

Oral Session Abstracts

106th Annual International Conference of the American Society for Horticultural Science

Millennium Hotel, St. Louis, Missouri

ORALS—Saturday

Presenting authors are denoted by an asterisk (*)

Oral Session 1: **Jefferson D/E**
Horticultural Crops Culture and Management:
Viticulture and Small Fruits 1
Saturday, 25 July 2009, 2:00–3:30 pm

Moderator: Carl Sams, carlsams@utk.edu

2:00–2:15 pm

Comparison of Growing Degree Unit Models for Primocane-fruiting Blackberry

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Four growing degree unit (GDU) models have been developed to predict bloom dates of florican-fruiting blackberries. These models, one multi-linear and three asymmetrical curvilinear, were compared to number of days to bloom and node formation for primocane-fruiting blackberries in combination with harvest season manipulation treatments. Two experiments were conducted to compare these models. One compared predictions in the context of three cane-mowing treatments. Treatments were mowing canes to the ground 1×, 2×, and 3× during the growing season. The other experiment compared genotypes Prime-Jan®, Prime-Jim®, and APF-46 under one cane-mowing treatment. Both experiments were replicated under hightunnels and ambient conditions. Nodes were counted weekly and bloom dates were recorded in both experiments. GDU were calculated for each model based on half-hourly temperature data under hightunnels and ambient conditions. Results indicate that node formation is consistent with the response models proposed. However, the linear model had the lowest coefficient of variation (proportion of variance to mean) for units required to flower. Total GDU at bloom and total node formation were affected by cane treatment and by genotype. For any given cane treatment, using simply the number of days was accurate to within 1 week.

Specified Source(s) of Funding: University of Arkansas Research Incentive Grant SARE

2:15–2:30 pm

Field Performance and Propagation of *Vaccinium elliotii* Selections

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A ¼ acre field plot was established at the North Willamette Research and Extension Center (NWREC) in late 2005 to evaluate three *Vaccinium elliotii* blueberry rootstock selections (NC284-5, NC823-2, and NC824-8) from the NC state blueberry breeding program. The evaluation criteria included plant vigor, sucker production, and stem diameter. In 2006 and 2007, the stem diameters of these three rootstock selections were not different. In 2006, NC284-5 exhibited longer shoot length compared to NC823-2, while NC824-8 had the shortest shoot length. NC824-8 had the most suckers produced after two growing seasons. In 2007, NC284-5 continued performing well in terms of number of suckers and new growth. NC284-5 also was the tallest plant with the fewest suckers produced in both years. NC284-5 appears to be the best selection to be a potential rootstock for blueberries with excellent vigor and low sucker production. Grafting of three blueberry cultivars ('Duke', 'Bluecrop', and 'Elliott') onto these rootstocks in 2008 indicate 'Elliott' appeared to be less compatible than 'Duke' and 'Bluecrop'. Propagation experiment found that all three rootstock selections are relatively easy to propagate for commercial production with over 90% rooting by both softwood and hardwood cuttings.

Specified Source(s) of Funding: Northwest Center for Small Frutis Research

2:30–2:45 pm

Use of Pine Bark in Soil Management of Southern Highbush Blueberries (*Vaccinium corymbosum* L.)

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Southern highbush blueberry plants (*Vaccinium corymbosum* hybrid) require acidic soils that are well-drained and have high organic matter content. Very few soils in Florida are suited for blueberry production without significant modification. As a result, blueberries are commonly planted on pine bark beds that are 15 to 18 cm deep and approximately 1 m wide and are situated on top of deep, well-drained, sandy soils. SHB blueberries are vigorous and productive on pine bark beds but typically require more water and fertilizer than when they are grown directly in soil partly because blueberry roots in pine bark beds are confined to the pine bark layer and do not typically grow into the underlying soil. Pine bark bed production systems may use up to 1,000 to 1,200 m³/ha of pine bark for establishment which represents a significant portion of the overall planting costs. A study was conducted at the University of Florida Plant Science Research and Education Unit, Citra, FL to examine methods of pine bark application with the goal of reducing pine bark inputs without reducing plant growth and fruit yield. Treatments consisted of 1) Non-amended soil; 2) 8 cm of pine bark incorporated into the top 15 cm of soil; 3) 8 cm of pine bark incorporated plus 8 cm of pine bark mulch; and 4)

15 cm deep pine bark beds on top of the soil. Canopy volumes were smaller and berry yields were less for plants grown in non-amended soils than for plants in any of the pine bark treatments. However, few differences were observed among the pine bark treatments for canopy size, berry yield, or mean berry size. Our preliminary results suggests that alternatives to pine bark bed production such as soil incorporation of pine bark may result in reduced organic matter inputs without reducing plant growth or yield.

2:45–3:00 pm

Mummy Berry Fruit Rot and Shoot Blight Incidence in Blueberry: What Length of Evaluation Is Needed for Reliable Disease Assessment?

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Mummy berry is an important disease of cultivated blueberry. The disease has two distinct phases; a blighting phase initiated by ascospores and a fruit infection stage initiated by conidia. In this study we investigated blueberry cultivar resistance to both phases of the disease and, utilizing ‘standards’ of known susceptibility over many years, and examined factors affecting disease incidence in controlled inoculations. The analysis of our data, including a variance decomposition, showed that a minimum of six years, and possibly eight or nine years of testing was necessary to obtain reliable rankings of cultivar susceptibility for either phase of the disease. This is largely due to uncertainty arising from the large environment × genotype interaction. For individual cultivars, temperature and the amount and frequency of precipitation in January–March were predictive of later disease incidence, though specific predictive factors and their coefficients differed among cultivars. We grouped cultivars that shared similar environmental responses in an effort to increase the predictability of disease response among cultivars.

Specified Source(s) of Funding: USDA–ARS

3:00–3:15 pm

Off-season Greenhouse Strawberry Production

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Strawberry production in the mid-South is mostly done in the field with harvest from April to June. There is year-round demand for fruit with the highest prices from November through February. Our research is ongoing to evaluate off-season strawberry production in polyethylene-covered greenhouses. Runner tips from ‘Camarosa’, ‘Carmine’,

‘Ventana’, ‘Albion’ and ‘Strawberry Festival’ were established as plug plants 1, 15, or 31 of July 2007. In mid September, the plug plants were transferred to 15.2 cm × 11.4 cm round pots containing 50% Promix and 50% perlite. An experiment was established with eight replications of five cultivars, three plug dates and six plants per experimental unit in a randomized block design. The plants were fertigated with timing controlled by a solar collector/controller (Davis Engineering, Los Angeles, CA). Bumblebees were used to pollinate the flowers. Yields of the five cultivars were relatively low for the fall (before 1 January) because of cultural factors, but those propagated on 1 July had approximately 4% and 75% more fruit than those propagated 15 July or 31 July, respectively. ‘Carmine’ produced high quality fruit and yielded the most fruit during November and December. ‘Ventana’ yielded the most fruit for the entire harvest period (600 g/plant) and had very good quality. However, this cultivar had relatively low fall yields unless propagated by 1 July. ‘Carmine’ and ‘Camarosa’ yielded about 20% and 10%, respectively, of their fruit in the fall but produced similar amounts (520 and 535 g/plant, respectively) for the entire harvest period. ‘Albion’ and ‘Strawberry Festival’ were relatively productive in the fall; producing 18% to 21% of their total yield, but were less productive than other cultivars after 1 January. The twospotted spider mite was initially the most difficult pest to control, but high populations of *Phytoseiulus persimilis* provided adequate control. Minor outbreaks of whiteflies were controlled with *Encarsia formosa*. *Amblyseius cucumeris* reduced a high thrip population in January but did not adequately control the pest.

3:15–3:30 pm

Severity of Sanding or Pruning Impacts Yield and Microclimate of Cranberry Vines

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Sanding and pruning are two practices used in the cranberry (*Vaccinium macrocarpon* Ait.) industry for vine management and yield stimulation. This study compared the effects of varying levels of sanding and pruning in April 2006 on vine canopy characteristics and yield over the course of two growing seasons. Each practice was applied at four levels: sanding application directly onto the vines at four depths: control (0 cm), light (1.5 cm), moderate (3.0 cm), or heavy (4.5 cm); pruning at four severities with a commercial pruner: control (not pruned), light (1 pass with pruner), moderate (2 passes), and heavy (3 passes). Pruning levels had no effect on upright density over the two seasons, but the heavy sanding treatment decreased the number of uprights per unit area significantly. A linear increase in light penetration to soil level was observed for the first season only as severity increased for both pruning and sanding. Number of fruiting uprights relative to total uprights decreased in the first year as severity increased for both practices. This effect continued in the second year for sanding treatments. Yield and net returns averaged over the 2 years were greatest in lightly pruned plots, followed by lightly sanded plots. Moderate and heavy treatments were associated with lower yields and net returns than those for the controls.

Specified Source(s) of Funding: NE SARE

Oral Session 2: **Laclede**
Crop Physiology/Physiology: Postharvest 1
Saturday, 25 July 2009, 2:00–4:00 pm

Moderator: Preeti Sood, preeti.sood@ufl.edu

2:00–2:15 pm

Biosynthesis of Branched-chain Esters in Ripening Apple Fruit: Implications of ^{13}C - Labeled Acetate Incorporation In Vivo

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We studied the incorporation of 20 mM ^{13}C - labeled acetate ($1\text{-}^{13}\text{C}$, $2\text{-}^{13}\text{C}$, $^{13}\text{C}_2$) into esters and ester precursors synthesized by peel discs of 'Jonagold' and 'Red Delicious' apple [*(Malus sylvestris* (L.) Mill. var. *domestica* (Borkh.) Mansf.) fruit. The incorporation of ^{13}C into headspace volatiles was analyzed by gas chromatography coupled with mass spectrometry (GC/MS). Following analysis of volatiles, apple discs were freeze dried and derivatized acids were also quantified using GC/MS. Labeled acetate was incorporated into isoleucine and esters containing 2-methylbutanoate, a degradation product of isoleucine. In addition, significant label was detected in propanoate esters, with a minor degree of incorporation of isotope in butanoate and pentanoate esters. Importantly, the acids citramalic acid and citraconic acid were also extensively labeled. The latter data suggests that the biosynthesis of isoleucine in ripening apple may, in part, be via a previously uncharacterized pathway that uses the starting products pyruvate and acetyl-CoA. The hypothesized alternative pyruvate pathway will be discussed as it relates to isoleucine biosynthesis and propanoate and 2-methylbutanoate ester production.

Specified Source(s) of Funding: My major professor Randy Beaudry

2:15–2:30 pm

Internal Fruit Quality Affected by Sunburn Browning in Apples

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Sunburn of apples is a physiological disorder caused by heat and light stress. Sunburn results in large economic losses to growers in several regions of the world. We previously identified three types of sunburn (sunburn necrosis, sunburn browning, and photooxidative sunburn), but consider sunburn browning to be most important commercially. Recently, we found several postharvest changes in internal fruit quality of apples with sunburn browning. Apples of five cultivars ('Gala', 'Golden Delicious', 'Jonagold', 'Granny Smith', and 'Fuji') harvested at commercial maturity were sorted into five classes ranging from no sunburn (Sb-0) to severe sunburn browning (Sb-4) and placed in cold storage. Flesh firmness, soluble solids concentration (SSC), and titratable acidity (TA) were measured on flesh tissue beneath the sunburned area of all apples at harvest and after 3 and 6 months of regular atmosphere cold storage. Flesh firmness and SSC increased significantly, but TA decreased in all cultivars as sunburn severity increased from Sb-1 to Sb-4. These trends persisted during cold storage, but TA declined markedly over time in apples with more severe sunburn. This resulted in a marked increase in the SSC to TA ratio

(SAR) in all five cultivars during cold storage. A rapid decline in TA has been reported to shorten storage life and to affect acid taste of fruit. A second study compared, only at harvest, the sun, shade and shoulder sides of the same five apple cultivars used previously with five classes of sunburn browning (Sb-0 to Sb-4). As severity of sunburn increased, flesh firmness, SSC, and SAR increased more on the sun side than on shade or shoulder sides. With increasing sunburn severity, starch index increased in the shade and shoulder sides, but changed little on the sun side of sunburned fruit. Hence sunburned apples were more mature than non-sunburned apples. These findings suggest that internal fruit quality of apples with sunburn browning is affected not only on the sun side, but also on shade and shoulder sides of sunburned fruit. We suggest that the common commercial practice of combining some sunburned apples with non-sunburned fruit in premium grades of apples for marketing should be re-evaluated.

Specified Source(s) of Funding: Washington Tree Fruit Research Commission

2:30–2:45 pm

Effects of Nitric Oxide Fumigation on Postharvest Life, Chilling Injury, and Quality of Japanese Plums (*Prunus salicina* Lindell)

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Short postharvest life and susceptibility to chilling injury (CI) limit marketability of Japanese plums in domestic and export markets. Nitric oxide (NO), a free radical gas, has been implicated in regulation of postharvest senescence in horticultural commodities. We aimed this research to extend postharvest life and alleviate CI of Japanese plums through NO fumigation. Therefore, commercially mature 'Amber Jewel' plums were fumigated with different levels of NO gas (0, 5, 10, and 20 $\mu\text{L}\cdot\text{L}^{-1}$) at 20 °C for 2 hours. Post-treatment, fruit were either allowed to ripen at ambient conditions [21 ± 1 °C and $60 \pm 7\%$ relative humidity (RH)] or were kept in cold storage (0 °C and $86 \pm 5\%$ RH) for 7 weeks. At ambient conditions, NO fumigation, irrespective of concentration applied, significantly suppressed the respiration rate of fruit compared to the untreated fruit. Ethylene production in fruit exposed to 10 and 20 $\mu\text{L}\cdot\text{L}^{-1}$ NO was significantly lower than those treated with 0 and 5 $\mu\text{L}\cdot\text{L}^{-1}$ NO. The fruit quality evaluation at 3 day intervals (0, 3, 6, 9, and 12 days) during ripening at ambient conditions revealed that NO fumigation decreased the loss in flesh firmness and restricted the changes in skin color (Lightness, chroma, and hue angle) and titratable acidity without a significant effect on soluble solids concentration. During cold storage at 0 °C, fruit quality was evaluated at 5, 6, and 7 weeks and after 5 days at ambient conditions (21 ± 1 °C and $60 \pm 7\%$ RH) for each interval. NO fumigation was effective in reducing the CI symptoms, which appeared in the form of flesh browning and translucency, after 5 and 6 weeks of cold storage and followed by ripening for 5 days at 21 ± 1 °C. NO fumigation also retarded the changes in fruit ripening parameters such as skin color, firmness, and titratable acidity during storage and ripening. In conclusion, NO fumigation (10 $\mu\text{L}\cdot\text{L}^{-1}$) extended the postharvest life of 'Amber Jewel' plums to 12 days at ambient conditions against 9 days in untreated fruit, and also alleviated CI symptoms during cold storage at 0 °C for 6 weeks. Our study shows that NO fumigation has potential to become a postharvest tool to increase the marketability of Japanese plums.

Specified Source(s) of Funding: Self and Curtin University (Partial)

2:45–3:00 pm

Optimal Harvest Maturity for Melting and Non-melting Flesh Subtropical Peach Varieties Ripened Immediately After Harvest or Following Storage

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Traditional melting flesh (MF) peaches ripen and soften quickly at ambient temperature. Thus they have to be harvested at the “firm-ripe” stage, which minimizes mechanical injuries but compromises flavor. Non-melting flesh (NMF) peach fruit potentially have a longer post-harvest life since they soften gradually and thus retain texture longer after harvest. The optimum harvest maturity stage is unclear for peach fruit that will be ripened following different storage conditions. A two year study was conducted to identify the optimal harvest maturity of subtropical peach varieties based on quality characteristics determined after immediate ripening and ripening after 2 weeks of refrigerated storage. Two MF cultivars, Tropic Beauty and Flordaprince, and two NMF cultivars, UFSun and Gulfking, were harvested three times during the season. For each harvest, a 50-fruit sample was sorted according to ground color and fruit diameter, assuming that the sampled peaches accurately represented the maturity distribution in the true population; fruit firmness and flesh color (FC) were measured at harvest on 10-fruit samples. The remaining fruit were divided into two groups of 20 for two storage treatments. The first group was ripened at 20 °C for 5 days (S1) and the second group was stored at 0 °C for 14 days, and then ripened at 20 °C for 5 days (S2). Ripe fruit were analyzed for peel ground color (GC) and blush color, FC, flesh firmness, soluble solids content (SSC), total sugars (TS), titratable acidity (TA), pH, and weight loss. In both seasons, MF peaches lost more than 90% of their initial firmness in both storage treatments, whereas NMF fruit lost around 50%. For both MF and NMF peaches, the SSC, TS, and pH did not change significantly in S1 or S2. TA decreased with advancing harvest maturity and decreased slightly in S1 and S2. The FC a-value increased with maturity and was higher in S2 than S1. In Season 2, the results indicated that both MF and NMF peach fruit could be harvested at more advanced maturity stages for S1 than for S2 in order to attain minimum acceptable eating quality. Furthermore, NMF cultivars could be harvested at even more advanced maturity stages than MF cultivars for both storage experiments. This study indicates that NMF cultivars may have the potential to increase peach consumption since they can be harvested at a ‘tree-ripe’ stage and still maintain desirable postharvest qualities during marketing.

Specified Source(s) of Funding: HATCH TSTAR

3:00–3:15 pm

Laser Labeling and Its Effect on the Storage Quality of Citrus Fruits

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Etching the required information on the skins of fruits and vegetables is an alternative way to label produce. A low energy CO₂ laser beam etches the outermost layer of the epidermis revealing the contrasting underneath layer while forming alphanumeric characters. These etched areas represent breakages of the natural protective barrier and can result in moisture loss and potentially act as an entry site for pathogens. The present study was aimed at determining the water loss, peel stability and potential decay in laser etched citrus fruits namely tangerine (*Citrus reticulata*) and grapefruit (*Citrus paradisi*) during storage. Laser labeled fruit stored at 10 °C and two different relative humidities (RH) (95% and 65%) for 5 weeks showed no increase in decay compared to control non-etched fruit, indicating that laser labeling does not promote decay. This was further confirmed by experiments where *Penicillium digitatum* spores were smeared on the laser etched areas before and after etching. In either case, no decay was observed. Water loss from etched areas and label appearance were determined in both the fruits during storage. Water loss from the etched label area declined sharply, and reached comparable levels to control non-etched fruit within seven days. Waxing the labeled surface reduced water loss by 35% to 95%, depending on wax formulation. Label appearance gradually deteriorated during storage and was proportional to the laser beam exposure time and ambient relative humidity. These results led to the conclusion that laser labeling could be a safe alternative for existing adhesive labels.

3:15–3:30 pm

Color, Chlorophyll Fluorescence, and Volatile Production in Banana Fruit Ripened at High Temperature

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Banana fruit (*Musa* AAA group) is the most consumed fruit in the world. Banana fruit quality is depended on color, flavour (aroma and taste), sweetness and nutritional compounds. The physiological and biochemical changes that occur in both peel and pulp tissues during ripening have been described. The peel tissue of banana plays an important role in banana fruit ripening including coloring, softening, starch degradation and volatile biosynthesis. It has been reported that color formation and chlorophyll breakdown in banana is inhibited by ripening temperatures above 24 °C due to the possible retention of thylakoid membrane at a higher temperature that results in reduced chlorophyll degradation. In this study, green, untreated fruit were obtained from a local whole-sale market and half of the fruit were subjected to ethylene treatment at 10 µl/L for 24 hours. After ethylene treatment, fruit were stored at 20 or 31 °C for 7 days. During this period, fruit were sampled at 0, 1, 4, and 7 days and evaluated for color, chlorophyll fluorescence, volatile production and gene expression. The investigation was repeated four times. Significant reduction of coloring from green to yellow at high temperature was shown. High temperature storage at 31 °C reduced yellow color development. Chlorophyll fluorescence of high temperature treated fruit has the highest of Fo and lowest Fv/Fm, indicating a possible heat stress of the fruit. The rapid decline of Fo and Fm in ethylene treated fruit stored at 20 °C showed their close relationship with peel yellowing. A total

of 22 volatile compounds were identified using SPME/GC/MS. Total volatile production increased at high temperature but was not affected by ethylene treatment. Production of 3-methylbutyl butanoate, butyl 3-methylbutanoate and heptyl 2-methylbutanoate increased similarly to total volatile production in response to ethylene treatment and high temperature, whereas ethyl acetate, 2-methylpropyl acetate and 3-methylbutyl acetate were induced by high temperature. Expression of four ripening and senescence related genes are also shown.

3:30–3:45 pm

Environmentally Friendly Microperforated Containers for Improving Postharvest Berry Shelf Life

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Strawberries and blueberries consumption have increased considerably in the last years due to consumer's convenience and health benefits awareness. Berries are mostly sold in vented clamshell containers made of poly(ethylene terephthalate), PET, or poly(styrene), PS. However, a rapid weight loss of berries during storage due to the vents causes shriveling and wilting and hence reduces marketability. Authors' previous research compared these containers with non-vented poly(lactic acid), PLA, and concluded that non-vented PLA containers could be an adequate choice for extending blueberries shelf life and reducing the plastic waste being landfilled. PLA was chosen because of its compostability and recyclability. Although, there was higher microbiological growth due to the high humidity inside the containers, sensory panelists significantly preferred blueberries in non-vented PLA containers to those in clamshells. The high CO₂ levels that are able to reduce fungal growth, cannot be achieved with non-vented PLA containers, but may be with microperforated lidding material. Its effectiveness on prolonging fresh product shelf life has been widely reported but so far only petroleum-based materials have been used. In this study, PLA was used as a bio-based alternative to petroleum-based, hence introducing the first microperforated PLA film. In this study, strawberries or blueberries were packed in rigid PLA containers and sealed with continuous or microperforated PLA films (0, 3, and 15 microperforations). PET clamshell containers were used as controls. Packages were stored at 23 °C and 55% RH. Physico-chemical properties (CO₂ and O₂ evolution, weight loss, fungal development, pH, and soluble solid content (SSC)) were analyzed at predetermined times. Strawberries and blueberries in clamshell containers showed significant weight loss (14.6% at day 4 and 22.0% at day 9, respectively) in comparison with that of PLA containers. Higher numbers of microperforations resulted in lower CO₂ development in the headspace, lower weight loss, and more fungal growth. Berries in microperforated PLA exhibited stable SSC while for those berries in clamshell containers, a slight increase was shown. Also, the flavor evolution of berries was determined. In conclusion, microperforated PLA was found beneficial for packaging moderate and high respiration rate berries, thus could

be commercially feasible for fresh produce industry besides a possible reduction of waste in landfills.

