low tunnel treatment and lowest in the high tunnel treatment. Earliness was highest in the high tunnel treatment. Pollinator effectiveness in the high tunnels was also tested. Both honey bees (*Apis mellifera*) and bumblebees (*Bombus impatiens*) were used to test for differences in yield and quality. Two commercial honey bee hives (one inside an open tunnel and the other outside by the fields) and one purchased bumblebee colony (inside a screened high tunnel) were used. There were no differences in fruit number or size among the three tunnels, suggesting that all three methods of supplying pollinators were equally effective. If these results are consistent in future years, growers may be able to save significant amounts of money by using honeybee hives rather than purchasing bumblebee colonies to place inside individual tunnels.

Specified Source(s) of Funding: Rhode Island Agricultural Experiment Station

(321) Light-emitting Diodes for Miniature Hydroponic Lettuce

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There is growing concern about food safety, environmental impact, and efficient energy usage in agricultural production systems. Producing lettuce under artificial lighting can be a solution addressing these concerns. Light-emitting diodes (LEDs) offer the advantage of a narrow light spectrum, low power consumption, and little heat production. The objective of this study was to determine the effects of different light sources on the growth of miniature 'Tom Thumb' butterhead lettuce in a noncirculating hydroponic system. Lettuce seedlings were started in Oasis cubes, which were transferred to net pots in 1.9-L containers containing a hydroponic nutrient solution. The solution was Hydro-Gardens' Chem-Grow Lettuce Formula 8–15–36 hydroponic fertilizer with added calcium nitrate (15.5%–0–0) and magnesium sulfate (9.8% Mg). The lettuce was grown in a lab under different light treatments—blue LEDs, red LEDs, and high output fluorescent lights. The light level was 58.9 μmoles/m^2/s with an air temperature 21.9°C. At the end of the study, the pH of the nutrient solution of the blue LED and the fluorescent light treatments were greater than the red LED treatment. Electrical conductivity of the nutrient solution of the fluorescent light treatment was greater than the blue LED treatment and the red LED treatment. Fluorescent lights resulted in greater root dry weight than blue LEDs and red LEDs. Total plant dry weight under fluorescent lights was greater than under red LEDs. There were no significant differences in shoot dry weight and plant height among the treatments. Percent partitioning of dry weight to shoots was greatest with red LEDs, followed by blue LEDS, and fluorescent lights. Percent partitioning of dry weight to roots was greatest with fluorescent lights, followed by blue LEDS, and red LEDs. Leaf chlorophyll content was greater under blue LEDs and fluorescent lights than red LEDs. In conclusion, LEDs can provide an alternative lighting source for miniature lettuce.

Specified Source(s) of Funding: Hatch

(322) Novel Methods to Highlight Relative Differences between Cultivars in a Variety Trial: An Example Using High Tunnel Tomatoes

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Throughout cool regions of the United States, tomatoes are an important commercial crop grown in high tunnels. This work evaluated 11 indeterminate beefsteak tomato cultivars for growth and performance in 2011 in Durham, NH. Using a randomized complete-block design with four replicates, tomatoes were transplanted into black plastic mulch and trained to a single leader, following standard commercial fertilization and irrigation recommendations. Fruit quality, weight, number, and physiological disorders, were recorded at each harvest date, and qualitative observations such as growth habit were noted. Two informal blind taste tests were conducted to provide qualitative assessments of flavor and visual characteristics. Significant differences were observed by variety ($P < 0.0001$) for yield per plant, days to maturity, total number of fruit produced, fruit size, and percentage of marketable fruit. 'Geronimo', 'Big Beef', and 'Arbason' were the highest producers of marketable fruit (mean lbs per plant: 25, 23, 21) while 'Jet Star', 'Big Beef', and 'Geronimo' had the highest percentage of marketable fruit per plant (mean: 90%, 87%, 87%). The cultivars earliest to mature were 'Conestoga', 'Brandywine', and 'Massada' (mean: 64, 66, 67 days) while 'Cobra' was the latest (mean: 74 days). Taste tests suggested consistent appeal for 'Brandywine', 'Jet Star', and 'Big Beef', while 'Geronimo' was consistently ranked unfavorably. These results, along with qualitative observations, suggest a high degree of tradeoff in commercially available cultivars, making universal recommendations difficult. Growers are adept at making multi-factor production decisions and agronomic research can be made both informative and open-ended to support their aptitude for complex reasoning. To this end, results have been reported using different approaches including "word clouds" and radar plots in an effort to capture the range of phenotypic variation between cultivars so individualized decisions can be made by the end users. Typically, variety trial results are presented as photographs, tables, and anecdotal information. We present the results of our high tunnel tomato cultivar trial using novel graphical formats that permit communication of the relative strengths and weaknesses of cultivars to agricultural producers.

Specified Source(s) of Funding: USDA–Hatch, New Hampshire Agricultural Experiment Station

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