Specified Source(s) of Funding: Project GREEN, Michigan's plant agriculture initiative at Michigan State University

3:45–4:00 pm

Shelf Life Study of Blackberry Fruit in an Eco-friendly Container

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The postharvest life of blackberry fruit (*Rubus ursinus*) is relatively short due to its high respiration rate and its extremely fragile structure. These drawbacks can be counteracted by packaging and cold storage. Blackberry fruit is usually packaged in vented petroleum-based clamshell containers made of poly(ethylene terephthalate), PET, or poly(styrene), PS, and stored at roughly 32 °F to maintain quality and gain marketability and profitability during the postharvest period. Eco-friendly and non-vented corn-based containers made of poly(lactic acid) (PLA) may exceed the effectiveness of the aforementioned packages in prolonging blackberry shelf life by reducing the weight loss caused by the presence of vents while mitigating environmental problems related to packaging waste at the same time. The aim of this study was to evaluate the shelf life of blackberries packaged in corn-based containers for approximately 3 weeks at 35 °F (market conditions). Current petroleum-based clamshell containers were used as controls. Physical, chemical, microbiological and sensorial properties of berries from both types of containers were measured during storage. The PLA container reduced the weight loss of blackberries by 32% compared with that of the PET clamshell container. The absence of vents and the water vapor transmission rate of the PLA caused this difference. The firmness of blackberries packaged in PLA containers was maintained for roughly two days longer than for those fruit packaged in commercial clamshell containers. The sensory evaluation, a consumer preference test with more than 50 panelists, showed that panelists preferred appearance, texture, and flavor of the blackberries of PLA containers. Especially, texture and appearance showed a difference of more than 1 point between containers. Visual changes (dryness, fungal growth, . . .) were monitored during storage by using a digital camera. The study was carried out for two different varieties of blackberry grown in MI, Cancaska, and Chester, during different periods of time in Summer 2008. This study may help to generate background research since there is little attention on blackberry postharvest studies compared to other berries such as strawberries, and those are basically focused on blackberry nutritional benefits, mainly antioxidants content.

Specified Source(s) of Funding: The Michigan Agricultural Experiment Station and the C.S. Mott Chair of Sustainable Agriculture at Michigan State University (MSU)

Oral Session 3:
Genetics/Germplasm/Plant Breeding:
Biotechnology
Saturday, 25 July 2009, 4:00–6:00 pm

Laclede

Moderator: Jude W. Grosser, jgrosser@ufl.edu

4:00–4:15 pm

Ethidium Bromide Induced Mutations from Inflorescence Cultures of Indiangrass

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Immature inflorescences of a *Sorghastrum nutans* (L.) Nash selection were cultured on CCM medium with 5 mg·L⁻¹ 2,4-D and 1 mg·L⁻¹ BA for 5 weeks. Callused inflorescence cultures were placed on CCM medium with 1 mg·L⁻¹ BA (CCmB¹) and 0 or 250 mg·L⁻¹ ethidium bromide (EtBr) for 1 day. Cultures were transferred to CCmB¹ without EtBr for shoot regeneration, then to CCM without plant growth regulators for rooting. Rooted shoots were transferred to soil under greenhouse conditions, then to the field. Fifteen putative M₁ mutants with atypical phenotypes were detected among 71 regenerants, all from the EtBr treatment. Two self-incompatible putative M₁ mutants were progeny-tested by using a wild-type Indiangrass seedling as the pollen parent. M₁ selection ISU06-35 was a dwarf mutant whose M₂ testcross progeny segregated 1:1 tall:dwarf seedlings. M₁ selection ISU06-56 was a red-flowered mutant whose M₂ testcross progeny segregated 1:1 green-flowered:red-flowered seedlings. These results are consistent with both M₁ mutants being dominant nuclear mutations.

4:15–4:30 pm

Improvement of Landscape Plants Using In Vitro Mutation Method

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Mutation breeding has proven as an established method for development of novel cultivars of many horticultural plants. However, the appearance of chimeras after vegetative propagation for several times seems a major concern of mutation breeding because mutations often occur in a small portion or an aggregate of cells mounded in the normal tissues and will never be identified. In vitro techniques might be the key to solve the problem. For example, multiple-micropropagation using existing buds will speed up the establishment of stable periclinal chimeras within a short time period; In vitro plant regeneration from single undifferentiated cell lines may circumvent problems associated with the formation of chimeras. In this study, induction of mutations by treating in vitro tissues of several ornamental plants with ethyl methanesulfonate (EMS) and gamma ray has been attempted. Concentration of EMS and treatment time and the dosage of gamma ray have been determined based on LD₅₀ (half of treated explants survived). Preliminary results showed that in vitro shoot tips survived after treated with EMS at 5 to 50 mM for 0.5 to 6 hr; however, growth of the plants treated with high EMS (> 25) for more than 2 hr was dramatically inhibited and some plants eventually died. Shoot tips of *Physocarpus opulifolius* 'Center Glow' exposed to gamma ray died in two months when the dose was

greater than 100 Gy. The EMS-survived plants grown in the greenhouse showed phenotypic variations (leaf shape, color, and plant stature). To date, approximately 80, 300, and 200 plants obtained from EMS-treated *Forsythia* × 'Meadowlark', *Physocarpus opulifolius* 'Center Glow', and *Cornus sericea* 'Cardinal', respectively and more than 100 *Physocarpus opulifolius* 'Center Glow' plants survived from gamma ray treatment, are being screened for useful mutants under both field and greenhouse conditions.

4:30–4:45 pm

Assessing Genetic Relationship among Scented Geraniums (*Pelargonium* sp.) with TRAP Markers

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Scented geraniums (*Pelargonium* sp.) are a group of attractive plants known for various growth habits, foliage colors, and aromatic scents. Recent reports and patents on their capabilities for heavy metal hyperaccumulation and insect deterrence have attracted attention and added new avenues for using these plants. Since the scented geraniums are comprised primarily of hybrids, the use of morphological characteristics is limited and often causes confusion in the identification of plants in this group. The utilizing GC/MS to analyze volatile compounds attributing to the scents of scented geraniums revealed distinct chemical profiles useful in grouping geraniums into distinctive chemotypes. In addition, morphological or chemical attributes rarely reveal genetic relationships among the plants under investigation. To overcome the difficulty in plant identification and genetic relationship assessment in scented geranium, we are employing DNA marker techniques in conjunction with morphological observation and chemical analysis. In this experiment, 96 scented geraniums were observed for morphological traits (flower color, leaf size and shape, and growth habit), analyzed by GC for volatile chemicals, and genotyped with the use of TRAP (Target Region Amplification Polymorphism) technique. Over fifteen hundred polymorphic markers were amplified from DNA samples extracted from young leaf tissue with just two sets of PCR reactions. One of the fixed primers was designed against the conserved plant telomere-repeat sequence (TTTAGGG)_n and the other a sunflower (*Helianthus annuus* L.) Expressed Sequence Tag (EST) with homology to an *Arabidopsis* homeobox gene. In the PCR reaction each fixed primer was combined with four arbitrary primers labeled with fluorescent dyes and the amplified products were analyzed on the ABI 3730 DNA Analyzer. These TRAP markers effectively discriminated each genotype of the 96 scented geraniums and are useful for clarifying plant identity and assessing genetic relationships. In the resulting dendrogram from cluster analysis, scented geraniums that are clustered closely together also share strikingly similar morphological characteristics and volatile chemical GC profiles.

4:45–5:00 pm

Generation and Analysis of ESTs for Differential Gene Expression to Anthracnose in Yam (*Dioscorea alata* L.)

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Molecular markers are ideal to investigate genetic effects on the resistance/susceptibility to disease. Simple Sequence Repeats (SSRs), repetitions of nucleotide motifs of 1-5 bases, are currently the markers of choice due to their abundant distribution in the genomes, and suitability for high-throughput analysis. Yam, (*Dioscorea alata* L), the main food source for over 100 million people in humid and sub-humid tropics, is vulnerable to anthracnose (*Colletotrichum gloeosporioides*) disease. This is one of the major limiting factors in the production of yam worldwide. A collaborative project between the International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria, Africa, and Virginia State University, Petersburg, VA, was developed for genetic improvement and germplasm characterization of yams using molecular tools. Very limited sequence information is available from public genome databases. Total RNA was isolated from young leaves of resistant and susceptible genotypes and cDNA libraries corresponding to these two lines were constructed using Clontech's Creator SMART cDNA library construction kit. The libraries from the resistant and susceptible genotypes now have a total of 85,000 and 80,000 cDNA clones, respectively. These cDNA clones are currently being sequenced and nearly 80,000 EST sequences generated from this project are presented.

5:00–5:15 pm

Development of SSR Markers for *Chionanthus retusus* (Oleaceae) and Cross Amplification of Closely Related Taxa

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Chionanthus is a genus of the Oleaceae family along with *Olea*, *Fraxinus*, and *Forsythia*. Albeit being used as ornamental and commercialized as a natural product, the genetic information of *Chionanthus* spp. is negligible. We have created microsatellite-enriched libraries of *C. retusus*, assembled 1072 contigs, and detected 1010 repeats. The frequency of the repeats decreased exponentially with the increase in repeat length, and the most abundant motifs were: AG, AC, AAG, ACC, AT and ACTC. We have screened 384 markers on 12 *Chionanthus* related taxa, characterized 57 microsatellite loci across four species of Oleaceae and characterized 195 within the species *C. retusus*, most of these being polymorphic. Polymorphic information content (PIC) values varied from zero to 0.85, and the percentage of heterozygous loci was in a

range from 24.6% to 68.4%. The SSR markers developed here could assist in the botanical characterization for breeding programs and in the industry for the quality control and authentication of varieties of these medicinal plants.

Specified Source(s) of Funding: USDA–ARS

5:15–5:30 pm

Fine Mapping Ty-3, a Major Begomovirus Resistance Gene in Tomato

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Fla. 8680, a *Tomato Yellow Leaf Curl Virus* (TYLCV) resistant breeding line, was used to develop an F₂ population for fine mapping Ty-3. Fla. 8680 has a *Solanum chilense* introgression of approximately 27cM on chromosome 6, spanning markers C2_At2g39690 (5.3cM) to T0834 (32cM). Seven-hundred-nineteen F₂ plants were screened with molecular markers to identify 30 recombinants within this region. F₄ and F₅ recombinant inbred lines (RILs) were tested for resistance to TYLCV in fall 2007 and spring 2008, respectively. Results indicate that Ty-3 maps to the 7 cM interval between markers T0774 (18cM) and P6-25 (25cM). Two recombinants, each containing this region within a shortened introgression, were used to develop a large segregating population to further fine map Ty-3. In spring 2009, over 9000 seedlings were screened with molecular markers at the distal ends of the introgressions, and over 200 recombinants were selected and transplanted to the field. Multiple cuttings taken from each recombinant were inoculated with whiteflies viruliferous for TYLCV and tested for resistance in a replicated field experiment. These results will be presented.

Specified Source(s) of Funding: USDA NRI

5:30–5:45 pm

Cloning and Characterizing Two PpSFBB-Alpha Genes in Chinese Sand Pear (*Pyrus pyrifolia* Nakai.)

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Gametophytic self-incompatibility (GSI) is genetically controlled mechanism to prevent inbreeding and promote out-crossing. It is controlled by a single multi-allelic S-locus, which contains two separate genes (a stylar S-RNase gene and a pollen S-gene). In gametophytic self-incompatible Japanese pear (*Pyrus pyrifolia* Nakai.) and apple (*Malus domestica*), three types of SFB genes (SFBB-alpha, SFBB-

beta, and SFBB-gamma) have been isolated of which the SFBB-alpha genes were identified as the best candidates for pollen S-genes. To investigate sequence characteristics of the possible pollen S-gene and elucidate possible GSI mechanism of Chinese sand pear (*P. pyrifolia*), SFBB-alpha homologies in Chinese sand pear cultivars were cloned and characterized by degenerate primers, PSFBA-F and PSFBA-R, that were designed based on Japanese pear and apple SFBB-alpha sequence information. Results showed that the PSFBA-F and PSFBA-R primers successfully amplified a fragment of approximately 1,300 bp from 'Maogong' ($S_{12}S_{13}$), 'Hongsucui' (S_4S_{12}), 'Tianchengzi' (S_7S_{12}), and 'Mantianhong' (S_4S_{12}), corresponding to pear SFBB-alpha gene. A total of two distinct sequences derived from the 1,300 bp product were identified that were named PpSFBB12-alpha (*P. pyrifolia* SFBB12-alpha) and PpSFBB13-alpha, respectively. RT-PCR revealed that both PpSFBB-alpha genes were expressed specifically in the pollen grains. The coding region of PpSFBB12-alpha was 1,194 bp in length encoding 397 amino acids with predicted molecular weight of 45.8 kDa and isoelectric point of 5.03. The coding region of PpSFBB13-alpha was 1,179 bp in length encoding 392 amino acids with predicted molecular weight of 45.4 kDa and isoelectric point of 4.92. Both genes displayed normal structural characteristics of SFB/SLF genes, i.e. an F-box motif and four variable regions. At the deduced amino acid level, they shared 18.6% to 97.7% similarities with other SFB/SLFs of rosaceous plants. These characteristics of the two PpSFBB-alpha genes fully demonstrated that they are good candidates of pollen S-gene. Phylogenetic analysis revealed that 34 rosaceous SFB/SLFs were divided into two subfamily groups, but did not further form species subgroup. The evolutionary pattern of SFB/SLFs concurred with that of rosaceous S-RNases, suggesting that SFB/SLFs occurred after divergence of subfamily, but before the divergence of species as S-RNases in Rosaceae. The two PpSFBB-alpha sequence data should be useful for studying the interaction between SFBs and S-RNases and clarifying the mechanism of GSI at the molecular level in Chinese sand pear.

Specified Source(s) of Funding: the Key Project of State Forestry Administration (2006-12) and the Agricultural Achievement Transforming Programs of Science and Technology Department (2008GB2D200219).

5:45–6:00 pm

Multiple Approaches for Genetic Engineering of Citrus for Disease and Pest Resistance

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Citrus in Florida is threatened by non-indigenous but now endemic bacterial pathogens causing the diseases Huanglongbing (HLB, caused by *Candidatus Liberibacter asiaticus*) and citrus canker (caused by *Xanthomonas citri* ssp. *citri*). These diseases have the potential to wipe out the entire industry due to unavailability of resistance in commercially cultivated Florida cultivars. HLB is vectored by the Asian citrus psyllid (*Diaphorina citri* Kuwayama), while canker is dispersed by windblown rain, contaminated equipment or human activity. In efforts to control the diseases, several transgenic strategies have been adopted. Citrus scion and rootstock cultivars were transformed with gene(s) encoding antimicrobial peptides, systemic acquired resistance (SAR) proteins or insecticidal proteins. Each gene was under control of an enhanced CaMV 35S promoter. Several genes were also under control of a phloem specific *Arabidopsis* SUC2 (*AtSUC2*) promoter as

C. Liberibacter asiaticus is a phloem limited bacterium and targeting gene expression in the phloem potentially resolves issues of presence of transprotein in the fruit. Molecular analysis confirmed the presence of the gene(s) in the citrus genome. We employed a rapid micrografting technique on tender rootstocks to quickly propagate our transgenic lines. Results from preliminary disease resistance tests suggested that some of the antimicrobial peptides could provide varying levels of resistance against both HLB and canker. Several studies are currently underway to evaluate resistance to either of the pathogens and also to the insect vector.

Oral Session 4:

Jefferson A

Horticultural Crops Culture and Management: Pest Management

Saturday, 25 July 2009, 4:00–6:00 pm

Moderator: Beiquan Mou, beiquan.mou@ars.usda.gov

4:00–4:15 pm

Effectiveness of Host Resistance Inducers and Humic Acid for Fire Blight Control and Shoot Growth on Apple Cultivars with M9 Rootstock

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Fire blight, caused by *Erwinia amylovora*, is the most devastating bacterial disease of apples with M9 rootstocks and often results in the death of the tree. The resistance-inducing compounds prohexadione-Ca (PC), harpin protein (Hp) and benzothiadiazole (acibenzolar-S-methyl) (BTH), the fertilizer humic acid (HA), the bactericides streptomycin and copper, and combinations of copper with chemicals were evaluated for their ability to control fire blight and shoot growth on apple cultivars, Gala, Red Elstar, Jonagold and Pinova, with M9 rootstock in two years. PC was applied at a rate of 125 mg·L⁻¹ at two shoot lengths (6–12 cm and 15–20 cm), while BTH (135 mg·L⁻¹) and harpin (50 mg·L⁻¹) were applied when the shoots measured between 15–20 cm, and again at 30–35 cm. HA (200 mg·L⁻¹), copper and streptomycin were applied at three phase of shoot lengths. In bioassay tests, bacterial populations were determined in plant tissues at 5th, 10th and 15th days. Disease severity and effectiveness of the applications were calculated using the following formulas: Disease severity (%) = (a/b) × 100; where a is the length of the blighted part of the shoot (cm), and b is the whole length of the shoot (cm) and Efficacy (%) = [(DICK – Ditr) / DICK] × 100 where DICK is mean disease severity in water sprayed control plants and Ditr is mean disease severity in treated plants. When the apple varieties and years were taken into consideration, PC alone (44% to 70%) and in combination with copper compound (48% to 63%) were the most effective treatment during both years on disease control, following by the streptomycin (76% to 95%) ($P \leq 0.05$). PC reduced both shoot length and shoot blight on the apple cultivars. The cultivar Red Elstar showed the lowest disease severity than the other cultivars and followed Jonagold, Pinova and Gala, respectively. HA applications were unsuccessful in controlling fire blight on all of the apple cultivars. Streptomycin treatment yielded the lowest rate of bacterial population, and it was followed by PC, Hp, BTH, copper and HA respectively. The use of resistance-inducing substances during the early phase of shoot growth may offer a means of managing the shoot blight phase of fire blight disease on apple cultivars with M9 rootstock.

Specified Source(s) of Funding: This work was supported by the Coordination of Selcuk University's Scientific Research Projects.

4:15–4:30 pm

Advanced Granular Technology for Material Delivery

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The Andersons, Inc., has engineered a breakthrough granular technology platform that addresses the economic, health, and environmental concerns of today's agricultural industry. The overall goal of this initiative is to accelerate commercial penetration of this technology into the multibillion-dollar Food and Agriculture system. The core concept of this proposal is to build on The Andersons' current market strengths and use advanced granules to effectively deliver fertilizers and pesticides or biologically active ingredients to specifically targeted areas. The Andersons granular technology effectively and accurately delivers biologically active ingredients precisely to target areas, disintegrates within seconds to reduce environmental risks, and have virtually no drift problem. This revolutionary technology will mitigate many of today's problems associated with fertilizers and pesticides while improving production efficiency of food, fiber, energy, and aesthetic environments. A consortium of Ohio and national leaders has been organized to initiate a chain reaction of job creation throughout the state in multiple industries. It organizes academia and industry in a sustainable and profitable partnership to create a strong economic impact to Ohio and improve farming efficiency and safety throughout the world. Through the university and industry collaboration, this initiative develops a skilled workforce, builds academic infrastructure, and creates innovative intellectual property and products for commercialization. By commercializing this platform technology, Ohio will become a global leader in advanced granular research, development, and manufacturing for the turf, nursery, floriculture, fruits, vegetables, and row crops markets all over the world. Furthermore, Ohio will pioneer environmental protection and health safety in agricultural practices for generations to come.

Specified Source(s) of Funding: Ohio Third Frontier—Technology Commercialization Grants

4:30–4:45 pm

Genetic Diversity Within and Between Nursery Populations of *Paria fragariae* Species Complex and Implications for Insecticide Resistance

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The strawberry rootworm (SRW), *Paria fragariae* Wilcox, has been a growing pest of production nurseries in the southeastern United States since its introduction in the mid 1980's. The small beetle feeds nocturnally on evergreen azaleas and causes severe damage to the leaves which diminishes the marketability of the plant. The strawberry rootworm species complex is currently subdivided into two subspecies, *Paria fragariae fragariae* Wilcox and *Paria fragariae kirki* Balsbaugh, but it is not confirmed whether these two groups interbreed. The presence of separate, non-interbreeding populations would reduce the amount of gene flow within and between populations and decrease the risk for insecticide resistance. However, the presence of fully interbreeding

populations would increase risks for insecticide resistance and further the need for rotation of pesticide chemistries as part of an IPM approach to effectively manage SRW populations. Field sampling paired with sequencing of mitochondrial DNA has detected at least two distinct groups of the SRW species complex in MS, AL, and LA production nurseries. Further sampling will be required to determine frequencies and distributions of different populations in production nurseries in the southeastern U.S. as well as to detect any hybridization between supposed subspecies of SRW.

Specified Source(s) of Funding: USDA–ARS

4:45–5:00 pm

Alternatives to Methyl Bromide for Raspberry Nurseries

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Raspberry nurseries use preplant soil fumigation with methyl bromide: chloropicrin (mb:pic) to produce disease- and nematode-free plants. The use of methyl bromide has been largely phased out, and exemptions for continued use are becoming more difficult to obtain. Successful alternatives to mb:pic must provide full control of plant-parasitic nematodes, *Agrobacterium tumefaciens*, and *Phytophthora rubi*. In trials conducted over two years mb:pic and alternative fumigants were evaluated, including: Midas® (Methyl Iodide:chloropicrin), Telone® C-35 and InLine® (Telone:chloropicrin), solarization and a solarization + InLine® combination. Midas® applied at 350 lb/A under a conventional (HDPE) tarp consistently provided excellent control of all weeds and pathogens. Reduced (175 lb/A) rates of Midas® were less effective than full rates. Use of a Virtually Impermeable Film (VIF) tarp enhanced the efficacy of Midas® applied at the reduced rate, and also enhanced efficacy of Telone® C-35. All of the treatments except for solarization controlled root lesion nematode (*Pratylenchus penetrans*), and all of the treatments evaluated enhanced marketable yield of nursery plants.

Specified Source(s) of Funding: USDA–ARS Pacific Area-Wide Pest Management Program for Methyl Bromide Alternatives

5:00–5:15 pm

Sweetpotato Storage Root Count Response to 1,3-Dichloropropene Plus Chloropicrin Treatments

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Fumigation is typically used as a management tool for reducing the negative effects of nematodes on sweetpotato storage root quality and yield. Past studies have not specifically investigated fumigation treatment effects on sweetpotato storage root count. Studies involving 1,3-Dichloropropene (1,3-D) as well as the use of a commercial formulation of 40% 1,3-D and 60% Chloropicrin fumigation treatments revealed a consistent increase in U.S. #1 storage root count in 'Beauregard' sweetpotato. This yield increase was detected despite very low nematode counts. Possible explanations for this yield response will be presented within the context of critical storage root initiation stages.

5:15–5:30 pm

Influence of *Cucurbita* spp. on *Macrophomina phaseolina* Soil Densities

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Charcoal rot caused by *Macrophomina phaseolina* is an important disease of soybean (*Glycine max*) in Illinois and can easily be isolated from most production fields in the state. Although charcoal rot is generally thought to be a minor pathogen of pumpkins and other cucurbits, these vegetables are often included in the soybean rotational scheme and can possibly increase or maintain high inoculum levels for future soybean crops. A greenhouse study was conducted to determine the reproductive ability of *M. phaseolina* on *Cucurbita pepo* 'Howden' and 'Sorcerer', *C. moschata* 'Libby's Select' and 'Buckskin', and *C. maxima* 'Big Moon' and 'Mammoth Gold' based on inoculation levels of 0, 10, 20, 50, and 100 CFU/g soil (or ~0, 6,000, 11,000, 29,000, 67,000 CFU/10 cm-dia. pot). Although, no symptoms of charcoal rot were observed on pumpkin plants three months after inoculation, *M. phaseolina* readily colonized and reproduced on all cultivars. No interaction was detected between inoculation level and cultivar, and no differences were observed between cultivars. Results indicated that various species of pumpkins (*Cucurbita* spp.) provide excellent hosts for *M. phaseolina* and that if charcoal rot is a recurring problem on soybean, pumpkins should not be included in the rotation as they tend to increase the soil population densities of this soil-borne fungus.

5:30–5:45 pm

Inheritance of Resistance to Leafminer and Downy Mildew in a Wild Relative of Lettuce *Lactuca saligna*

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Leafminer (*Liriomyza* spp.) is a major insect pest of many important agricultural crops including lettuce (*Lactuca sativa* L.). Downy mildew caused by *Bremia lactucae* is one of the most important diseases of lettuce. Resistant varieties remain the most economical means of insect and disease control. Resistance to leafminers was found in PI 509525, an accession of wild relative *Lactuca saligna* that is considered a non-host of *Bremia*. The objective of this study was to determine the genetics of resistance to leafminer stings and downy mildew in PI 509525. PI 509525 was crossed to susceptible cultivars Bibb, Da Ye Wo Sun, Margarita, and Salad Bowl, and progenies were evaluated in the field for leafminer sting density and downy mildew severity in four years. F₁ plants all had low sting density and downy mildew resistance, indicating that the resistances were dominant. Chi-square analyses of F₂ progenies showed that each resistance was conferred by a dominant allele in PI 509525. Monogenic control of resistance was confirmed by the segregation ratios of F₃ families. Identification of the resistance genes will greatly facilitate the integration of resistance to leafminers and downy mildew from the wild species into cultivated lettuce in a breeding program.

5:45–6:00 pm

Methods for Managing Phytophthora Blight (*Phytophthora capsici*) of Pepper

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Phytophthora blight, caused by *Phytophthora capsici*, is one of the

most important diseases of peppers worldwide, causing yield losses of up to 100%. The pathogen can infect plants at all growth stages. *P. capsici* infects roots, crowns, stems, leaves, and fruit, causing seedling damping-off, stem lesion, stem blight, leaf spot, and fruit rot. The first symptom on pepper in the field is commonly crown rot. A lesion girdling the base of the stem causes rapid collapse and death of the plant. The affected plants usually die within few days. In some cultivars only fruit are infected. Infected fruit develop dark, water-soaked lesions, which are commonly covered with white mycelium of the pathogen. Three approaches, (i) using resistant cultivars, (ii) induction of resistance in plants by red-light treatment, and (iii) application of fungicides, were evaluated for management of Phytophthora blight in peppers. To identify resistant pepper cultivars to *P. capsici*, more than 80 cultivars/accessions of bell pepper were tested in the greenhouse and field. In the greenhouse, 8-week-old seedlings were inoculated with *P. capsici*. Pepper cultivars were also evaluated in naturally infested commercial fields with *P. capsici*. Cultivars, Aristatol, Declaration, Emerald Isle, Paladin, Reinger, Revolution, Seigers 9915776, and Snapper F₁ were resistant to isolates of *P. capsici*. Pepper seedlings grown under red light (600–700 nm) for four weeks reduced *P. capsici*-infection by 74% in the greenhouse, but the treatment failed to provide a season-long protection against *P. capsici* in the field. More than 40 fungicides were evaluated for their effectiveness for control of Phytophthora blight in the fields. Cyazofamid (Ranman 400SC), dimethomorph (Forum 4.16 SC), famoxadone + cymoxanil (Tanos 50WDG), mandipropamid (Revus 2.09SC), and mefenoxam (Ridomil Gold Copper 65WP) were effective in controlling *P. capsici* in pepper in the fields. Applications of the fungicides should be at weekly intervals, beginning transplanting seedlings in the field until 3–4 weeks before the final harvest.

Oral Session 5:

Jefferson C

Horticultural Crops Culture and Management: Fruit and Nut Crops 1

Saturday, 25 July 2009, 4:15–6:00 pm

Moderator: R. Paul Schreiner, paul.schreiner@ars.usda.gov

4:15–4:30 pm

Cytokinin for Chemical Fruit Thinning of Asian Pears

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Asian pear fruit price and quality are closely associated with fruit size. Large fruit are highly desired and bring excellent market price. In most years heavy fruit set in Asian pears requires expensive hand thinning to reduce crop load enough to obtain optimum fruit size. Effective chemical thinners are urgently needed by Asian pear growers. Experiments were conducted to evaluate a cytokinin (6-benzyladenine formulated as MaxCel) as a chemical thinner for Asian pears. The experiments were conducted in commercial orchards in New Jersey in 2007 and 2008.

Spray applications of MaxCel at 0, 200, or 250 ppm were applied at 12 mm average fruit diameter to 'Hosui' (in 2007) and 'Kosui' trees in Northern New Jersey and at 0, 50, 100, 150, 200, and 250 ppm to 'Hosui' (in 2008), 'Shinko', and 'Yoinashi' trees in Southern New Jersey. Treatments were applied in 100 GPA of water at 80 PSI with a handgun sprayer. In both experiments in Northern New Jersey the 200 and 250 ppm treatments reduced fruit set significantly but, 200 ppm was not different from 250 ppm. In Southern New Jersey, where crop load was much less, significant thinning was only obtained with 250 ppm and only in one cultivar ('Yoinashi'). Time required for follow-up hand thinning to adjust crop levels was significantly decreased only in the experiments in Northern New Jersey. Time required for hand thinning was significantly reduced in 'Hosui' trees treated with 250 ppm and in 'Kosui' trees treated with either 200 or 250 ppm. MaxCel can be an effective a chemical thinner for Asian pears.

4:30–4:45 pm

Does Foliar-applied Phosphorus Influence Vine P Status, Mycorrhizal Fungi, or Fruit Yield and Quality of 'Pinot Noir' Grapevines?

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Foliar application of phosphorus (P) fertilizers in Western Oregon vineyards was previously linked to reduced root colonization by arbuscular mycorrhizal fungi (AMF) at veraison. Vines grown in low P soils typical of most Oregon vineyards may benefit from additional P supplied to the canopy. Alternatively, vines may be negatively affected by foliar P use if lower root colonization by AMF reduces uptake of other nutrients or increases vine water stress. The impact of foliar P fertilizer use on vine growth, nutrient status, AMF colonization, drought stress, and fruit yield and quality was studied in two 'Pinot noir' vineyards over three years. Three treatments (phosphite fertilizer, phosphate fertilizer, water control) were applied to the foliage three times over the growing season using a standard air-blast sprayer at a commercial vineyard. Two treatments (phosphite fertilizer, water control) were applied using a hand sprayer at a smaller research vineyard. Fertilizers were applied to foliage on the same days and at the same rate and volume per acre at both sites. The level of P applied to the foliage in each year was equivalent to 50% of the yearly canopy accumulation of P for vines grown in the region. Foliar P applications increased leaf and petiole P concentrations and reduced arbuscular colonization of roots at the research vineyard, but not at the commercial vineyard. This may be a result of greater precision of application at the research vineyard. Foliar P use had no effect on vine growth, drought stress, yield, or fruit quality attributes at either site. These results indicate that there is little benefit to applying P fertilizers to the canopy of grapevines, even in low P vineyards. The slight reduction of AMF root colonization that did occur at the research vineyard in response to foliar P applications did not result in a measurable increase in vine water stress or significant effect on other vine parameters.

4:45–5:00 pm

Water Relations and Net Carbon Assimilation Rate Response in Two Commonly Used Pecan Rootstocks

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Pecan is an important nut crop grown throughout much of the southern

U.S., with New Mexico, Georgia, and Texas ranked as the leading producers. The commercial pecan nursery industry currently relies on improved cultivars grafted on rootstocks derived from open-pollinated seeds. Seedstocks are chosen in relation to their geographical origin and general historical performance as rootstocks. Despite the fact that certain seedstocks are recommended more than others for particular soil or climate conditions, little is known about the physiology of known rootstock cultivars of pecan. An experiment was conducted to investigate the physiological differences between two open-pollinated pecan seedlings (Apache and Elliott) grown in field conditions. Traditionally, 'Apache' has been recommended for the dryer regions of the pecan producing area, whereas 'Elliott' is more frequently used in the more humid southeast. The study was conducted from May to September 2007 on rain-fed, six-year-old, open-pollinated 'Elliott' and 'Apache' seedlings. Leaf relative water content (RWC) and leaf water potential were measured throughout the season at predawn and midday. Single leaf net CO₂ assimilation rate (A) was measured with a portable infrared gas analyzer in May, June, August, and September at 1000 and 1500 HR. At 1000 HR the two rootstocks had similar A values, but at 1500 HR 'Apache' A values were greater in May and lower in August and September than 'Elliott'. Pressure-volume (P-V) curves were also performed four times during the season. Except for isolated exceptions, all parameters derived from the analysis of the P-V curves (modulus of elasticity, RWC at zero turgor, and osmotic potential at full turgor) were similar between the two rootstocks. A/C_i curves [net CO₂ assimilation rate (A) versus calculated internal CO₂ concentration, C_i] were performed once in September. The maximum velocity of RuBisCO for carboxylation, the rate of photosynthetic electron transport, the rate of use of triose phosphates, respiration, and mesophyll conductance were calculated and there were no significant differences between the two rootstocks in any of these parameters. Overall the results from the present investigation revealed that the known performance differences in phenotype performance of the two rootstocks did not translate into differences in gas exchange or water relations parameters. Further evaluation of pecan germplasm for useful sources as rootstock in diverse environmental conditions is warranted.

5:00–5:15 pm

Effects of Nitrogen, Potassium, Irrigation, and Crop Load on 'Honeycrisp' Fruit Quality

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Two field studies were planted in 2002 using 'Honeycrisp' apple trees on M.9 rootstock. The first experiment compared soil applied nitrogen (0 and 100 kgN/ha), potassium (0 and 200 kgK₂O/ha) and irrigation (none and trickle irrigation) in a factorial treatment scheme from 2002–2006. The second study compared foliar fertilizer treatments of N, B, Zn, Mg, and Ca, and irrigation in a factorial treatment scheme from 2002–2006. From 2004–2006 four crop loads (0, 4, 8, 12 fruits/cm² TCA) were imposed on whole trees as a subplot treatment. Nitrogen soil fertilization increased tree growth in the first two years but not after cropping began. Nitrogen fertilization increased fruit size, yield, soluble solids and rot incidence but resulted in reduced red color, firmness and total value of the crop in two years. Potassium fertilization increased shoot and tree growth, fruit size, red color and total crop value but reduced fruit dry matter concentration. Irrigation increased shoot and tree growth, yield and fruit size but reduced fruit soluble solids and increased crop value in only 1 year. The combined effects of rainfall and irrigation were evaluated by calculating annual water balance and correlating tree and fruit responses to water balance over the 3 years. Fruit red color, size, incidence of soggy breakdown and incidence of soft scald

were positively related to annual water balance while fruit firmness, soluble solids, bitter pit incidence and rot incidence were negatively related to water balance. Bitter pit incidence was most influenced by water balance during the early season near petal fall. Crop load had a negative effect on shoot and tree growth, fruit size, firmness, soluble solids and dry matter concentration. Increasing crop load reduced storage disorders (especially bitter pit), fruit rots and percentage of bad fruits. Crop value increased with increasing crop load up to 8–10 fruits/cm² TCA. Foliar nutrient sprays has little effect on tree growth, yield or fruit quality. Ca sprays reduced bitter pit incidence in only 1 year. Fruit mineral concentrations and ratios of nutrients were correlated with fruit responses. Fruit P/S ratio was positively related to fruit red color. Fruit Ca content was not related to fruit firmness or bitter pit incidence. Fruit P concentration was positively related to incidence of bitter pit. Fruit Ca/water ratio and fruit P concentration were positively related to fruit dry weight, whereas fruit Ca was negatively related to it. Fruit S content was positively related with blue mold incidence.

Specified Source(s) of Funding: New York Apple Research and Development Program

5:15–5:30 pm

ReTain Can Increase Nutmeat Yield of Pecan Trees

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Excessive fruit-drop limits profitability of certain pecan [*Carya illinoensis* (Wangenh.) K. Koch] cultivars. The present study examined the efficacy of ReTain®, a natural ethylene inhibitor, for reducing fruit-drop. Four years of field studies on ‘Desirable’ pecan trees found that ReTain® can substantially reduce fruit-drop; thus, increasing crop-load over non-treated trees by as much as 16-38%, with the percentage retention being greatest in trees with a relatively heavy crop load and minimal in trees with a light crop load. The efficacy of ReTain® for reducing fruit-drop increases with crop load. Efficacy is also greatest when applied soon after the termination of stigma receptivity. Two post-bloom applications of ReTain® increased fruit-set in an “on-phase” commercial orchard with an moderately heavy crop by 38%, while not reducing in-shell yield or kernel quality the following year when ReTain® was not used and the orchard possessed a light to moderate crop-load. Proper usage of ReTain® appears to offer commercial producers of ‘Desirable’ nutmeats a practical tool for reducing fruit-drop and managing crop-load.

Specified Source(s) of Funding: USDA–ARS

5:30–5:45 pm

Development of Citrus Cultivars Resistant to Huanglongbing Disease by Transformation with AMP Genes

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New citrus cultivars with resistance to the devastating disease Huanglongbing (HLB) are urgently needed in Florida and everywhere HLB is found. Surveys of citrus germplasm for resistance to HLB that may be used in conventional breeding have not yet identified any reliable sources of strong resistance to this bacterial disease. Even if sources of resistance are identified, developing new citrus cultivars through conventional breeding may take too long to wait for the desperately needed new cultivars. The most promising approach appears to be transformation of good existing cultivars with transgenes that confer resistance to HLB or its vector. Antimicrobial peptide (AMP) genes have been selected for our initial work in transformation because of their broad activity against bacterial pathogens and preliminary work indicating suppression of bacteria closely related to the *Liberibacter* pathogen that causes HLB. Methods for the *Agrobacterium*-mediated genetic transformation of citrus using seedlings of the rootstocks US-802 and US-812 were refined to obtain about 4 putative transformed shoots in vitro per explant seedling of US-802 and 5 shoots per explant seedling of US-812. Candidate transformed shoots of the rootstocks were rescued, after antibiotic selection, by an improved micrografting technique. Approximately 30% and 86% of the shoots from US-802 and US-812, respectively, survived the micrografting and transition to the greenhouse. Testing of established micrografted plants in the greenhouse for transgene insertion, indicated that 37% and 76% of the US-802 and US-812 greenhouse plants, respectively, were transformed with the target AMP transgene. Selected transgenic citrus plants with the AMP transgene were challenged with HLB disease using psyllid and graft inoculation under greenhouse conditions. During preliminary testing, some AMP transgenics appeared fully susceptible to HLB infection, while others appeared to have some resistance. Testing of the AMP transgenic citrus for resistance to HLB is continuing.

Specified Source(s) of Funding: CRIS

5:45–6:00 pm

Yield and Postharvest Quality Attributes of Date Palm Are Affected by Sub-optimal Irrigation During Fruit Development

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Date palm (*Phoenix dactylifera*) is primarily cultivated in arid and semi-arid regions that are characterized by high evapotranspiration, low and sporadic rainfall and dependency on irrigation for crop cultivation. Frequent drought periods influence growth, yield and fruit quality of fruit crops in these regions. The effects of sub-optimal irrigation on the yield and fruit quality attributes of dates were investigated. Physico-chemical quality attributes of date palm (cv. Khalas) grown in northern Oman showed variable response to reduced frequency and amount of irrigation water applied during fruit development. Bunch weight, fruit weight, Fruit juice content, titratable acidity, and reducing sugars were reduced in the fruits of the least irrigated date palms, whereas, total soluble solid contents (°Brix), percentage of dry matter, and pectin were increased. No significant differences were observed in tannins, pH, and ash content. Yield and eating quality of dates were directly related to the amount of irrigation water received during fruit development.

Oral Session 6: Jefferson D/E
Horticultural Crops Culture and Management:
Floriculture Crops 1
Saturday, 25 July 2009, 4:45–6:00 pm

Moderator: James Barrett, jbarrett@ufl.edu

4:45–5:00 pm

Production Environment Light and Temperature Affects Postharvest Vaselife of Cut L.A. *Lilium* ‘Dazzle’ and *Helianthus* ‘Sunbright’

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Preharvest temperature and light conditions are thought to alter post-harvest vaselife of cut flowers. Cut *Lilium* ‘Dazzle’ (L.A. type) and *Helianthus* ‘Sunbright’ were grown in a 3 × 2 factorial at 10, 15, or 20 °C night temperature and high or low light. In additional treatments, plants were moved from a starting environment to a finishing environment two weeks prior to harvest: 1) plants started at 15 °C in high light were moved to low light and vice versa; 2) plants started in low light at 10 or 20 °C were moved to high light at 20 or 10 °C, respectively; and 3) plants started in high light at 10 or 20 °C were moved to the opposite temperature at high or low light. Night temperatures of 20 °C decreased vaselife of cut *Lilium* to 11.0 days compared to 13.9 or 13.1 days, for 10 and 15 °C, respectively. Similar results were obtained when plants that were moved two weeks prior to harvest were grouped with plants remaining in their starting environment. However, when plants that were moved were grouped with plants from their finishing environment for analysis, vaselife was 13.0, 12.8, and 12.1 days for 10, 15, and 20 °C, and only 10 and 20 °C were different. Thus, starting temperature may be more important than finishing temperature in determining vaselife in *Lilium*. Light had no effect on vaselife of cut *Lilium*; however, the number of marketable stems with at least three buds at harvest was reduced by low light as well as by high temperature. For *Helianthus*, there was a temperature by light interaction where vaselife decreased from 14.8 days for stems grown in low light at 15 °C night temperature to 10.2 days for those grown in low light at 20 °C night temperatures. For *Helianthus*, it is not clear whether starting environment or finishing environment is more important in determining vaselife.

5:00–5:15 pm

Bulb Tissue Cold-tolerance Sensitivity Differences in Non-hardy and Winter Hardy *Lilium*

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The genus *Lilium* contains 80–100 species in seven sections distributed across the northern hemisphere between 10°N and 60°N. lat. Many species are important commercial floricultural crops. Not all lily species and cultivars are winter hardy in northern latitudes (USDA Z3-Z4) such as Minnesota. For instance, *Lilium longiflorum* (Easter lily) and *L. formosanum* only marginally survive in Z4 with adequate snow cover and mulch while others are extremely cold tolerant (*L. regale*, *L. martagon*). As part of a breeding objective for selection and

development of winter-hardy, seed-propagated interspecific lily hybrids this research focuses on the identification of which bulb tissue(s) are the most cold-sensitive. This information will provide selection criteria in assessing and selecting for cold tolerance. Lily germplasm evaluated in this study included Z3-4 hardy (2-Oriental, 28-Asiatics, 1-Aurelian, 3-Trumpets, 4-Orienpets, 8-LAs, 6 *L. martagon*, *L. regale*) and Z5+ non-hardy (*L. davidii* var. *unicolor*, *L. henryi*, *L. longiflorum*, *L. formosanum*, *L. leichlinii*, *L. speciosum album*, *L. tsingtauense*) genotypes. Bulbs were acclimated to 2 °C for 1,000 hrs prior to conducting programmed laboratory freezing tests of intact bulbs in soilless medium. Cold tolerance was assessed at 0 °C, -2 °C, -6 °C, -8 °C, -12 °C with varying ramp time periods and a 2-h soak time. After each treatment, samples were placed into a cooling chamber at 2 °C for 20 d in darkness until completely thawed. Subsamples were dissected and the remainder were moved to greenhouse conditions of 20/17 °C (day/night) temperature with a 16-h photoperiod. Three weeks later those samples were dissected. For non-hardy species, e.g. *L. longiflorum* ‘Nellie White’, LT₅₀ = -2 °C for <1/3 damage to the mother scales, whereas LT₅₀ = -12 °C for 50% kill of mother scales, 33-50% kill in daughter, and 100% of the meristems. Leaves were less sensitive (LT₅₀ = -8 °C for < 33% kill). However, an LT₅₀ = -6 °C for was found for the basal plate leading to bulb lethality in most cases; at -8 °C, virtually all bulbs were dead and did not regrow. The order of tissue sensitivity was mother scales first, followed by the basal plate, leaves, and then daughter scales and meristem. Hardy and non-hardy groups differed in tissue sensitivities.

Specified Source(s) of Funding: North Star Lily Society; North American Lily Society; MN Agric. Expt. Station

5:15–5:30 pm

Application of Benzyladenine and Gibberellic Acid Prevents Abscisic Acid Induced Leaf Chlorosis in Pansy and Viola

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Maintaining the postproduction quality of floriculture crops is a major economic issue for the green industry. Profit losses can result from harsh environmental conditions that are encountered by finished floriculture crops in the retail setting or during shipping. Such conditions include extreme heat and drought stress. For floriculture crops to tolerate environmental stresses, such as drought, they must reduce water loss. The plant hormone abscisic acid (ABA) has been associated with many physiological responses in plants, among which is the closing of the stomata to reduce water loss during drought stress. Applications of s-ABA, an ABA biochemical (Valent Biosciences Corp.), were effective at reducing water loss but resulted in leaf chlorosis in some plant species such as *Viola × wittrockiana* (pansy) and *Viola cornuta* (viola). This leaf chlorosis resulted in an unmarketable crop regardless of the developmental stage of the pansies or violas. To reduce or eliminate the leaf chlorosis, applications of benzyladenine (BA), gibberellic acid (GA₄₊₇), a combination of benzyladenine and gibberellic acid (BA and GA₄₊₇) and ethylene receptor blocker (1-MCP) were evaluated. Applications of 5 and 10 mg·L⁻¹ benzyladenine and gibberellic acid (BA and GA₄₊₇) prior to an application of 250 or 500 mg·L⁻¹ s-ABA eliminated leaf chlorosis and maintained the water status of the plant

allowing marketability of the crops to be maintained even under severe drought conditions.

Specified Source(s) of Funding: Department, College, State and/or HATCH Federal competitive, Valent BioSciences, Gladys Wittmeyer Knox-Gene Wittmeyer Scholarship

5:30–5:45 pm

The Timing and Duration of High Temperature Exposure Impacts Flowering Time of Poinsettia

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High temperature delay in poinsettia floral initiation termed ‘heat delay’ has been recorded following 28 days of exposure to 28 °C day/24 °C night temperatures around the time of floral initiation. The role of the relative timing and duration of high temperature exposure on heat delay in poinsettia ‘Autumn Red’ is investigated. Two experiments were carried out under natural day conditions at 29°40’N latitude. Plants were exposed to high temperatures (28 °C day/24 °C night) for 14 or 21 days as designated by treatment and grown at moderate temperatures (24 °C day/21 °C night) for the remainder of the experiment. Both experiments included control groups exposed to 0 and 28 days of high temperatures. High temperature treatments were imposed at 7 day intervals beginning 21 days before predicted floral initiation through 14 days before predicted anthesis. The calendar dates representing the predicted initiation and anthesis dates for ‘Autumn Red’ with natural day lengths at 29°40’N latitude were determined in previous experiments. Data were collected on the number of days from pinching (1 Sept. 2006 in Expt. 1 and 1 Sept. 2007 in Expt. 2) to floral initiation and anthesis. Plants in the high temperature control groups reached floral initiation 11 or 12 days later and anthesis 11 or 14 days later than the low temperature control plants in Expts. 1 and 2, respectively. In Expt. 1, plants exposed to 14 days of high temperature beginning 14, 7, or 0 days before predicted floral initiation reached floral initiation 5, 5, and 1 days and anthesis 4, 6, and 1 days later the low temperature control plants, respectively. In Expt. 2, plants exposed to 14 days of high temperatures beginning 21, 14, 7, or 0 days before predicted floral initiation reached floral initiation 0, 4, 5, and 0 days and anthesis 0, 5, 6, and 1 days later the low temperature control plants, respectively. Plants exposed to 21 days of high temperatures beginning 14 or 7 days before predicted floral initiation reached floral initiation 10 and 14 days and anthesis 11 and 12 days later than low temperature control plants, respectively which are 3 or 0 days before high temperature control plants, respectively. These data indicate that the timing and duration of high temperature exposure determines the magnitude of heat delay of poinsettia.

5:45–6:00 pm

Effects of Spray Volume and Washing on Efficacy of S-ABA Spray Applications

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S-ABA is being developed for use on bedding plants and other crops to reduce transpiration and increase time to wilt. The objective of this work was to evaluate two factors that might alter the efficacy of S-ABA in commercial applications. Water use was determined by change in weight over 24 hr. To evaluate the effects of spray volume, S-ABA was applied at 1,000 or 2,000 mg/L to petunia ‘Dreams Appleblossom’ and impatiens ‘Super Elfin XP Blue Pearl’. Spray volumes were 100,

200, 300 or 400 ml/m². Nonsprayed control plants were included in each experiment. The amount of water used by petunia plants sprayed with 1,000 mg/L in 100 ml/m² was 57% of amount for control plants. Water use decreased to 38% in plants sprayed at a volume of 400 ml/m². For impatiens, the amounts of water used by plants in the respective treatments were 74% and 66% of amounts used by the control plants. The effect of 2,000 mg/L of S-ABA at all spray volumes was similar to 1,000 mg/L. In experiments to evaluate the potential for washing off S-ABA with irrigation following a spray application, plants were quickly dipped in water at intervals after S-ABA was applied at 2,000 mg/L. Amount of water used in Salvia ‘Jedi Red’ plants washed at 5, 15, 30 or 60 min after the spray was increased by 53%, 24%, 24% and 12%, respectively, compared to plants that were sprayed and not washed. For Petunia ‘Dreams Red’, water use amounts were increased by 57%, 30%, 22%, and 19% by washing at 5, 15, 45, and 135 minutes after the S-ABA spray application. These results indicate that overhead irrigation shortly after S-ABA is applied may cause a significant decrease in efficacy. Changes in spray application volume do cause a variation in efficacy, but above 200 ml/m² the effects are relatively minor.

Oral Session 7: Jefferson A Horticultural Crops Culture and Management: Fruit and Nut Crops 2 Sunday, 26 July 2009, 10:15 am–12:00 pm

Moderator: Lenny Wells, lwells@uga.edu

10:15–10:30 am

Monitoring and Evaluation of the Mango Supply Chain to Improve Mango Quality

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Mango fruit quality may be influenced by production practices, maturity at harvest, postharvest technologies, and various handling practices. Therefore, in order to identify areas in which market losses can be reduced and fruit quality can be improved for the ultimate consumers, an evaluation of the entire mango supply chain from farms to packer/shippers to receivers and retail handlers in the United States was conducted

with sponsorship by the National Mango Board (NMB). Members of the 'Mango Quality' team worked in the five major mango exporting countries (Ecuador, Peru, Guatemala, Mexico, and Brazil) throughout a full year to evaluate mango export handling operations and to conduct mango shipping trials. Team members evaluated those same shipments upon arrival in the United States and monitored retail mango displays in Florida and California throughout the year to understand and document the quality of mangos being offered to consumers at retail. Key observations relating to mango quality centered on four areas: harvest maturity; precooling and general temperature management; grading at the packinghouses; and management of mango displays at retail stores. Harvesting and shipping mature (i.e., ripening initiated) mango fruit reduces heat injury and chilling injury, and ensures full flavor development and best overall quality at retail. Hydrocooling after hot water treatment, conducted according to APHIS protocol, reduces hot water injury; proper forced-air cooling to 12 °C prior to loading transport vehicles obviates the perceived need to use lower shipping temperatures that can cause chilling injury (temperatures as low as 7 °C were observed for some shipments). Effective grading at the packinghouses has several important benefits: it reduces exposure of shippers to adjustments and claims, relieves importers in the United States from re-working shipments to satisfy retailer specifications, and portrays a more appealing image of mangos in the market place; removing defective fruit at the source also avoids unnecessary costs and wasted energy. Temperatures to which mangos were exposed in distribution centers and retail stores varied from 4 °C to 21 °C. Retail Produce Department personnel need better training to remove poor quality fruit and fruit that are ripening abnormally or developing disorders when rotating displays. The results of this project were reported to the NMB in quarterly reports and developed into a Mango Postharvest Best Management Practices (BMP) Manual. Subsequently, the NMB has funded follow-up research to determine the chilling sensitivity of major mango varieties under commercial conditions, and initiated an outreach program of webinars to communicate mango BMPs to stakeholders.

Specified Source(s) of Funding: National Mango Board

10:30–10:45 am

Differential Effects of Nitrogen Supply On Skin Pigmentation and Flesh Starch Breakdown of 'Gala' Apple

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Apple maturity is often assessed by starch hydrolysis indices, skin color, soluble solids, flesh firmness and the rate of ethylene evolution. In red fruited apple cultivars, the intensity and the extent of coloration is an important factor in determining the time of fruit harvest. Negative relationships have been found between tree N status and fruit skin pigmentation, but how nitrogen affects flesh starch breakdown has not been examined in detail. The objective of this study was to determine how nitrogen supply affects flesh starch breakdown relative to skin color development. Seven-year-old 'Gala'/M.26 trees were supplied twice weekly with 4 L of a modified Hoagland's solution at a nitrogen concentration of 5.0, 15.0, 30.0, or 60.0 mM in Hoagland's solution. The influences of nitrogen supply on yield, fruit quality, and fruit maturation were evaluated. At harvest, fruit in the lowest N supply treatment was significantly smaller, and had lower soluble solids, but higher starch, better color, and higher firmness than those grown at higher N supplies. Increasing N supply decreased both chlorophyll degradation and anthocyanin synthesis in fruit skin, but increased amylase activity in flesh. These results indicate that increasing N

supply delays skin red color development but enhances flesh starch degradation in 'Gala' apples. These differential effects of nitrogen supply should be taken into account when assessing fruit maturity for optimizing harvesting time.

Specified Source(s) of Funding: Cornell Agricultural Experiment Station

10:45–11:00 am

Genetic Determination for Susceptibility to CO₂-induced Injury in Apple

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Use of CA storage is common in horticulture for extending the shelf life and quality attributes of fruits. However, maintaining CO₂ at levels low enough to avoid CO₂ injury is a major problem in the operation of CA facilities. This study was aimed at determining genetic basis for susceptibility to CO₂ injury in apple to facilitate 1) parental selection and development of new varieties with little or no susceptibility to CO₂ injury, and 2) setting up further genetic studies to dissect the underlying genetic mechanisms involved. We carried out studies in 2001 and 2002 with 41 and 35 seedling families respectively, selected from 'breeding population 94' of an apple recurrent selection programme well suited for genetic studies. Fruit from these families were harvested at or near physiological maturity and subjected to 3 CA treatments; air, 5% CO₂ (+ balanced air) and 10% CO₂ (+ balanced air) for 10 weeks in 2001 or 6 weeks in air and at 5% CO₂ in 2002. The incidence and severity of CO₂ injury were assessed after storage and various statistical procedures including GLM, ANOVA, permutation tests, Monte Carlo simulations and Bootstrapping were used to explore the sources of variation for incidence of CO₂ injury. There was a significant family or genetic effect ($P < 0.001$) on susceptibility to CO₂ injury. The results provide the basis for further studies to identify the underlying genetic mechanisms involved as well as selection of parents to develop new varieties with little or no susceptibility to CO₂ induced injury.

Specified Source(s) of Funding: Capability funds-Plant & food Research New Zealand Limited

11:00–11:15 am

Are Resting Spurs Necessary for Return Bloom in Apple?

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Flowering was studied in 'Gala' and 'Fuji' apple trees over 2 growing seasons to determine the importance of resting spurs. At bloom, spurs were selected that were vegetative, flowered but had the flowers removed at bloom, or flowered and allowed to carry a single fruit. Buds were samples from each of these spur categories throughout the growing season and dissected to follow the course of flower development. The presence of flowers or fruit on a spur had no effect on the degree or timing of flower formation for either cultivar in either year. Cultivar did not affect the time of flower formation in either year. However there

was a dramatic difference in the time of flower formation between the two years. From these data, it appears that return bloom in moderate-sized buds depends more on total tree crop load than whether a particular spur bears fruit.

11:15–11:30 am

Assessing Apple Cultivar Characteristics for Hard Cider Production

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Several mesoclimates in Western Washington are similar to the regions in Europe where fermented apple cider is produced. For cider making purposes, apples are classified primarily by the levels of tannins, sugars (brix) and pH in their juice. Juice analysis enables us to categorize each apple variety by standards established at the Long Ashton Research Station in Bristol, UK, and include 4 basic categories; bittersweet; bittersharp, sharp and sweet. To evaluate apple juice characteristics and qualities in our region, two orchard blocks were established at the Washington State University Mount Vernon NWREC. The first study was planted in 1994 and consisted of six varieties with five trees per variety in a non-replicated plot; fourteen varieties were added and one removed in 1999-2002, and 7 varieties were added in 2005 so the planting now includes 25 varieties. The second block was planted in 2004 and consists of 36 varieties planted in single tree plots. In 2008 juice samples were taken from 34 varieties from both test blocks. The juice samples were analyzed for °Brix, pH, titratable acids (TA) and percentage of tannins. Tannins were ascertained by the Association of Analytical Chemists (AOAC) titration method. Brix readings were taken with a refractometer and pH was taken with a pH meter. Values for percent tannins ranged from a high of 0.41% (Vilberie) and 0.34% (Kermerrien) to a low of 0.06% (Redstreak) and 0.05% (Granniwinkle). The °Brix ranged from 18.0 in Golden Russet to 10.4 in Breakwell seedling while pH ranged from a high of 4.47 in Dabinett to a low of 3.35 in Bramley's seedling. Knowing the characteristics of apple varieties is critical for a cider making. The amount of tannin in a cider affects the flavor, the mouth feel, and complexity of the fermented cider product. In addition, balancing juice pH is important in making a stable and drinkable product. A good drinkable cider normally has a juice pH between 3.3 and 3.8 provided that good fermentation practices are employed. If the pH is below 3.3; (characteristic of many sharps and dessert apples), the product will be too tart to drink when the juice is fermented. A juice pH above 3.8 (most bittersweets), makes the product susceptible to contamination from microorganisms. Knowing the juice characteristics of each variety can help a grower decide what to plant for blending purposes.

Specified Source(s) of Funding: Washington Wine Advisory Board

11:30–11:45 am

Establishment, Productivity, Cross-Compatibility, and Pollen Vectors for 28 Pawpaw Cultivars in Upstate New York

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A pawpaw (*Asimina triloba*) variety trial was established near Ithaca, N.Y. in April 1999, consisting of 28 advanced selections and cultivars from the USDA PawPaw Germplasm Repository in Kentucky. Eight replicate trees of each genotype were obtained as dormant bench-grafts on seedling rootstocks, and planted in a randomized block design at a site near Cayuga Lake. Survival during the first two years ranged from 100% (for Taytwo, 2-54, and NC-1) to 12.5% (for 3-21), and heat stress during the first summer was the primary cause of mortality. Dead trees were replaced in 2000, and after 10 years tree survival ranged from 100% (for Taytwo and NC1) to 25% (for 3-21 and 4-2). Cumulative tree size (TCSA at 30 cm above graft unions) after 10 years ranged from 128.2 cm² for NC-1, to 44.5 cm² for 1-7-2. Cumulative yields per tree ranged from 67.2 kg per tree for 1-7-1, to 3 kg per tree for 3-21. Average fruit fresh weights ranged from 231 g for 1-7-1, to 74 g for Wilson. All of the surviving trees remained healthy during ten years of observations, and did not exhibit the leaf blight reported for other pawpaw plantings, although cultivars 9-47, 1-68 and 5-5 did show mild leaf spot symptoms during some years. Most cultivars began flowering and bearing in the fifth year after planting. Biennial bearing was evident in most cultivars, with 1-7-1, 2-10, PA-Golden and Taytwo being the most annually productive. The average ripening dates ranged from day-of-year 264 (for 3-21) to day 291 (for 2-54). We monitored pollinator activity throughout bloom in 2006, and observed aggregations of Nitidulidae beetles around the stamens, and occasional floral visits by Lampyridae beetles, but no visits by carrion flies or beetles. Pollen anthesis preceded or followed apparent stigma receptivity in most cultivars, but controlled cross-pollination tests indicated that all 28 of the varieties were at least partially self-compatible. Consumer acceptance of all 28 cultivars was generally positive in a local retail market; fruit that were harvested when they began to soften and ground color had changed from pale green to pale yellow maintained acceptable condition for about six weeks in regular air storage at 2 °C.

Specified Source(s) of Funding: USDA-CSREES

11:45 am–12:00 pm

Mechanical Fruit Thinning Enhances Production of Cape Fear and Sumner Pecan

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The effects of mechanical fruit thinning on pecan [*Carya illinoensis* (Wangenh.) K. Koch] yield, nut quality, and profitability was assessed for the cultivars Sumner and Cape Fear. Ten 20-year old trees of both pecan cultivars growing in a commercial pecan orchard in Irwin County, Georgia were used for the study. Trees were selected based on uniformity of size, vigor, and excessive crop load. Trees were spaced 12.2 × 12.2 m and were drip irrigated. Trees were in good health and were managed according to University of Georgia Extension recommendations. Treatments were replicated five times in a randomized-complete block design. Five trees of each cultivar were mechanically thinned for 8 seconds by trunk shaking to remove approximately 30% to 40% of the fruit on each tree on August 1, 2007, and five trees were non-thinned. Initial crop load for all trees was excessive in 2007 with ≥ 85% of terminals bearing fruit on each tree at the time of thinning. The OFF year return crop and return crop value of both 'Cape Fear' and 'Sumner' was increased by mechanical thinning in the ON year. This enhanced the 2-year average value of both cultivars. Increased profitability of these cultivars with mechanical fruit thinning results primarily from higher yields and prices in the OFF year of production, which offset any loss in yield and/or crop value generated by fruit thinning in the ON year. Premature germination of 'Cape Fear' pecans were reduced by 29% with mechanical fruit thinning.

Oral Session 8:
Genetics/Germplasm/Plant Breeding:
Cross-Commodity
Sunday, 26 July 2009, 10:30 am–12:00 pm

Field

Moderator: Linda Wessel-Beaver, lbeaver@uprm.edu

10:30–10:45 am

**Breeding Snap Beans (*Phaseolus vulgaris*)
for Large-scale Production**

James Nienhuis*

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The most common organic vegetable producers tend to be small entrepreneurs who spread the risk of disease, pests, weeds, and weather patterns among many different crops and cultivars. In contrast, large-scale production of organic processing vegetables cannot spread risk among crops; it is a contractual agreement with a grower, often for a specified cultivar to be harvested and delivered to a processing plant on a specific date. To achieve large-scale production that is compatible with organic standards, technology must be developed to reduce the risk and costs associated with organic production. Regardless of whether the production system is conventional or organic two of the most important constraints to large scale snap bean production in the upper Midwest, are root rot disease and nitrogen availability. In Wisconsin, the two most severe root rot pathogens are *Pythium ultimum* and *Aphanomyces euteiches* f. sp. *phaseoli*. We have developed root rot resistant snap bean cultivars the seed of which can be planted in the central sands region of Wisconsin without seed treatment. We are presently investigating the combination of root rot resistance, Entrust organic insecticide and organic fertilizer as a package for large-scale organic snap bean production.

10:45–11:00 am

**Genetic Diversity of USDA *Cucumis metuliferus*
Collection Revealed by Cucumber Genomic
Microsatellite Markers**

Yiqun Weng*

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Cucumis metuliferus E. Mey. ex Naud (African horned cucumber, AHC) is indigenous to Africa and is a relative of cultivated cucumber (*C. sativus* L.) and melon (*C. melo* L.). AHC is being promoted as a specialty fruit crop in a number of countries. In addition, several traits in *C. metuliferus* such as high level resistance to the southern root knot nematode and papaya ring spot virus, sequential and concentrated fruiting are very attractive for improving cucumber or other cucurbit crops. However, attempts in the past to cross AHC with either cucumber or melon have been unsuccessful. In the present study, genetic diversity among the USDA *C. metuliferus* collection was evaluated with microsatellite (simple sequence repeat, SSR) markers derived from cucumber genomic DNA sequences. Of the 564 cucumber SSRs tested, over 50% (286/564) were able to amplify PCR products from *C. metuliferus* genomic DNA templates suggesting high degree DNA sequence homology between the two species. Forty cross-species transferable SSRs were selected to investigate genetic variability among 37 USDA accessions and 2 commercial source *C. metuliferus* selections. Clustering analysis of marker data revealed unexpectedly low genetic diversity among these *C. metuliferus* accessions. Each marker, on average, was able to detect only two alleles. Seventeen of the 40 markers were monomorphic among the 39 lines tested. The possible reasons of the very low genetic diversity among *C. metuliferus* accessions and the implications of this finding with regard to use of *C. metuliferus*

resources in cucurbit improvement will be discussed.

11:00–11:15 am

**Phenotypic Variation for Resistance to Tomato
Spotted Wilt Virus in Pepper**

Kevin Crosby*

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Resistance to TSWV in pepper has been documented from *Capsicum chinense* accessions PI 152225 and PI 159236. The dominant *Tsw* gene has been introduced into several commercial cultivars but it frequently fails to prevent systemic infection, depending on thrips pressure and the genetic background of the cultivar. We have recently documented novel resistance phenotypes in *Capsicum annuum*. Currently we are evaluating the genetic inheritance of the genes involved. Based on F_1 hybrid data, there appears to be a strong dominant component. However, unlike with *Tsw*, there has not been any hypersensitive reaction with local lesions. In addition we also recorded extreme differences in the time required for the virus to become systemic, in lines carrying *Tsw* and others without this locus. We have developed inbred lines of *C. chinense* which contain *Tsw* with relatively short periods until breakdown of the hypersensitive response, and others which have never demonstrated systemic infection after 8 months of viruliferous thrips infestation in the greenhouse. The same phenomenon has been observed with *C. annuum* lines which do not have the *Tsw* gene. Finally, we have recorded a tendency of some lines, including several derived from *C. chinense* × *C. annuum* crosses, to recover from systemic necrosis, while adjacent susceptible lines continued to develop more severe symptoms and even die. We have developed some unique inter-specific hybrids to combine the different resistance genes and these lines have demonstrated excellent durability in our inoculated screening tests compared to any commercially available hybrids with the *Tsw* gene. In addition we have developed two new F_1 hybrid Habanero cultivars with extremely durable TSWV resistance. These cultivars contain the *Tsw* gene introgressed into *C. chinense* lines which previously had demonstrated excellent field resistance to TSWV, heat tolerance, early maturity and heavy yields. In addition to TSWV, one of the cultivars is homozygous recessive for the *pvr1* locus, providing resistance to PepMoV and TEV.

Specified Source(s) of Funding: Texas A&M University

11:15–11:30 am

**Genotype and Environment Effects on Carotenoid
Content of Broccoli**

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Carotenoids are secondary plant metabolites in vegetables reported to confer various positive health-promoting effects when consumed. *Brassica oleracea* L. vegetables are recognized as excellent sources of dietary carotenoids. Broccoli has emerged as the most important *B. oleracea* crop in the U.S. and it likely supplies more carotenoids to the U.S. diet than the other crops of the species. Little is known about the general carotenoid profile of this important vegetable or the levels of specific carotenoids and how they might vary among genotypes. Thus, the objectives of this study were: to assess carotenoid profiles of different inbred broccoli heads; to assess chlorophyll concentrations measured simultaneously during carotenoid assays; to determine the relative effects of genotype versus environment in influencing head carotenoid levels; and to examine phenotypic correlations between carotenoid levels and other traits. Results show lutein to be the most abundant

carotenoid in broccoli heads ranging from 65.3 to 139.6 $\mu\text{g}\cdot\text{g}^{-1}$ dry mass (DM) among nine inbreds tested in three environments. Genotype had a highly significant effect on lutein levels in broccoli heads and the ratio of genotypic variance to phenotypic variance for this carotenoid was 0.84. Violaxanthin also exhibited a significant genotype effect but it was found at lower levels (17.9 to 35.4 $\mu\text{g}\cdot\text{g}^{-1}$ DM) than lutein. β -carotene and neoxanthin were detected at levels similar to violaxanthin, but genotypic differences were not detected when all environments were compared. Significant genotypic differences were observed for both Chlorophyll a and b among the studied inbreds. Results indicated that most carotenoids measured were positively and significantly correlated with one another, indicating that higher levels of one carotenoid were typically associated with higher levels of others. This study emphasizes the relative importance of lutein in broccoli heads and the key role that genotype plays with this compound.

Specified Source(s) of Funding: USDA

11:30–11:45 am

Plant Breeding Recruitment and Education: A Puerto Rico–North Dakota Collaborative Initiative

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Plant breeders provide new or improved food, feed, fiber and ornamental plants that enable us to develop new markets, improve agricultural production efficiency, promote healthier food choices, and enhance the environment. Puerto Rico is home to the off-season nurseries of many of the world's largest seed companies. Plant breeding activities are an important component of agriculture on the island. The demand for graduates to fill jobs in both private and public sector plant breeding in Puerto Rico and across the U.S exceeds the supply. Without plant breeders, new knowledge coming from DNA technologies cannot be incorporated into a product that can be delivered to the farmer and consumer. Using funding from the USDA-CSREES-Hispanic Serving Institutions Education Grants Program, the University of Puerto Rico at Mayaguez (UPRM) is carrying out educational activities with the objective of recruiting and training students for careers in agriculture, with emphasis on plant breeding. The Department of Plant Sciences at North Dakota State University (NDSU) is collaborating in this effort. Both UPRM and NDSU have a tradition of providing their plant breeding graduates with the applied plant breeding skills in demand in today's employment marketplace. Nineteen undergraduate and graduate students from UPRM have participated in the NDSU Intern Program over the past three summers. Students are paid a weekly stipend and work full time in a plant breeding research program for 2.5 months. Twenty-four faculty and staff participated in a 3-day workshop on plant breeding and genetic resources, enabling participants to more effectively serve on graduate committees of plant breeding students. More than 10 undergraduates have carried out plant breeding related research projects. Nearly 200 high school students have learned about plant breeding via classroom visits. Educational materials have been developed. New equipment has been purchased for the plant breeding and molecular marker labs at UPRM. Five MS graduate students have benefited from partial financial support from this program. As of Spring 2009, six former UPRM students are beginning degrees in plant breeding and genetics at NDSU, including a PhD student fully supported by this grant.

Specified Source(s) of Funding: USDA-CSREES

11:45 am–12:00 pm

Resistance to the Large Raspberry Aphid (*Amphorophora agathonica*) in Black Raspberry

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Aphid resistance has long been recognized as an important tool in breeding red raspberries (*Rubus idaeus* L.) that escape infection by aphid vectored viruses in Europe and North America. Existing black raspberry (*R. occidentalis* L.) cultivars do not have resistance to the large raspberry aphid *Amphorophora agathonica* Hottes and sources of resistance in black raspberry germplasm have not been identified. Consequently, aphid transmitted viruses are a serious problem and have been implicated in the short life of black raspberry fields in Oregon and elsewhere. In 2007, approximately 4800 seedlings from 85 wild populations of black raspberries, collected as seed from across the species' native range, were screened in the greenhouse for resistance to *A. agathonica*, a major vector of *Black raspberry necrosis virus* and other viruses in *Rubus*. Strong resistance was found in two of these populations, one from Ontario and the other from Maine. Two selections from each of these populations were crossed with the susceptible cultivars 'Black Hawk' and 'Munger' and all of the resulting progeny tested showed strong aphid resistance. Subsequent tests with the closely related non-vectoring aphid *A. rubitoxica* Knowlton, showed that the population from Maine was resistant to this species while those from the Ontario population were not. The data suggest that aphid resistance in these two populations is controlled by different genes, and each is inherited as a dominant trait.

Specified Source(s) of Funding: Federal competitive

Oral Session 9: Jefferson C Horticultural Crops Culture and Management: Floriculture Crops 2 Sunday, 26 July 2009, 2:00–3:30 pm

Moderator: Marc van Iersel, mvanier@uga.edu

2:00–2:15 pm

Possible Roles of Silicon, Calcium, and Regulated Deficit Irrigation on Poinsettia Plant Quality and Postharvest Performance

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The effect of silicon on improving containerized plant quality is an area of active study. Improved stress tolerance, mechanical strength and disease resistance have been reported for several species, as well as changes in plant architecture and inflorescence size. To investigate possible beneficial effects of substrate applied Si and Ca in Poinsettia (*Euphorbia pulcherrima* Willd. ex Klotzsch) production. The treatment design was a factorial arrangement having 2 Ca concentrations, 2 Si concentrations, and 3 irrigation regimes. We applied 0 and 56 $\text{mg}\cdot\text{L}^{-1}$ Si, 0 and 100 $\text{mg}\cdot\text{L}^{-1}$ Ca, as part of regular

fertigation. In addition, plants were given 100, 80 and 60% regulated deficit irrigation (RDI). Regulated deficit volumes were established gravimetrically using several well watered (100%) reference plants. Plants were evaluated for a variety of factors during production and postharvest storage. We observed a significant improvement in postharvest water stress tolerance, as measured by degree of wilt, when plants were supplemented with silicon. Leaf wilt angle was reduced 31% after 5 days of simulated postharvest storage without water. Regardless of nutrition regime, plants subjected to 60% and 80% optimal irrigation exhibited reduced postharvest wilting compared to well watered plants. Yet, these plants had significantly smaller bract sizes compared to well watered plants. Interestingly, bract sizes of well watered plants and RDI plants supplemented with silicon did not differ significantly, which suggests a role for Si in supporting cell expansion under water limiting conditions. In addition, we found significant differences in disease incidence, height, and branch strength between silicon and calcium supplemented plants, and control plants.

Specified Source(s) of Funding: New York Farm Viability Institute, Post Schenkel Endowment, HATCH, Private

2:15–2:30 pm

Effects of Controlled Release Fertilizer on the Post-production Performance of *Impatiens wallerana*

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Controlled release fertilizers (CRF) in production systems have been known to reduce environmental contamination. However, there is a lot to be explored as per its use in bedding plant production. There is little information about CRF use and their possible post-production (retail or consumer phase) benefit in bedding plant production. The objective of this study was to evaluate the carryon effect (post-production in the field) of CRF on the field performance of bedding plants. Plants were treated with Osmocote Plus 16-9-12 (16 N-4 P-10 K) of 5–6 month longevity (5–6 M), 8-9 month longevity (8-9 M), or a blend of both CRF (50% each), and 150 mg·L⁻¹ N of 20-10-20 (20 N-4.4 P-16.6 K) water-soluble fertilizer (WSF). The plants were grown for 54 days in the greenhouse where some of the plants from each treatment were harvested and shoot dry weight determined. The remaining plants were transplanted in the field and left to grow for 73 days, after which shoot dry weight was determined. During the study, flower number, flower dry weight, plant quality and leaf yellowing were evaluated. CRF treated plants with 5–6 M produced the least shoot dry weight in the greenhouse compared to those treated with 8–9 M or WSF. There was no significant difference in the shoot dry weight of plants from all treatments after growth in the field. However, CRF treated plants produced less flower dry weight in the field. Based on plant dry weight, CRF does not have a post-production benefit on the performance of *I. wallerana*. However, consumers preferred CRF treated plants in the field as compared to WSF treated plants. CRF treated plants were more compact and robust with less leaf yellowing as compared to WSF treated plants. The compactness of the CRF treated plants may be associated with the lower amount of phosphorus in the plant tissue. The ultimate purchasing decision by a consumer depends on the aesthetic value of the plant rather than on its weight. This experiment demonstrated that CRF has a positive effect on consumer preference yet no effect on the dry weight of *Impatiens wallerana*.

Specified Source(s) of Funding: USDA–ARS / OSU OARDC

2:30–2:45 pm

Daily Water Requirements of Petunias as a Function of Plant Age and Environmental Conditions

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Most ornamental plant growers use excessive irrigation water to prevent the risk of unwanted drought stress. Quantifying the daily water requirements of greenhouse crops may provide a useful tool to reduce excessive irrigation. Two petunia (*Petunia ×hybrida*) cultivars, ‘Single Dreams Pink’ and ‘Prostrate Easy Wave Pink’, were grown in three different size pots (diameters = 10, 12.5, 15 cm) to quantify their daily water use for 6 weeks. A datalogger with dielectric soil moisture sensors was used for automated irrigation control to maintain the substrate moisture content at 0.40 m³·m⁻³, and every irrigation event was recorded by the datalogger and used to calculate daily water use. On overcast days early in the experiment, plants used only 4.7 to 8.8 mL/day. The maximum daily water use of ‘Single Dreams Pink’ was 63, 96, and 109 mL in 10-, 12.5-, and 15-cm pots, respectively. ‘Prostrate Easy Wave Pink’ used more water (up to 104, 168, and 209 mL/day in 10-, 12.5-, and 15-cm pots), because of their larger size. Daily water use was modeled as a function of days after planting, daily light integral, and maximum vapor pressure deficit (0.75 < R² < 0.90). The cultivars and pot sizes affected the model coefficients. Plants in larger pots used more water (*P* < 0.001) and had higher dry weight and larger total leaf area (*P* < 0.001) than those in smaller pots. These models, describing the daily water use as a function the plant age and environmental conditions, can be used to predict the water requirements of petunias in greenhouses. This use of such models can improve irrigation scheduling in greenhouses, resulting in water, fertilizer, electricity, and labor savings.

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

2:45–3:00 pm

Water Content in Soilless Substrates: Spatial and Temporal Dynamics

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Increasing the efficiency of greenhouse irrigation requires a better understand of the dynamics of water movement in soilless substrates. Changes in the distribution of water in soilless substrates occur continuously due to such processes of drainage, capillary action, evaporation, and water uptake by plants. Using soil moisture sensors, we determined the spatial distribution of water in soilless substrates, and quantified these changes in water content over time. These data were used to quantify the rate of water movement through the substrate following overhead or sub-irrigation and changes in water distribution within the substrate as a result of plant water uptake. By measuring the depletion of water from different substrate layers within container, we determined which layer provided most of the water to the plants. Typical stratification of substrate water content was seen in subirrigated containers, with the highest water content in the bottom layer, and increasingly lower water levels in higher substrate layers. Water from the lower substrate layers gradually moved up through the substrate through capillary action. In overhead-irrigated containers we did not always see similar stratification. In relatively dry substrate, overhead irrigation results in the highest substrate water content in the top layer of the substrate,

and there was little capillary movement downward.

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

3:00–3:15 pm

Influence of Root Medium Water Content and Supplemental Calcium on Severity of Oedema During Ivy Geranium Production

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The effect of root medium water status, supplemental calcium (Ca) fertilization and vapor pressure deficit (VPD) on the occurrence of the physiological disorder oedema was evaluated on ivy geranium (*Pelargonium pelatum* L'Her ex Ait) in two greenhouse experiments (summer and fall). Cultivars in the experiments included 'Amethyst 96,' 'Lambada,' and 'Sybil Holmes.' Root medium water status treatments included dry (plants were re-watered when pot weight dropped by 65% from container capacity), optimal (30% water loss), wet (15% water loss) and saturation (pots were placed in a saucer filled with water at all times). Supplemental Ca was applied at rates of 0 and 300 mg·L⁻¹ from CaCl₂ at each irrigation and weekly to saturated treatments. Two VPD environments were created by building tent-like structures out of PVC and plastic film. The high VPD tent had plastic film only on the top, and fans blew over the plants at all times. The low VPD tent had plastic film on all surfaces except the bottom, and mist supplemented humidity. At harvest, all plant leaves were scanned using a flatbed scanner to quantify the percentage of leaf area affected by oedema. Growth, measured as fresh weight, dry weight and leaf area was different based on the water status treatments with dry consistently smaller than the other treatments. Water status, Ca and VPD had no effect on the leaf area damaged by oedema in either experiment, but cultivar, water status, and Ca did influence the percentage of damage in the summer experiment. The traditional recommendation that growers produce ivy geranium 'on the dry side' to minimize the occurrence of oedema should be reevaluated.

Specified Source(s) of Funding: The Gloeckner Foundation

3:15–3:30 pm

Predicting Calcite (CaCO₃) Requirements of Sphagnum Peat Moss from pH Titration Curves

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Liming materials are required to neutralize acidity in peat moss to make it a suitable substrate for growing container crops. A series of time-consuming incubations of peat:lime mixtures are typically used to determine the liming rate to achieve a desired pH. Our objective was to evaluate the utility of a rapid, acid-base titration method for predicting calcite (CaCO₃) requirement of sphagnum peat moss. In this method, peat moss with an initial pH of 3.7 was titrated in aqueous suspension with 0.1 M NaOH or 0.1 M HCl solution from pH 3 to 11

(forward titration), then from pH 11 to 3 (backward titration). Because of hysteresis, the forward and backward titration curves were averaged to predict calcite requirements. For comparison, peat moss samples were incubated in plastic bag for 13 days after applying calcite at rates between 0 and 1.5 mol·kg⁻¹ of CaCO₃ peat moss (dry weight basis), and pH was monitored until a steady-state was established. The pH achieved by incubation could be predicted up to pH 6.2 by the averaged acid-base titration curve. Above pH 6.2, calcite solubility limits caused a deviation between the two methods as the pH in the incubation experiment reached a plateau with increasing calcite additions. Geochemical speciation calculations showed that calcite solubility limits imposed by atmospheric CO₂ and dissolved Ca²⁺ activity restricts the maximum pH achievable. Nevertheless, the acid-base titration is a quick method for accurately predicting calcite requirements of acidic peat moss for target pH levels ≤ 6.2.

Specified Source(s) of Funding: USDA

Oral Session 10: Crop Physiology/Physiology: Vegetable Crops

Laclede

Sunday, 26 July 2009, 2:00–4:00 pm

Moderator: Genhua Niu, gniu@ag.tamu.edu

2:00–2:15 pm

Effect of ABA Rates and Application Frequency on Growth of Bell Pepper and Watermelon Transplants

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In many southern regions of the U.S., high temperatures and temporary soil drying conditions can be detrimental during transplanting and stand establishment of vegetable crops. Our previous research suggested that abscisic acid (ABA) was an effective tool to modulate transplant shoot growth and enhance drought stress tolerance of several vegetable species, including pepper, tomato, melon and artichoke. Our current work is targeted to optimizing methods of foliar spray application to control growth of 'mature' vegetable transplants in the greenhouse. The objective of this experiment was to determine the effects of rates and frequency of ABA application on growth and overall transplant quality of watermelon and pepper exposed to ABA concentrations up to 2000 mg/L applied weekly up to 3 weeks after transplant maturity. Growth responses to ABA were species-dependant. In triploid watermelon cv. Majestic, ABA reduced shoot dry matter, but increased dry matter partitioning to roots compared to the untreated control. Temporal chlorosis/phytotoxicity was observed for the highest ABA rates (>1000 mg/L) in diploid watermelon cv. Summer Flavor 800; however, those rates delayed the onset of flowering compared to control transplants when remained in trays in the greenhouse. In bell pepper cv. Aristotle, ABA decreased leaf abscission rates after 3 weeks in the greenhouse and there was a trend for ABA to improve survival under stressful field conditions in south Texas. Understanding seedling morphological and physiological responses prior to and after field establishment under extreme temperature and drought environments is crucial to developing seedling conditioning treatments to mitigate those stresses.

Specified Source(s) of Funding: Valent BioSciences, and partial sup-

port from CSREES, USDA No. 2008-34461-19061 (Rio Grande Basin Initiative) and CSREES, USDA No. 2008-34402-19195 (“Designing Foods for Health”).

2:15–2:30 pm

Commercial Tomato Rootstock Performance When Exposed to Natural Populations of Root-Knot Nematodes in Florida

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An experiment with greenhouse grown grafted tomatoes (*Solanum esculentum*) on commercial rootstocks was conducted to evaluate performance of scions under natural RKN (*Meloidogyne sp*) pressure. The rootstocks tested included the varieties ‘Aloha’, ‘Aegis’, ‘Anchor-T’, ‘Armada’, ‘B.B.’, ‘Camel’, ‘Survivor’, ‘Beaufort’, ‘Multifort’ and ‘TX301’. The scion variety was ‘RealEZA’ a small fruited variety. Plants were grown under greenhouse conditions in untreated thoroughly mixed soil from a vegetable production site with a history of RKN infestations. The plants were placed in a completely randomized design in 12-L pots with low volume irrigation. Included in the rootstock treatments were self-grafted scion controls. Nematode damage was assessed using the Zeck scale with 0 no visible infestation and 10 as maximum infestation with severe galling and little or no root system. Root damage from nematode feeding was greatest on the self-grafted ‘RealEZA’ scion with 100% of the plants rated between a 6 and 8. Several rootstocks showed little or no visual infestations in the form of galls including ‘Armada’, ‘Camel’, and ‘BB’ with a 0 rating. The next group was essentially free of damage with a rating of 0–1 and included ‘Aegis’, ‘Aloha’ and ‘Anchor T’. Rootstocks with the greatest infestation were ‘TX301’ at 2–3, ‘Beaufort’ with a 4–5 rating and ‘Multifort’ with a mixed rating of 5–6 for two plants and 0 for the remaining three individuals in this group. Overall the self grafted control fared the worst with rating of 7–8 showing extensive damage on the root system. No shoots originating (suckers) from the rootstocks was observed during the duration of these experiments which was not the case in the field where regrowth was prominent in several varieties.

Specified Source(s) of Funding: USDA and CREES

2:30–2:45 pm

Emergence and Seedling Characteristics of Native American Maize from the Southwestern United States

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Native American maize landraces are traditionally planted deeply and grown for direct consumption. Therefore the emergence capabilities of eleven Native American maize landraces were evaluated at various planting depths and compared to one Corn Belt dent check population. Emergence from various depths between 5 and 45 cm was evaluated in a growth chamber study. Seedling dry matter partitioning and morphological characteristics were also examined. A field study was then performed to check those landraces that successfully emerged ($\geq 75\%$ success) from the 25 cm depth in the growth chamber. Results indicate that some of the Native American landraces evaluated have a greater

capacity to emerge from depth than the check population. Emergence capacity was not related to initial seed weight. Mesocotyl elongation largely accounted for emergence success from the greater planting depths. The landraces partitioned relatively more dry matter to roots than shoots compared to the check population. These results suggest that several of these Native American landraces may be useful for the development of maize varieties tolerant to deep planting and resistant to drought stress.

2:45–3:00 pm

Rapid Screening for Salt Tolerance in Specialty Peppers

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Chile peppers are economically important crops in southern regions in the United States. Limited information is available on irrigation management with low quality water or with salt-affected soils. Although previous studies indicate that peppers are moderately sensitive to salt stress, some cultivars may express more tolerance than others. The threshold of salinity that initiates growth suppression varies with species and other environmental factors. The objective of this study was to rapidly screen the relative salt tolerance of a large number of cultivars and breeding lines. Seeds of selected peppers were germinated and seedlings grown in 1.8-L pots. When plants reached 4 to 6 true leaves, salinity treatments were initiated by irrigating with nutrient solutions (control) or saline solutions at electrical conductivity of 3.0 dS/m for the first week and 6.0 dS/m thereafter. Leaf conductance was measured several times during the course of the experiment. After one month of treatment, shoots were harvested and dry weights were recorded. In experiment 1, 13 cultivars or breeding lines were tested. Among them, ‘Early Jalapeño’, ‘AZ-20’, ‘Joe Parker’, and ‘Sandia’ had smaller reductions in shoot dry weight. In Experiment 2, among the seven cultivars or breeding lines, ‘TAM Hab 1’, ‘TAM Jal 1’, and ‘Jupiter’ had smaller growth reductions. Further studies will be conducted to confirm the relative salt tolerance of these cultivars.

Specified Source(s) of Funding: RGBI of CSREES-USDA

3:00–3:15 pm

Drought Tolerance of Specialty Chile Peppers

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Chile peppers are economically important crops in many southern states of the U.S. Limited information is available on drought tolerance for chile peppers. As new cultivars are bred and commercialized each year, some may be more tolerant than others. The objective of this study was to investigate the drought tolerance of four representative commercial cultivars of chile peppers. Seeds of 'AZ-20', 'Early Jalapeño', 'Joe Parker', and 'Sandia' were germinated in 2.6-L plastic containers filled with sandy loam soil. Three dry-down cycles were applied by withholding irrigation until leaves were severely wilted. The first dry-down was applied when seedlings had eight true leaves, the second cycle was applied 12 days after the first dry-down. Before terminating, plants in the drought treatment received a third dry-down. Plants in the control treatment were well irrigated throughout the experiment. Soil moisture contents were monitored using soil moisture sensors. Leaf conductance was measured daily during the dry-down cycles. The experiment was terminated when plants reached the flowering stage. Shoot, root and total dry weights were reduced by drought stress in 'AZ-20', 'Joe Parker', and 'Sandia', but not in 'Early Jalapeño'. The ratio of root to shoot dry weight was not affected by drought stress, regardless of cultivar. Drought stress reduced leaf conductance of all cultivars but the relationship between the leaf conductance and soil moisture content differed among cultivars. Leaf conductance in 'Early Jalapeño' decreased more slowly as soil moisture content decreased compared to the other cultivars.

Specified Source(s) of Funding: RGBI of CSREES-USDA

3:15–3:30 pm

Crop Coefficients Specific to Phenological Stages for Evapotranspiration-based Irrigation Management of Onion and Spinach

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Weighing lysimeters are used to measure crop water use during the growing season. By relating the water use of a specific crop to a well-watered reference crop such as grass, crop coefficients (K_c) can be developed to assist in predicting crop needs using meteorological data available from weather stations. This research was conducted to determine growth-stage-specific K_c and crop water use for onions (*Allium cepa* L.) and spinach (*Spinacia oleracea* L.) grown under South Texas conditions. Seven lysimeters, consisting of undisturbed 1.5 × 2.0 × 2.2-m deep soil monoliths, comprise the Texas AgriLife Research–Uvalde lysimeter facility. Six lysimeters, weighing about 14 Mg, have been placed each in the middle of a 1-ha field beneath a linear low-energy precision application irrigation system. A seventh lysimeter was established to measure reference grass reference evapotranspiration. Daily water use for onion and spinach was measured at 5-min intervals. Crop water requirements, K_c determination, and comparison with existing Food and Agricultural Organization (FAO) K_c values were determined over a 2-year period for each crop. The K_c values determined over the growing seasons varied from 0.2 to

1.3 for onion and 0.2 to 1.5 for spinach, with some of the values in agreement with those from FAO. It is assumed that the application of growth-stage-specific K_c will assist in irrigation management and provide precise water applications for a region of interest.

Specified Source(s) of Funding: Texas Water Development Board (TWDB; Project No.0603580596), Rio Grande Basin Initiative (RGBI; Grant No.2005-34461-15661) and partial funding from USDACSREES No. 2004-34402-14768 "Designing Foods for Health").

3:30–3:45 pm

Leaf Tissue Carotenoids and Chlorophyll Fluorescence Parameters Differ Among Sweet Corn Genotypes with Differential Sensitivity to Mesotrione

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Leaf tissue carotenoid pigments play essential roles in the photo-protection of photosynthetic membranes. Carotenoids contribute to non-photochemical quenching (NPQ) of excitation energy in antenna systems. Mesotrione (Callisto®) is currently labeled for selective pre- and post-emergence weed control in sweet corn (*Zea mays* var. *rugosa*). Mesotrione competitively inhibits the enzyme *p*-hydroxyphenylpyruvate dioxygenase (HPPD), essential to plastoquinone production. Plastoquinone is a cofactor for phytoene desaturase, a critical enzyme for carotenoid biosynthesis. Sweet corn is tolerant to mesotrione applications; however, differing sensitivity exist among genotypes. What remains unclear is the impact of mesotrione on leaf tissue carotenoids and chlorophyll fluorescence parameters following post-emergent applications. Our research objectives were to characterize leaf tissue: 1) visual injury; 2) carotenoid concentrations; and 3) chlorophyll fluorescence parameters following post-emergence mesotrione applications to cultivars of different sensitivities ['Merit' (sensitive), 'Temptation' (tolerant), 'Incredible' (moderately sensitive)]. Cultivars were seeded in Knoxville, TN on 01 May 2008 in a randomized complete block design with four replications at two separate, adjacent sites. Post-emergence treatments included: 1) untreated control; 2) mesotrione (105 g ai/ha) as early post; 3) mesotrione (105 g ai/ha) as late post; 4) mesotrione (105 g ai/ha) + atrazine (560 g ai/ha) as early post; 5) mesotrione (105 g ai/ha) + atrazine (560 g ai/ha) as late post; 6) atrazine (560 g ai/ha) as early post; and 7) atrazine (560 g ai/ha) as late post. Corn plants were 5–10 cm and 15–20 cm in height for early-post and late-post applications, respectively. Leaf tissues were sampled 14 days after treatment (DAT) of the late post applications. Leaf tissues were dark acclimated for 1 hour, and measured for chlorophyll fluorescence parameters. The same leaf tissues were freeze-dried prior to HPLC analysis of carotenoid and chlorophyll pigments. Leaf tissues had outgrown visual bleaching symptomology at time of tissue collection. Data revealed that genotype contributed significantly to leaf tissues pigments of beta-carotene, chlorophyll *b*, and the xanthophylls energy dissipation cycle pigments (zeaxanthin, antheraxanthin, violaxanthin). Xanthophyll cycle pigments contribute to NPQ in leaf tissues, and NPQ values also differed among genotypes. Leaf tissue SPAD measurements were influenced by both genotype and herbicide treatment. Post-emergence herbicide treatments did not impact concentrations of leaf tissue pigments or photochemical quenching and NPQ parameters when tissues were sampled 14 DAT. Results demonstrate genotypic variation among leaf pigments and chlorophyll fluorescence parameters may contribute to sweet corn

sensitivity to mesotrione applications.

Specified Source(s) of Funding: Project funded by gift received from Syngenta Crop Protection

3:45–4:00 pm

Effect of Organic and Inorganic Amendments on Soil and Produce Quality

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The mushroom industry produces a large quantity of spent mushroom substrate (SMS) annually. Most of this material is considered a by-product that companies must dispose of regularly. SMS may be of great value to crop production by improving soil structure and nutrient availability. Although the mushroom compost was used to improve soil structure in analysis it was determined to have a high salt content. SMS (an organic soil amendment) is commonly used in agriculture to improve soil characteristics; however, SMS has a high salt content. Remin (a non-organic soil amendment) is shown to add micronutrients to soil and remove salts by leaching. This product was applied to a multi-year study using SMS. The objective was to use and organic and inorganic soil amendment to improve soil and produce quality. The variables tested were as follows: the experiment contains 48 treatments with 16 treatments per compost rate. The area within each compost rate is approximately 7 beds (40 inches/bed) wide and 250 feet long; 0.15 acre. SMS + Remin were applied to a 0.7 acre field at various rates with three replications each. SMS was applied in 2006 and 2007 at rates of: 0 tons /acre, 2 tons/acre, 10 tons/acre, and 26.5 tons /acre. SMS applications were based on tomato N Requirements. Remin was applied to each area receiving different rates in 2008. Experimental plots received: (0 lbs. Remin/acre, 500 lbs. Remin/acre, 1000 lbs Remin/acre, and 2000 lbs. Remin/acre) using randomized block design. All soil, leaf, and fruit samples were sent to a laboratory to be analyzed for N, P, K, Ca, and Mg. The laboratory also analyzed soil pH and electrical conductivity. Yield results were measured for each plot. These methods were used to determine the effects of Remin and its ability to leach salts in the presence of SMS and its effect on yield in the soil by means of a non-synthetic amendment. Data from the first year of the study will be reported.

Oral Session 11: Vegetable Culture and Management 1 Sunday, 26 July 2009, 4:00–6:00 pm

Laclede

Moderator: Richard Smith, rifsmith@ucdavis.edu

4:00–4:15 pm

Growth Rate of Lettuce: Implications for Nitrogen Fertilization

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Lettuce (*Lactuca sativa* L.) matures in 65 to 70 days in summer and typically takes up 100–120 lbs of nitrogen (N) in the above ground biomass. Grower N fertilization programs vary widely but average from 150 to over 200 lbs of N/A. In 2008 three trials on head and romaine lettuce were conducted to compare best management practices (BMP) and standard growing practices in commercial fields in the Salinas Valley, CA. In the BMP treatments irrigations were scheduled from estimated consumptive water use for lettuce which was based on CIMIS evapotranspiration data and the water holding capacity of the soil; nitrogen fertilizer applications were determined by measuring soil residual nitrate-N using the soil nitrate quick test. Standard treatments were based on the grower's practices. Suction lysimeters were installed to capture leachate at two feet soil depth. Suction was maintained at 10–20 cbar and leachate was collected during irrigation events and total nitrate leaching was calculated based on estimates of water movement through the soil. Soil mineral N, crop biomass and biomass N were evaluated several times during the crop cycle, and yield evaluations were conducted. Total N uptake by lettuce during the first 30 days is less than 6 lbs of N per acre. A high proportion of total seasonal applied water is used during germination and establishment of the crop. Given low N uptake by lettuce in the first 30 days, prudent N and water management are needed to reduce nitrate-N leaching during the early phase of the growth cycle. Following thinning (app. 30 days after planting) lettuce grows exponentially and the rates of nitrogen uptake increase substantially. Using N biomass data normalized for growing degrees days (GDD, using 4 and 30 °C threshold temperatures) indicated that, for a site in the northern Salinas Valley with a summer temperature regime that averages 21 GDD per day, on average lettuce take up 3.3 lbs of N/A/day. Lettuce grown in the southern Salinas Valley with higher GDD would on average have N uptake > 4.0 lbs of N/A/day. The post thinning period is the most critical period for fertilizing lettuce. In the BMP treatment, by accounting for residual soil nitrate-N and careful water management, we reduced N fertilizer application by 66 lbs/A as well as nitrate leaching by 22.1 lbs/A in two irrigation events. BMP yields equaled the standard in two of three trials.

4:15–4:30 pm

Influence of Preplant Nitrogen and Sulfur Fertilization on Bell Pepper

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Field studies were conducted to determine the effect of different preplant nitrogen (N) and sulfur (S) fertilizer sources and rates on the growth and yield of 'Aristotle' bell pepper (*Capsicum annuum*). Fertilizers were applied 2 weeks before transplanting in two bands on bed tops at 15 cm from either side of the planting row and incorporated 2.5 cm deep. Fertilizer sources were ammonium sulfate (AS; 21% N, 24% S), ammonium nitrate (AN; 34% N), and fusion ammonium sulfate nitrate (FASN; 26% N, 14% S). Fertilizer rates were 112, 224 and 336 kg/ha of N. AS and FASN supplied 128, 255 and 383 kg/ha and 60, 121 and 181 kg/ha of S at their corresponding N rates, respectively. Data showed that there were no significant differences in plant vigor and height at 6 WAT, and petiole sap NO₃-N concentration at 8 WAT. However, there was significant effect of N sources and rates on bell pepper fruit weight. When N rates increased from 112 to 224 kg/ha, bell pepper yields increased 14%, regardless of N sources, with no further yield change with higher N rates. However, AS and FASN improved

bell pepper yields by 9% and 10% in comparison with AN at a N rate of 224 kg/ha. There were no significant differences on bell pepper yield when AS or FASN were used at rates of 224 or 336 kg/ha.

4:30–4:45 pm

Sufficiency Ranges for Nitrate in Leaf Petiole Sap of Greenhouse Pac Choi Produced with Organic Versus Inorganic Fertilizers

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Leaf petiole sap nitrate ($\text{NO}_3\text{-N}$) analysis with hand-held meters has proved to be a valuable tool to guide in-season application of nitrogen (N) for many crops. Sufficiency levels have been determined for many leafy green crops, including lettuce (*Lactuca sativa* L.) and cabbage (*Brassica oleracea* L.), but not for pac choy (*Brassica rapa* L.). The response of pac choy to different fertility rates and sources [conventional (Conv) and organic (org)] was investigated to establish optimal soluble N application rates and Cardy meter sufficiency ranges for greenhouse-grown pac choy. An experiment was conducted during winter 2008 in a glass greenhouse in Manhattan, Kans. The Conv soluble fertilizer was formulated from inorganic salts and was $4\text{NO}_3\text{-N}:1\text{ ammonium-N}$. The Org soluble fertilizer was fish hydrolyzate ($2\text{N}:4\text{P}:1\text{K}$). Both fertilizers were applied at rates of 0, 32, 75, 150, 225, 300, or 450 $\text{mg}\cdot\text{L}^{-1}$. Seedlings were transplanted and fertilizer application began at 18 days of age. Plants were harvested at 7 weeks (5 weeks post transplanting) and received 15 fertilizer applications during production. Samples of the most recently matured leaves were harvested on a weekly basis and analyzed for petiole sap $\text{NO}_3\text{-N}$ and leaf blade total N concentration. Leaf count, leaf length and chlorophyll content were also measured weekly. Fresh and dry weights were determined on whole shoots and roots. Optimum yield was achieved at the 150 $\text{mg}\cdot\text{L}^{-1}$ fertility rate with both Conv and Org fertilizers. The sufficiency levels of $\text{NO}_3\text{-N}$ for pac choy leaf petiole sap during weeks one to three of production is 1500–2000 $\text{mg}\cdot\text{L}^{-1}$, and then drops to 1000–1500 $\text{mg}\cdot\text{L}^{-1}$ during weeks three through harvest for both Conv and Org fertilizers source. Total N in leaf tissue was less sensitive in showing fertilizer rate effects than leaf petiole sap $\text{NO}_3\text{-N}$. Chlorophyll content was not a useful measurement for evaluating pac choy N status. These guidelines provide farmers with standards for leaf petiole sap $\text{NO}_3\text{-N}$ to guide in-season N applications.

4:45–5:00 pm

Glucosinolate Content of Potential Brassicaceae Biofumigant Crops

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Glucosinolates, sulfur containing thioglucosides occurring in aliphatic, aromatic, and indoles forms, are defensive compounds found primarily in the Brassicaceae (mustard) family. In damaged tissue, myrosinase degrades glucosinolates into isothiocyanates, nitriles, epithionitriles, and thiocyanates. The predominant breakdown products, isothiocyanates,

are generated from aliphatic glucosinolates. Isothiocyanates remain active in soil up to a few weeks, and are general biocides. Green manure crops in the Brassicaceae family have been used as biofumigants but the effectiveness of specific accessions depend on the specific glucosinolates profile and concentrations. Our objective was to determine levels of aliphatic, aromatic, and indole glucosinolates in a wide range of Brassicaceae potential biofumigants. We evaluated accessions from *Brassica barrelieri* (1 accession), *B. juncea* (10 accessions), *B. napus* (6 accessions), *B. nigra* (3 accessions), *B. oxyrrhina* (1 accession), *B. rapa* (4 accessions), *Camelina sativa* (2 accessions), *Enarthrocarpus arcuatus* (1 accession), *E. sativa* (1 accession), *Sinapis alba* (3 accessions), *S. arvensis* (1 accession), and *S. flexuosa* (1 accession). The seed were obtained from commercial sources and the USDA Mustard Germplasm Repository in Ames, IA. The accessions were seeded in 10 cm pots filled with greenhouse media. The experiment was a randomized complete block design with four replications. The mustards were thinned to two plants per pot and allowed to grow until first flowers. Shoot tissue was harvested, mass determined, freeze-dried, and glucosinolates analyzed. Shoot mass at flowering ranged from 2.97 (PI263866) to 39.71 (PI597864) g/plant. Generally, total glucosinolates levels were similar among accessions. Ida Gold mustard (*Sinapis alba*, L.A. Hearne Seeds) and Red Giant mustard (*Brassica juncea Integ-lifolia* Group, Seeds of Change) had higher total glucosinolate levels than accessions such as Jupiter rapeseed (*Brassica napus*, Ames 6100, USDA Mustard Germplasm Repository). Ida Gold is sold as a high-glucosinolate containing cultivator for biofumigation while Jupiter is an older European rapeseed cultivar. Gluconapin and sinigrin are the predominant glucosinolates in most of the accessions, with Ida Gold containing the most gluconapin (271 $\mu\text{g}\cdot\text{g}^{-1}$ dry weight) and Red Giant containing the most sinigrin (128 $\mu\text{g}\cdot\text{g}^{-1}$ dry weight). Progoitrin and glucoalysin were the other two common aliphatic glucosinolates. Shoots of Red Giant mustard and Jupiter rapeseed contained the largest amount of the aromatic glucosinolate, gluconastrutiin. Ida Gold, Jupiter, and Red Giant shoot mass were approximately 12 g/plant. The biofumigant ability of mustard plants will depend not only on the amount of glucosinolates, but also on their shoot mass.

Specified Source(s) of Funding: USDA Competitive Grant

5:00–5:15 pm

Increasing Sustainability of Vegetable Production By Using Urban Waste Compost: Results of a Two-year Rotation

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Vegetable production is typically characterized by an intense cropping system due to the high input level applied needed to adequately sustain crop production and because of the rapid crop succession. As a consequence, this sector of agriculture has probably the highest environmental risks also because it is often carried out in areas considered “highly sensitive” for their pedological and hydrological features. From the other side more and more organic residues are becoming available as a consequence of the increased composting activity of urban wastes and sludge. The aim of this experiments was to evaluate the possibility to partially or completely substitute mineral nitrogen fertilizers with compost in a vegetable 2 year rotation. Crop succession in the first year was, processing tomato and spinach (used as a cover crop) and in the second year was beans and French bean as a main crop and spinach and beets as a second crop. Treatments compared were five, including a non fertilized control (T0) and a mineral N fertilizer control (TMIN).

On the base of the amount of N distributed in TMIN two additional treatments were applied, T50 with 50 % of N distributed as mineral N and 50% using compost, and T100 with 100% of N was organic. The last treatment was T200 where a double amount of N respect TMIN was distributed as compost. The first year of experiment although no strong differences were found, mainly because of the high initial fertility of the soil, however a little delay of senescence of plant receiving high doses of compost was observed. Crops grown in the second year were more affected by treatments. For both the leguminous species T50 was the treatment that allowed the highest yield and, only for bean, the highest harvest index. Beet and spinach responded differently to the treatments, probably because of the morphology of the root systems. Beet reached the maximum yields with T100 e T200 while spinach responded better to the mixed fertilization (T50). Both crops showed a reduction in the leaf nitrate content when compost was used. Concentration of macronutrients in soil water during and after spinach crop showed that N potentially leached was bigger with TMIN than in plots where compost was used. As a general conclusion, the experiments demonstrated that compost can be used to replace, although not completely, mineral nitrogen fertilizers in vegetable crop rotation reducing potential environmental risk and maintaining unaffected the production.

5:15–5:30 pm

Effects of Rye Cover Crop Mulch on Pumpkin Yield and Fruit Quality

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Grain rye (*Secale cereale*) is one of the cover crops widely used in the Midwest. It is planted in the fall after harvesting vegetables to provide ground cover during winter and early spring. In some parts of Illinois, it is mowed and tilled in, and some strips are left between vegetable rows to protect plants from sand blast. An experiment was conducted in 2008 at St. Charles Horticulture Research Center in northern Illinois to assess the effects of rye cover crop seeded at the rates of 90 and 120 pounds per acre on pumpkin yield, fruit size, fruit cleanliness, spots on fruits, and fruit rots on 'Howden' and 'Magic Lantern' pumpkin varieties. The two rye seeding rates and conventional method where pumpkins are grown on bare ground without mulch between the rows (Control) were used as the treatments. These three treatments were replicated four times in complete randomized block design. The pumpkin seeds were planted in tilled bare ground strips between rye mulch and compared with pumpkins grown on bare ground without rye mulch in between rows (Control). Rye was killed at flowering stage by rolling. Each plot had two varieties of pumpkins. The results showed that plots with rye mulch in between pumpkin rows had higher mature pumpkin fruit weight (21% to 25% higher) than Control plots in both varieties. The Control plots had larger fruits that weigh 15% to 20% more per fruit than fruits from plots with rye mulch between the rows in both varieties. There were significantly dirtier fruits (over 60%) in Control plots than in plots with rye mulch between the rows (17%). Pumpkin fruits from Control plots had significantly more ('Howden' – 37%; 'Magic Lantern' – 27%) fruit spots than from plots with rye mulch between the rows ('Howden' – 15%; 'Magic Lantern' – 14%). There were more fruit rots in Control plots (22%) than in plots with rye mulch between the rows (2%) in 'Howden' variety but there was no significant difference in fruits between Control plots (9%) and plots with rye mulch between the rows (1.4%) in 'Magic Lantern' variety. In summary, rye mulch between the rows did not affect pumpkin yield but led to lower weight per fruit. Plots with rye mulch had cleaner fruits, and lower incidences of spots on fruits, and fruit rots compared to Control plots.

Specified Source(s) of Funding: Illinois Department of Agriculture

Conservation 2000 Grant Award No. SA 08-35.

5:30–5:45 pm

The Need to Integrate Plant Populations Into Cover Crop Seeding Recommendations: Case Study with Two Oilseed Radish Cultivars with Contrasting Seed Masses

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Seed size, seed mass, and seeding rate have been shown to have profound impact on the performance of plants, yet those characteristics have not been integrated into most cover crop recommendations. Most recommendations continue to call for lb/A or kg/ha as the seeding rate despite the large variations in seed size among cultivars and sometimes among seed lots of the same cultivar. A study using two oilseed radish cultivars with contrasting seed masses was conducted to demonstrate the need for using plant populations as the most appropriate seeding recommendation. The cultivars were 'Defender' with small seeds (13.9 g/1000 seeds) and 'Daikon' with large seeds (20.4 g/1000 seeds). Planting densities were 444,416; 333,312; and 222,208 seeds/A (14, 10, 7 lb/A, respectively for Defender and 20, 15, 10 lb/A, respectively for Daikon). Both cultivars had a germination rate greater than 95%. The experiment was conducted in Hamilton, Michigan on a high organic matter (muck) soil in 2008 used previously for celery production. A randomized complete block design with 8 replications was used. The cover crops were planted on 30 April using a no-till drill with row spacing of 9 inch. The cover crops were mowed and incorporated at flowering stage on 13 June. Celery 'Dutchess' was planted on 1 July. Cover crop biomass was estimated on 13 June by destructively harvesting plants in a 50 × 50 cm quadrat placed randomly in each plot. Biomass production of both cultivars showed significant response to planting density. Increasing planting density caused high intraspecific competition which resulted in reduced biomass. The extent of the response varied between cultivars with Defender exhibiting the steepest curve. Total biomass decreased from 4.2 to 2.5 T/ha for Defender and from 4.1 to 3.3 T/A for Daikon when the seeding rate increased from 222,208 to 444,416 seeds/A. For cultivar Daikon the decline in biomass with increasing plant population was less dramatic suggesting a greater resilience to intraspecific competition, likely due to larger seed mass. This study suggests that in situations where the primary objective is to maximize biomass production by oilseed radish, seeding rate should take into account seed mass to mitigate effects of cultivar and seed lots. This study also raises the broader need to integrate plant population/density into cover crop seeding recommendations.

Specified Source(s) of Funding: Michigan Celery Industry

5:45–6:00 pm

Arbuscular Mycorrhizal Dependency of Three Moringa Genotypes

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The genus *Moringa* includes several multi-purpose species that are receiving increased attention worldwide because of their potential to enhance human health, nutrition, and to generate income in the tropics. Although adapted to low-input environments, fertilization of *Moringa* is generally required for optimum production. Inoculation with arbuscular-mycorrhizal (AM) fungi is a promising strategy to enhance plant growth and P nutrition while reducing inputs in the tropics. However, there is almost no information available regarding the response of

Moringa sp. to AM fungal inoculation. To bridge this knowledge gap, two genotypes of *Moringa oleifera* ('PKM-2' and 'Hawaii') and one accession of *Moringa stenopetala* (Steno) were evaluated for their response to inoculation with *Glomus aggregatum* under varied soil solution P concentrations in two greenhouse experiments. The response of the three genotypes varied significantly and was dependent on soil solution P concentration. Dry matter accumulation and tissue P levels of all genotypes were generally enhanced by inoculation at relatively low soil-solution P concentrations (0.009–0.02 mg·L⁻¹). The degree to which the accessions tested depended on mycorrhizal association for growth and P uptake was calculated to be 40% to 50% for 'Hawaii', 20% to 50% for 'PKM-2', and <20% for 'Steno'. We, therefore, classified *M. oleifera* as moderately dependent and *M. stenopetala* as marginally dependent on mycorrhizal association. At higher soil solution P concentrations (0.02–0.20 mg·L⁻¹), 'PKM-2' exhibited a sharp decrease in dry matter accumulation with AM fungal colonization resulting in negative dependency values (–20% to –40%). The parasitic effect of *G. aggregatum* at the higher soil solution P concentrations was not observed in the other genotypes. Our work represents the first investigation on the interaction of *Moringa* sp. with arbuscular-mycorrhizal fungi.

Specified Source(s) of Funding: USDA TSTAR, HATCH

Oral Session 12: Jefferson A
Horticultural Crops Culture and Management:
Herbs, Spices, and Medicinal Plants
Monday, 27 July 2009, 8:00–9:15 am

Moderator: Hazel Y. Wetzstein, hywetz@uga.edu

8:00–8:15 am

Flower Morphology and Development in
***Artemisia annua*, a Medicinal Plant Used**
as a Treatment Against Malaria

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Artemisia annua produces a wide spectrum of bioactive phytochemicals that possess pharmacological properties including antimalarial, antitumor, anti-inflammatory, and anthelmintic activities. The main active ingredient, artemisinin, is extremely effective against multi-drug resistant *Plasmodium falciparum*, and is recommended by the World Health Organization to be used, in combination with a second drug, in artemisinin-based combination therapies (ACTs). Breeding to develop high-artemisinin producing *Artemisia annua* cultivars would provide a means to meet the worldwide demand of artemisinin and its derivatives. However, the fundamental processes of flower development, stigma receptivity, self-incompatibility, and seed development are poorly understood, and severely impairs breeding programs. Consequently morphological and histological evaluations of flower development in *Artemisia*, were made to define the developmental timing of flower types within inflorescences, and to evaluate stigma receptivity and pollen-stigma interactions. Plants were given short-day treatments to induce flowering, and floral development was evaluated using light and scanning electron microscopy. Flowers are born in a capitulum, with pistillate ray flowers and centrally located bisexual disc flowers. Pistillate

flowers have elongated, bifurcated stigmas which are extended prior to the opening of the disc flowers. In bisexual flowers, the appearance of a pollen presenter and pollen release precedes the emergence of two stigma lobes that expand and become reflexed. The stigmatic surfaces of both types of flower have unicellular papillae and appear to be of the dry type lacking a copious exudate. Pollen-stigma interactions and the effects of flower age and pollen source will be described.

8:15–8:30 am

Harvesting and Drying Effect on Oil Yield
and Composition of Four Mint Genotypes
Grown in Mississippi

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A field experiment was conducted in Mississippi to evaluate the effect of harvest time and drying on biomass yields and oil composition of peppermint (*Mentha x piperita* L. 'Black Mitchum' and 'B-90-9'), Japanese mint (*Mentha arvensis* L. 'Arvensis 2' and 'Arvensis 3'), Scotch spearmint (*Mentha gracilis* L. 'Scotch'), and Native spearmint (*Mentha spicata* L. 'Native'). Drying of peppermint biomass prior to oil extraction tended to increase the concentration of (–)-menthol in 'Black Mitchum' but not in 'B-90-9'. Drying of 'Black Mitchum' increased (–)-menthone and eucalyptol concentration in the oil in harvest 5, whereas drying of 'B-90-9' increased only eucalyptol in harvest 3. The concentration of (–)-menthol in 'Black Mitchum' increased slightly until harvest 3, 4, and 5, and then slightly decreased in harvest 6. In 'B-90-9', (–)-menthol concentration in freshly distilled biomass was lower in harvest 1 and higher in the other harvests. The concentration of (–)-menthone in both cultivars of peppermint was highest during harvest 1 and decreased with every subsequent harvest time to reach the lowest values in harvest 6. In Japanese mint, (–)-menthol concentration in freshly distilled oil of Arvensis 2 tended to increase with later harvest dates. However, this trend was not apparent in 'Arvensis 3' or in dry distilled 'Arvensis 2'. Drying of Japanese mint biomass did not significantly alter (–)-menthol concentration in either cultivar. Drying of Scotch spearmint biomass before extraction reduced (–)-carvone only in harvest 3 and did not change it in other harvesting times. Also, drying reduced the concentration of (R)-(+)-limonene in harvests 1 and 2, but increased it in harvest 6. In most instances, harvesting time did not alter the concentration of carvone. In native spearmint fresh biomass, (–)-carvone concentration was lowest in harvest 4 and higher in the oils from the other harvests. Harvesting time did not significantly affect carvone concentration in the oil from the dried biomass. Generally, (R)-(+)-limonene concentration in native spearmint oil was high in harvest 1, then decreased in harvest 2 and 3 and then tended to increase again. Drying of the biomass before extraction of the essential oil did not affect (R)-(+)-limonene concentration. Our results indicate that the four mint species could be grown in Mississippi and could provide relatively good yields and oil composition comparable to the values reported in the literature. Hence, these mints may be viable crop alternatives for Mississippi and the Southeastern United States.

Specified Source(s) of Funding: Mississippi State Specialty Crops Research Project

8:30–8:45 am

Enhancing Medicinal Plant Growth in Southwest Mississippi

Patrick Igbokwe*

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Two field experiments were used to determine the effect of three cropping systems (Conventional, Transitional, and Organic), and three row preparation methods (Heap, Bed, and Flat) on purple coneflower (*Echinacea purpurea*) survival, growth potential and quality. The studies were conducted on a Memphis silt loam soil in southwest Mississippi during the 2005 and 2006 planting seasons. A split plot arrangement in a randomized complete block (RCB) experiment design was used, with the cropping systems as the main plots, and row preparation methods replicated four times as the sub-plots. Transplanting at a within-row spacing of 0.61m, on 6.1m long and 1.2m wide were similar for all cropping systems. However, other field preparation activities, fertilization and pest management varied with the cropping system. Findings indicate that the cropping system (Transitional) and row preparation method (bed row) with lowest plant survival rate and canopy height had the highest quality (root volatile oil content) for both study periods. The interaction between cropping systems and row preparation methods were significant except for root length (2005) and root volatile oil (2006). The transitional cropping system and bed row preparation method should be considered when both the root and shoot biomass are desired.

Specified Source(s) of Funding: Alcorn State University

8:45–9:00 am

Desert Parsley (*Lomatium* spp.) Seed Production Challenges

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About 80 species of desert parsleys (*Lomatium* spp.) are native to the western United States. They are important parts of the natural plant diversity and include edible and medicinal species. Mechanized cultivation and seed production technology is virtually unknown for these species. Fernleaf biscuitroot or fernleaf desert parsley (*Lomatium dissectum*) has been a specie of concern, since it has been dug for medicinal use without replacement. Commercial seed production is necessary to provide the quantity of seed needed for rangeland restoration efforts and any sustainable commercial root production activities. Over the last four years, we have sought means to mechanically produce *Lomatium* and its seed at the Malheur Experiment Station in eastern Oregon. Seed of Nineleaf desert parsley (*L. triternatum*), Gray's desert parsley (*L. grayi*), and fernleaf desert parsley (*Lomatium dissectum*) were drilled in rows 30 inches apart. The seed production response of desert parsley to irrigation was tested in 2006, 2007, and

2008. Irrigation treatments were applied to plots four rows wide and 30 feet long arranged in a randomized complete block design with four replicates. Irrigation was applied using drip tape installed at 12 inch depth between two rows of plants spaced 30 inches apart. The drip tapes were installed on alternating inter-row spaces (5 feet apart). Desert parsley was submitted to three irrigation rates: 0, 1, and 2 inches of water applied starting at the beginning of flowering four times for a total of 0, 4, and 8 inches/year. Seed was harvested by hand. Mechanical combine harvest would have been possible if substantial development investment had been possible to reduce the ventilation and still separate seed from chaff. In 2007, seed yield for Gray's and nineleaf desert parsleys were low and increased with increasing water applied up to the highest amount evaluated, 8 inches. In 2008, seed yields showed a quadratic response to irrigation rate. Seed yields of nineleaf desert parsley were maximized by 8.4 inches of water applied. Seed yields of Gray's desert parsley were maximized by 6.9 inches of water applied in 2008. While both of these species produced over 1000 lb/acre of seed in the fourth year, fernleaf desert parsley failed to prosper and produce seed, because the selection planted was highly susceptible to infection by *Alternaria arborescens*.

Specified Source(s) of Funding: U.S. Forest Service, BLM, Oregon State University

9:00–9:15 am

Peppermint Productivity and Composition In Mississippi as a Function of Cutting Date and N Rates

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The goal of this project was to evaluate the potential of peppermint (*Mentha piperita* L. cv. Black Mitcham) as a high-value essential oil crop for Mississippi. The objective was to assess the effect of N rates (0, 80, 160 kg/ha) and cut on peppermint productivity and composition harvested in bud formation. The biomass and oil yields from the first cut (July 13) were significantly higher than the second cut (October, 2). Essential oil concentration was not significantly influenced by cutting dates but the oil yield decreased with the second cut. Peppermint oil composition was altered with cutting dates: (-)-menthone concentration and its yield were higher at first cut, whereas the concentration of (+)-menthofuran and its yield were higher at second cut. N rate at 160 kg/ha significantly increased peppermint dry biomass weight and oil yield at cut 2. Our results indicated that peppermint productivity and its essential oil composition in Mississippi could be altered by cutting dates and N application rates.

Oral Session 13:
Teaching Methods 1
Monday, 27 July 2009, 8:00–9:15 am

Laclede

Moderator: Ann Marie VanDerZanden,
vanderza@iastate.edu

8:00–8:15 am

**Employer Attitudes and Perceptions of Job
Preparedness of Recent Iowa State University
Horticulture Graduates**

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The Iowa State University undergraduate horticulture program is ranked as one of the best in the nation. Regular and systematic assessment of curriculum, graduates and employers who hire our students is one means to evaluate the program for purposes of sustaining this level of excellence. The purpose of this study was to evaluate the attitudes and perceptions of employers who have recently hired Iowa State University Department of Horticulture graduates in regard to the graduate's preparedness when entering the workforce and their abilities to complete job responsibilities. A 77-question survey instrument was distributed electronically to 106 employers who hired ISU Department of Horticulture students who graduated from spring semester 2004 through summer session 2007. A majority of the survey questions were directly related to expected learner outcomes from the undergraduate curriculum. These outcomes related to abilities in professional skills (19 questions), general horticulture (6 questions), and global perspective (7 questions). Twenty-four additional questions asked employers to rank the importance of skills in the areas of general horticulture (12 questions) and business (12 questions). A final set of nine questions asked employers to rank the importance of work experience, attitude and job preparedness. The response rate was 36%. Results showed that 52% of employers felt graduates were more than adequately to exceptionally well prepared for the position they were hired for, and another 41% felt students were adequately prepared. Overall employers ranked graduates abilities in professional skills (4.18), general horticulture (4.25) and global perspective (4.30) as good to excellent on a scale of 1 to 5 (1 = very poor; 2 = poor; 3 = fair; 4 = good; 5 = excellent). Employers ranked all 12 of the general horticulture skills listed in the survey as having average to above average importance (4.02) and the 12 questions related to business skills had a similar average ranking (4.11) on a scale of 1 to 5 (1 = not important; 2 = below average importance; 3 = average importance; 4 = above average importance; 5 = very important). In the final group of questions related to work experience, attitude and job preparedness employers ranked 'good work ethic' as the most important skill giving it a 5.0 on a 1 to 5 scale (1 = not important; 5 = very important). The remaining eight questions averaged 3.75 on the 1 to 5 scale. Results from this research will be used to modify existing curriculum and expected learner outcomes to better prepare ISU horticulture graduates entering the workforce.

8:15–8:30 am

**Service-learning in Horticulture: The Freshman
Experience**

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Service-learning is a pedagogy which provides faculty with an opportunity to teach students by linking academic course objectives with community needs. In Fall 2008, as part of a living-learning community on the Mississippi State University campus, six incoming freshman from various academic majors began a service-learning project with Sudduth Elementary School (K–2). With an Assistant Professor of Plant and Soil Sciences as their mentor, the students were given the task of renovating an aged landscape while integrating learning tools for both the elementary teachers and students to use in the new gardens. Additionally, the college freshmen were asked to instruct the elementary students through the use of innovative activities regarding gardening and plants. Throughout the fall term, the freshmen transformed an overgrown, colorless, neglected landscape into a garden designed to educate and facilitate learning. For example, some of the new gardens were arranged in different shapes to build vocabulary skills, while other gardens had themes increasing overall gardening knowledge. Each student worked with a different elementary class and met once a week for an hour to work in the gardens or raise awareness about plants and the environment. Implementation of projects such as painting stepping stones, planting spring bulbs, and coloring celery with food dye kept elementary students entertained and advanced horticultural learning. The students also developed an assessment questionnaire for the elementary teachers with which they worked. This data proved helpful in making improvements to the garden. At the end of the term, the freshmen presented their service-learning project at a leadership showcase for the community, administration, and family members. The reported outcomes of the project were overwhelmingly positive as they included insights about leadership lessons learned, as well as information gained about horticulture, and civic responsibility. The project continues to flourish as the elementary school has adopted the garden and the students and teachers maintain its development and upkeep.

8:30–8:45 am

**The Power of Peer Reviewing to Enhance
Writing in Horticulture**

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Writing assignments in horticulture classes, particularly complex ones involving multiple rounds of editing and revision, may be enhanced with the aid of a peer review process. A mandatory peer review process was formulated and instituted in a Writing Intensive (WI) course, Greenhouse Management (Hort 3002W; University of Minnesota), and tested over 5 years (2003–2007; N = 156 students) to determine its effectiveness in improving student writing. A 3-phase WI assignment, designed as a bank loan application to establish a 50,000 ft² year-round greenhouse operation, had in-class peer review sessions. Phases I and II of the writing assignments were anonymously peer-reviewed by two students and graded by the instructor/teaching assistant. A peer review critique form was developed for peer reviews, which included specific methods of editing the assignments, answering essay questions, and quantitative scoring answers to relevant questions. The class then met in laboratory groups to conduct review panels, presenting their critiques to each author on writing improvement and proposal strengthening. Each subsequent phase of the project had to include a memorandum explaining how the panel's suggested changes had been addressed. Student's quantitative data from the peer review process were statistically compared with their numeric scores assigned by the

instructors to assess whether the process enhanced student writing and, subsequently, their course grades. Student writing, particularly for new or inexperienced writers in the profession, was enhanced by input from the peer review panel. A significant amount of network learning also occurred, enabling enhanced quality for each phase of the assignment. There were significant differences between years, Phases I and II, and students for most numeric reviewing scores. In general, across all classes and years, there was a significant improvement in writing ability as the writing assignment advanced. Student grades and peer reviewing scores were positively and significantly correlated for Phase I, but rarely for Phase II peer reviews, indicating that writing was enhanced with the peer review process.

Specified Source(s) of Funding: MN Agric. Expt. Station U of Minnesota Center for Writing

8:45–9:00 am

Student Perceptions of Skills for Solving Ill-structured Problems

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Problem-based learning has become a popular pedagogical strategy for teaching problem-solving skills as well as subject content. Ill-structured problems, like those typically found in case studies, provide a realistic simulation of real-world problem-solving. The objectives of this study were to: 1) determine how juniors and seniors perceive their own problem-solving skills in relation to an ill-structured problem presented as an online case-study and 2) if they perceived that problem-solving skills in general were important. Students were assigned a series of four ill-structured case study problems based on a realistic residential landscape. Data were collected via surveys and group discussions from students enrolled in a landscape management course during the fall semesters of 2007 and 2008, 24 and 21 students, respectively. In general responses between the two groups of students were similar. Students rated nine steps in a generic problem-solving sequence on a scale from 1 to 5 (1 = not at all important; 5 = very important). Fall 2007 students rated both determining the problem that needed solving and determining the best solution the highest (4.75), while Fall 2008 students rated determining the best solution and determining the variables involved in creating the problem the highest (4.90). Students ranked the statement about determining what standards and judgment criteria should be used to evaluate a decision the lowest, 3.75 (Fall 2007) and 4.20 (Fall 2008). Students were asked nine additional questions about decision-making on the job. Students identified the value of the solution to the customer/client (Fall 2007: 4.63, Fall 2008: 4.80), how well the cause of the problem was addressed by the solution (Fall 2007: 4.46, Fall 2008: 4.30), and any potential negative consequences (Fall 2007: 4.33, Fall 2008: 4.40) as the most important factors that influence decision-making on the job. Results indicated students understood the need for developing problem-solving skills, especially as they relate to future employment opportunities. However, students were concerned with obtaining the right answer to a specific problem, not with developing a strategy for solving problems.

9:00–9:15 am

Clickers in the Classroom: Student Perceptions and Prior Knowledge in a Home Horticulture Course

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Personal response devices or clickers have been shown to be a useful tool in interacting with students in a large lecture. In Fall 2007 and Spring 2008, clickers were used in Home Horticulture (Hort. 121) at Iowa State University to determine the perceptions, opinions, and prior knowledge of undergraduate students on gardening. Fifty four students were enrolled in the class in Fall 2007 and 49 students were enrolled in Spring 2008. Both group and individual clicker responses were recorded using Turning Point™ software. Students also participated in a printed pre- and post-survey on their perceptions of clicker use in the classroom. Students were of diverse backgrounds with 44% and 77% being majors outside the College of Agriculture and Life Sciences (2007 and 2008, respectively). Many students taking the class had limited knowledge and experience of horticulture and gardening practices prior to the class. For example, 54% of respondents stated they had little or no experience or confidence in pruning plants in the landscape. Data from the post survey indicates that over 70% of respondents agreed that the use of clicker technologies is beneficial to classroom learning. In addition, over 80% of respondents agreed that clickers make classroom learning more fun and engaging.

Specified Source(s) of Funding: Departmental

Oral Session 14: Horticultural Crops Culture and Management: BioEnergy **Monday, 27 July 2009, 8:00–9:30 am**

Field

Moderator: Donglin Zhang, donglin@maine.edu

8:00–8:15 am

How Are Greenhouse Growers Coping with Rising Energy Costs?

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A 2003 survey on benchmark costs found energy costs including heating fuel, fuel for vehicles, and electricity were 5.3% of sales. Heating costs were 4.9% or \$0.82 per square foot per year. By Fall 2008, heating oil costs (the most common fuel used for heating New Jersey greenhouses) have almost tripled. Other energy costs had gone up too. A 2003 mail-in survey of the New Jersey greenhouse industry found that 61% of respondents were considering energy saving technologies, 17% were considering alternative energy sources, and 10% were considering co-generation. Energy costs in 2008 were fluctuating, but mostly increasing rapidly. We surveyed growers to understand how they were coping with ever increasing energy costs. One option some growers can consider is to produce their own biofuels. We wanted to find out how many growers had enough land to consider this option. We also want to know how growers are handling the fuel cost increases. A total of 397 surveys containing a list of 21 questions related to energy use were mailed to greenhouse growers in the state of New Jersey in September 2008. A total of 56 (a 14% return-rate) usable surveys were returned. Oil, propane, and natural gas were the most common types of heating fuels used either alone or in combination as their primary heating source by the respondents. While only 4% of respondents have adopted alternative energy, 45% of them are investigating new methods of energy use, storage, and generation. Some of the alternative energy uses include biomass (wood, corn, switch grass, etc.), co-firing (coal and biomass), solar, wind, electric, geothermal, and double energy curtains.

Survey respondents do not feel that fuel surcharges are the answer in dealing with increasing fuel costs, and nine percent of respondents feel they have lost customers from charging a fuel surcharge. Sixty-six percent think fuel surcharges are bad for business. While eighty-four percent of the respondents indicated that their vendors were charging a fuel surcharge, twenty-three percent of respondents had asked their vendors to waive the fuel surcharge, and 13% have switched vendors because of fuel surcharges. Only 23% of respondents were charging their customers a fuel surcharge, thirteen percent had customers who have asked them to waive the fuel surcharge, and 25% would consider waiving fuel surcharges in the future.

8:15–8:30 am

Investigating Seed Dormancy in Switchgrass (*Panicum virgatum* L.)

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Switchgrass (*Panicum virgatum* L.) is a perennial warm-season grass native to North America established through seed. As in many other perennial grasses, freshly harvested seeds exhibit dormancy, resulting in delayed and sporadic germination and emergence, jeopardizing the stand establishment success. Dormancy can be imposed by morphological, physical, and physiological properties of the seed, or by a combination of them. Dormancy in switchgrass was alleviated by mechanical or chemical scarification and by stratification, suggesting physical and/or physiological dormancy. Furthermore, success of the treatments depend on the age of the seeds, after-ripening period, cultivar, temperature, cultural practices, storage conditions, seed weight, and seed size, among others. The causes, mechanisms, and physiology of switchgrass dormancy are not well understood. Understanding these factors will provide important and valuable information for future breeding programs focused on the development of low-dormant cultivars, and for the improvement of dormancy-breaking treatments. We tested the hormonal response of dormant switchgrass seeds to inhibitory and stimulatory temperatures, and investigated the contribution of the lemma, palea, embryo, and endosperm to dormancy in switchgrass seeds with high and low dormancy. Glumes, lemma, palea, and endosperm contribute to the dormancy in the seed lots analyzed. Germination was 50% higher in seeds in which glumes, lemma, and palea were removed. As the imbibition time prior to removal of covering layers was extended from 12 to 24 hours, removal of the palea did not improve the germination percentage. Removal of the endosperm resulted in faster germination and higher germination percentage. In excised embryos (no glumes, lemma, palea, endosperm) germination was 100% suggesting a lack of morphological dormancy, characterized by underdeveloped embryos, but rather a “physiological dormancy”. In a four year-old seed lot, with low dormancy, the germination percentage was not affected by the removal of the different layers. However, intact seeds germinated slower than seeds with covering removed. Germination was independently affected by temperature, abscisic acid, and gibberellins. Sensitivity of the seed to different levels of ABA and GA was affected by temperature, translated into a significant effect of the temperature × hormone interaction.

8:30–8:45 am

Susceptibility of *Camelina sativa* to Blackleg Disease, *Leptosphaeria maculans*

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Camelina (*Camelina sativa*) is an emerging economically important oilseed crop. *Leptosphaeria maculans*, blackleg, is a disease prevalent in canola, a Brassicaceae species closely related to camelina. Presently there is little available information about resistance to this pathogen in camelina. Four varieties of camelina, Blaine Creek (MT1), Celine, Ligena, and Suneson (MT5) were screened for resistance to *L. maculans*. The cotyledons of five day-old plants were inoculated with spore suspensions from two races of this fungal pathogen. One resistant canola variety, HyClass 924, and one moderately resistant canola variety, Freedom, were screened as controls using the same technique. Water-soaked lesions were observed in 100% of both resistant and moderately resistant canola lines. Blackleg lesions were more severe in the moderately resistant canola line than in the resistant line. In contrast, disease symptoms were not observed in any of the camelina varieties. This data suggests *C. sativa* is resistant to two specific races of *L. maculans* that are virulent to canola.

Specified Source(s) of Funding: Undergraduate Scholars Program (USP) Montana State University - Bozeman

8:45–9:00 am

Fermentation of Sweet Sorghum Juice

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Sweet sorghum [*Sorghum bicolor* (L.) Moench] is a tropical grass native to Africa, and was introduced into the U.S. in 1854. It was originally cultivated in the southern U.S. for small-scale syrup production, and was developed as a sugar source during World War II. We are testing the juice/sugars in sweet sorghum as a direct feedstock (not requiring starch hydrolysis) for ethanol production in Arizona. In previous work we found great variation for sugar profile (amounts of sucrose, glucose and fructose) among lines, and we developed a predictive model to estimate ethanol yield per area. Three questions were addressed in this study: 1) how does actual fermentation of juice compare to our predicted model; 2) how do sugar profiles change after fermentation (what sugars are left); and 3) how do the different sugar profiles affect final ethanol yield? Juice samples were collected from a date-of-planting study that was harvested between August and December 2008. The resulting juice was fermented utilizing a bench-top procedure, and the sugars were analyzed (by HPLC with refractive index detection) before and after fermentation to determine changes in the sugar profile. Correlations were made between sugar profile and final ethanol yield. Fermentations resulted in ethanol yields between 8% and 11% (about a 77% conversion rate). Most samples fermented 24 hours or longer had no detectable amounts of remaining fructose, glucose, or sucrose, and two samples had very small concentrations of fructose. This can be due to the fact that the strain of *Saccharomyces cerevisiae* prefers glucose and, once that has been depleted, will also

utilize sucrose and fructose. However, this is unlikely and we may be observing post-harvest changes in the sugar profile (one sample that had been stored frozen for four months showed a significant increase in sucrose concentration with a concomitant reduction of fructose and glucose). Most interesting was the occurrence of an unidentified peak around 3.8 minutes, found in all fermented samples.

Specified Source(s) of Funding: USDA

9:00–9:15 am

Evaluation of Several Horticultural Plants as Biodiesel Crops

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Biodiesel is a non-petroleum-based fuel consisting of short chain alkyl (generally methyl or ethyl) esters, made by transesterification of a vegetable oil or an animal fat which can either be used alone, or blended with petroleum diesel in conventional diesel-engine vehicles. Biodiesel has better lubricating properties and generally higher cetane values than petrodiesel. Biodiesel can be produced from any triglyceride, and the predominant feedstock used in the United States is soybean oil, although other vegetable oils, such as corn, mustards, sunflower and peanut can be used. We are exploring several horticultural crops whose seeds are rich in oil and have potential as biodiesel sources, including coriander (*Coriandrum sativum* L.), cress (*Lepidium sativum* L.), meadowfoam (*Limnanthes alba* Benth.) and flower-of-an-hour (*Hibiscus trionum* L.). Compared to soybean oil, all of the species had higher unsaturated fatty acid levels, with meadowfoam having over 97 % unsaturates. Flower-of-an-hour oil contained the highest levels of polyunsaturates (which are oxidatively unstable), with coriander having the lowest levels. Biodiesel was prepared from all four species by reacting the triglycerides with sodium methoxide. The low temperature fluidity varied among the biodiesels, with coriander biodiesel exhibiting the most favorable cold flow properties. All four biodiesels had excellent lubricity values compared to petrodiesel, with cress being the best. Meadowfoam biodiesel was the most oxidatively stable, with coriander biodiesel also having higher oxidative stability than soy biodiesel. Both flower-of-an-hour and cress biodiesels were significantly less oxidatively stable than soy biodiesel. Our results indicate coriander and possibly meadowfoam show excellent potential as biodiesel crops.

Specified Source(s) of Funding: USDA

9:15–9:30 am

Potential Biodiesel Plant Resources from China

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Compared with petroleum diesel, biodiesel has lots of advantages, such as biodiesel is a renewable resource. Exploration of plant-based

fuels has gained a lot of popularity in recent years and plant oils and fats as fuels have a bright future. This study had analyzed 135 angiosperm plants and 61 of them had great potential for biodiesel. Fatty acid components (especially C16-18 content), saponification number (SN), iodine value (IV), and cetane number (CN) had been examined to evaluate their potential for biodiesel, actually their fatty acid methyl esters, based on the EN and ASTM biodiesel standard. *Cornus controversa* (C16-18 content of 99.9%, SN = 204.79 mg/g, IV = 82.91 mg/100g, CN = 51.81), *Elaeocarpus hainanensis* (95.3%, 199.25, 80.30, 53.22), *Garcinia multiflora* (97.9%, 200.10, 72.78, 55.02), *Jatropha curcus* (99.7%, 203.70, 82.50, 52.06), *Lindera latifolia* (70%, 228.38, 63.02, 54.13), *Meliiodendron xylocarpum* (98.7%, 201.62, 72.03, 55.00), *Michella hedyosperma* (84.6%, 174.57, 86.06, 58.20), *Prunus undulate* (98.1%, 202.24, 84.53, 51.73), *Tutcheria championii* (100%, 202.59, 82.65, 52.17) and other 37 trees were recommended as potential biodiesel plants. *Euonymus alatus* (97%, 205.27, 85.65, 51.05), *Maytenus austroyunnanensis* (79.8%, 165.77, 57.77, 64.49) and other 4 shrubs should be included for biodiesel studies. *Akebia trifoliata* (98.4%, 201.72, 70.16, 55.47), *Hodgsonia macrocarpa* (100%, 206.02, 84.60, 51.22), *Iodes vitiginea* (100%, 217.92, 65.89, 54.54), and other 4 lianas should be considered as potential biodiesel plants. Two annuals, *Cyperus esculentus* (100%, 202.06, 89.04, 50.61) and *Trichosanthes villosa* (76%, 153.42, 105.32, 55.02), were also important biodiesel candidates. Further studies and targeted breeding of these plants and establish some biodiesel plantations with these plants will better secure our future renewable energy.

Oral Session 15: Lewis/Clark
**Horticultural Crops Culture and Management:
Landscape and Turf**
Monday, 27 July 2009, 8:00–10:00 am

Moderator: Richard C. Beeson, Jr., rbeeson@ifas.ufl.edu

8:00–8:15 am

Relationship of Transpiration, Reference Evapotranspiration and Tree Size During Six Years of Growth for *Ilex* × ‘Nellie R. Stevens’

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Actual evapotranspiration (ET_A) of three *Ilex* × ‘Nellie R. Stevens’ trees was determined continuously for six years using weighing lysimeters, as trees grew from rooted cuttings to 6 m in height. Trees were grown in containers which are increased in diameter incrementally each year. Measured ET_A was composed principally of transpiration because tops of the containers were covered to limit evaporation. Trees size, consisting of projected canopy area, tree height, and trunk circumference at 15 and 30 cm above substrate level and just below the first major branch collar, were recorded every three weeks. Reference evapotranspiration (ET_o) was calculated daily using an on-site weather station. Measured values of trees size were used to normalize ET_A . Normalized ET_A values were then modeled as a function of ET_o . Justification for the best model and its implications will be discussed.

8:15–8:30 am

A Survey of Urban Tree Damage After a Major Ice Storm Event in Northwest Arkansas

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On 26 January, 2009 during a freezing rain event lasting 12 hours, ice accumulations of up to 4 cm formed on trees at the University

of Arkansas arboretum located on the main campus in Fayetteville causing extensive damage to the collection. A survey was conducted in early February 2009 to assess damage as related to tree species and a damage rating of 0 (no damage), 1 (minor peripheral twig damage), 2 (minor limb breakage to 10 cm in caliper), 3 (moderate scaffolding limb breakage with caliper greater than 10 cm and minor trunk shearing), 4 (major scaffolding limb breakage with caliper greater than 10 cm and major trunk shear), to 5 (completely destroyed: tree removed) was assigned to each tree in the survey. Tree species belonging to the families *Ulmaceae* and *Aceraceae* showed the greatest damage along with the genus *Pyrus* in the *Rosaceae*. Mature specimens of several species of *Quercus*, normally considered resistant to ice damage, showed extensive damage with several individual specimens receiving a rating of 5, a complete loss. Species belonging to the *Magnoliaceae*, *Aquifoliaceae*, and *Taxodiaceae*, and certain members of the *Pinaceae* generally had minor to moderate damage. Survey results indicate that while all species showed varying degrees of damage, observations suggest extensive damage was more closely related to tree age, general health, and prior scaffold training and management than to any particular species. Tree damage with a rating of 4 or 5 was usually associated with limbs and branches that had bark inclusions, poor branching structure, or signs of internal wood decay. Results of this survey will be used to help generate guidelines for local and regional tree species selection and urban tree management in areas prone to ice damage.

8:30–8:45 am

Assessing Water and Nutrient Use by Leafy Mistletoe (*Phoradendron* spp.) and Some of Its Urban Host Trees

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Some urban tree species are suffering from severe leafy (broadleaf) mistletoe (*Phoradendron* spp.) infections. These infestations are mostly considered an aesthetic nuisance and their water and nutrient tapping from the host trees is often disregarded, with the parasite being left without control or management. In this preliminary study we are collecting baseline information on some water and nutrient use parameters by mistletoe plants and three Texas native tree hosts, cedar elm (*Ulmus crassifolia*), hackberry/ sugarberry (*Celtis laevigata*) and bois d'arc (*Maclura pomifera*). Data collected to date indicates that mistletoe leaves are actively transpiring (stomatal conductances, g_s , of 18–20 $\text{mmol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$), on both leaf sides (abaxial and adaxial), through the winter months, when the hosts are dormant (leafless). In the spring and summer the mistletoe leaves had g_s averages, on both sides of the leaves, of $\sim 45 \text{ mmol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ on the bois d'arc and hackberry hosts and $\sim 100 \text{ mmol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ on the cedar elm host. The g_s activity in host trees was similar to those in the semi-parasite leaves but largely confined to the abaxial (lower) leaf surfaces. The water potential values of mistletoe leaves were lower (more negative) than those observed in the twigs of the host trees. Based on preliminary data, nutrient concentrations in mistletoe leaves appear to be within the normal ranges reported for landscape trees and shrubs, but higher leaf chlorophyll indexes were found in mistletoe leaves.

Specified Source(s) of Funding: Texas AgriLife Research and Rio Grande Basin Initiative

8:45–9:00 am

Defining Variability in Residential Landscape Soils That Influence Nutrient Runoff

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Stormwater runoff is a significant concern in urban landscapes when soil water infiltration rates are low. This condition occurs when pore size is limited in fine texture soils or through soil compaction. Soil samples were collected from widespread, existing, newly constructed landscapes in Central Florida to examine the relationship between soil texture, bulk density, and infiltration rate. Infiltration rates were determined on site at the time of sampling. Samples were also collected to examine soil-moisture retention characteristics. The relationship of compaction and texture on infiltration rates and soil-moisture retention will be discussed.

9:00–9:15 am

The Effects of Four Pre-emergent Herbicides on the Rooting Architecture of Hybrid Bermudagrass (*Cynodon dactylon* L. Pers. × *C. transvaalensis* Burt-Davy)

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Weed control is an essential aspect of managing high quality turf. Controlling weeds improves turf uniformity and density, but also reduces plant competition for light, water, and nutrients. Monosodium methylarsonate (MSMA) is a widely used post-emergent herbicide for summer weed control in bermudagrass turf because of the low cost and broad spectrum of weeds controlled. The United States Environmental Protection Agency has limited the use of MSMA in turf until December 31, 2013, when all use will be prohibited. Turf managers will then have to rely on other products to control summer weeds or implement different weed control strategies. One option for summer weed control is using a pre-emergent (PRE) herbicide. Pre-emergent herbicides for summer weed control are applied in early spring, prior to weed seeds germinating, to form a protective chemical barrier near the surface of the soil. Several PRE herbicides work by affecting cell division and thus causing death in susceptible plants. Turf plants emerging from dormancy produce new root initiates that must penetrate this chemical barrier. Four PRE herbicides (Dithiopyr, Oxadiazon, Pendimethalin, and Quinclorac) were applied to dormant 'Tifway' bermudagrass in mid-March and their effects on root architecture (surface area, length, and mass) were evaluated and compared to an un-treated control. Root samples were harvested using a 17.8 × 1.9cm soil slab sampler and washed clean of foreign material. Samples were divided into top and bottom profiles at a depth of 7.6 cm. Root surface area and average root length were determined using the Win-Rhizo™ system and root mass determined gravimetrically. The roots were evaluated 2, 4, 8, 12, and 16 weeks after treatment (WAT) and all sampling intervals

revealed significantly reduced average root length and surface area. The greatest decrease in root length occurred 8 WAT by Pendimethalin (55%), followed by Quinclorac (40%), Dithiopyr (25%), and Oxadiazon (25%). The greatest decrease in surface area occurred 8 WAT by Pendimethalin (60%) followed by Quinclorac (40%), Dithiopyr (35%), and Oxadiazon (35%). Twelve WAT root length was not as severely affected. The data showed a decrease in length by Dithiopyr (40%) followed by Pendimethalin (20%), Oxadiazon (5%), and Quinclorac (0%). Twelve WAT root surface area was not as severely affected. However, data showed that Dithiopyr had the greatest reduction (40%) followed by Pendimethalin (35%), Oxadiazon (3%), and Quinclorac (0%). This study shows that the PRE's tested have a negative influence on hybrid bermudagrass root parameters well into the growing season.

9:15–9:30 am

Restoration Techniques for Landscape Soils Damaged by Construction

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Land development is accompanied by construction activities that damage soil structure, remove organic matter, and subsequently can reduce tree survival and establishment, slow growth rates and reduce ultimate canopy cover. Soil rehabilitation protocols are needed to assist arborists, landscape contractors, landscape architects, developers and planners to recommend and implement effective soil improvement methods that allow maximum root development and growth for urban and landscape trees. This study evaluates several specific soil rehabilitation protocols to determine their effects on soil physical properties, tree establishment, root development, and other growth parameters for five tree species on a graded and heavily compacted site. This represents the second year of a long-term study that will evaluate whether increasing access of roots to lower soil regions will enhance carbon sequestration in the soil and contribute to soil biogenesis. Twenty-four 4.6 × 18.3 m plots were installed in 2007 on a 1980 m² field site comprised of Shottower and Slabtown loam soils. Control plots were left undisturbed while remediation plots were scraped and graded according to common construction protocols. Subsoil compaction to an average bulk density of 2.0 g/cm³ was initially achieved following topsoil removal with 8 passes of a 4,800 kg sheep's foot vibrating riding compactor. Protocols under evaluation consist of combinations of topsoil replacement, amendments and mechanical loosening techniques: Undisturbed (no topsoil removal, no compaction, no amendments), Minimum Effort (topsoil surface application), Enhanced Topsoil (topsoil application and rototilling), and Profile Rebuilding (compost amendment, subsoiling with excavator to a depth of 60 cm, topsoil application and rototilling). Six replications of each treatment are installed in a completely random design with five deciduous tree species in each experimental unit. Bulk densities throughout the soil profile 9 months after treatment installation are characterized. After one growing season, Profile Rebuilding resulted in a 112% to 223% greater increase in trunk cross-sectional area than the average of the other treatments. Height increase, photosynthesis rates, and rooting depth are also described. This long-term study site will allow assessment of the effects of mechanical loosening and incorporation of organic matter on the soils' ability to provide ecosystem services (e.g. support vegetation, intercept rainfall, promote groundwater recharge, sequester carbon, etc.) over time.

Specified Source(s) of Funding: Tree Fund

9:30–9:45 am

Landscape Performance of 'Razzle Dazzle' Crape Myrtles

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Three gallon containers of 'Razzle Dazzle' crape myrtles ['Ruby Dazzle' (pink blooms with bronze-red foliage), 'Cherry Dazzle' (cherry red blooms), 'Snow Dazzle' (white blooms), 'Dazzle Me Pink' (pink blooms) and 'Raspberry Dazzle' (raspberry red blooms)], 'Chickasaw' crape myrtle and 'Pocomoke' crape myrtle were planted in late Summer 2006 in full sun landscape trials at Burden Center, a LSU AgCenter agricultural experiment station in Baton Rouge, LA (USDA hardiness zone 8B, AHS heat zone 8). Plants were placed in raised rows of Oliver silt loam soil (normal pH 6.2) approximately five feet apart in a randomized complete block design with each cultivar replicated three times. Supplemental irrigation was provided as needed via a drip system. Plants were fertilized in March 2007 and 2008 with Sta-Green Nursery Special 12-6-6. Pine straw mulch was maintained at a depth of two inches refreshed two times annually. Hand weeding, glyphosate and Amaze pre-emergent granular herbicide were used for weed control. Plants have not been pruned, pinched, or deadhead from the initial planting time through 2008. In addition, fungicides and insecticides were not been applied. Visual quality ratings based on a scale from 1 to 5 (1 = dead, below average landscape performance, 3 = average landscape performance, 4 = above average landscape performance, 5 = superior landscape performance) were taken monthly from April–November 2007 and monthly from April–November 2008. *Cercospora* leaf spot ratings were taken in October 2007 and October 2008 based on a scale from 1 to 6 where 1 = no leaf spot, 2 = 1% to 10% foliage with leaf spots, 3 = 11% to 25% foliage with leaf spots, 4 = 26% to 50% foliage with leaf spot, 5 = 51% to 75% foliage with leaf spot, and 6 = 76% to 100% foliage with leaf spot. Height measurements were taken in October 2007 and October 2008. 'Pocomoke' had the tallest overall height. Among the 'Razzle Dazzle' group, 'Snow Dazzle' and 'Raspberry Dazzle' were the tallest plants, followed by 'Cherry Dazzle', 'Dazzle Me Pink', and 'Ruby Dazzle'. Leaf spot was not observed on 'Raspberry Dazzle'. Leaf spot was slight on 'Ruby Dazzle' and moderate on 'Dazzle Me Pink', 'Cherry Dazzle', and 'Snow Dazzle'. Quality ratings were highest for 'Raspberry Dazzle', 'Cherry Dazzle', and 'Pocomoke'.

Specified Source(s) of Funding: Hatch Funds, State Funds, Louisiana Nursery and Landscape Association

9:45–10:00 am

Comparison of Root Measurements for Kentucky Bluegrass Sod Establishment

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Sod establishment is often gauged utilizing dry weight measurements even though other root parameters such as root length have been shown

to more directly affect nutrient uptake. Therefore, two methods for measuring sod rooting, root dry weight and root architecture were compared. Kentucky bluegrass (*Poa pratensis* L.) (KGB) sod was harvested and re-established in April 2006 and 2007. Roots were collected pre-harvest (P-H) and biweekly for 8 weeks after sod re-establishment (WAE) and analyzed for total root length (TRL), surface areas (SA) and dry weight. Pre-harvested roots served as controls and represented mature KBG root systems. Total root length and SA of rooting sod returned to P-H levels within 6 to 8 WAE, whereas, root dry weights constituted only 46% and 54% of P-H levels at 8 WAE in 2006 and 2007, respectively. Roots during sod re-establishment had small root diameters but greater specific root length and specific surface area compared to mature KBG roots. This shows carbon allocations were used to construct finer roots during establishment compared to a mature KBG root system. Use of dry weight to assess sod rooting rather than root architectural parameters may result in over application of inputs during KBG sod re-establishment.

Oral Session 16:
Horticultural Crops Culture and Management: Citrus Crops
Monday, 27 July 2009, 9:30–10:30 am

Moderator: Timothy Spann, spann@crec.ifas.ufl.edu

9:30–9:45 am

Effect of Humic Acid on Some Morpho-physiological and Bio-chemical Attributes of Kinnow Mandarin (*Citrus reticulata* Blanco)

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Pakistan is one of the top thirteen citrus producing countries of the world. However, average yield of Kinnow in Pakistan is about 9.0 t ha⁻¹ which is 3-fold lower than other developed citrus growing countries. Malnutrition practices coupled with poor soil organic matter (0.5% to 0.7%) and improper plant protection measures are the major reasons for the low yield. Use of humic acid to improve nutrient efficiency of applied fertilizers is an activity still in its infancy in Pakistan. Humic acid is one of the major components of humic substances which enhance organic matter contents of the soil. Liquid humic acid having pH 5.9 was applied at 40, 60 and 80 ml per tree to 12-year-old Kinnow mandarin plants in single, two and three equal splits as well. The humic acid significantly affected morpho-physiological and bio-chemical attributes of Kinnow mandarin plants compared with untreated plants. Maximum photosynthetic rate (42.38 μmol·m⁻²·s⁻¹ CO₂), stomatal conductance (52.09 mmol·m⁻²·s⁻¹) and total chlorophyll contents (3.092 mg·g⁻¹ of

fresh matter) were recorded in plants where a total of 80 ml humic acid per plant was applied in three equal splits in February (before flowering), April (after fruit setting) and August. There was also minimum fruit drop (50.43%) in these plants as compared to control (84.06%). Maximum sugar contents (16.21 mg·g⁻¹ of fresh matter) with higher juice percentage were also noted in fruits of these plants. Humic acids also affected the biochemical attribute as it decreased reducing sugar and total titrable acidity of fruit juice. Moreover, application of humic acid in three splits significantly increased fruit size, fruit weight, while decreased leaf drop percentage. Similarly all the humic acid treatments surprisingly enhanced photosynthetic rate, transpiration rate and stomatal conductance along with chlorophyll contents. So, it was concluded that humic acid application in three equal splits at different growth stages play a vital role in improving the growth and yield of citrus and also improve fruit taste and quality.

Specified Source(s) of Funding: Higher Education Commission of Pakistan

9:45–10:00 am

The Use of Plant Growth Regulators for Yield and Quality Improvement of Kinnow Mandarin

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The yield and quality of Kinnow mandarin (*Citrus reticulata* Blanco) in Pakistan is very low compared to other citrus growing countries of the world. The experiment was conducted to improve the yield and quality of Kinnow and also to trigger the maturity for early harvesting as Kinnow is late maturing cultivar under agro ecological conditions of Pakistan. Various growth regulators (2,4-D, GA₃ and NAA) were applied at three different levels each during the last week of November, 2005 on ten years old thirty plants of Kinnow grafted on Rough Lemon. The exogenous application of various plant growth regulators significantly increased the yield of Kinnow by decreasing the preharvest drop. Among the quality parameter juice percentage, total soluble solids (TSS), acidity percentage, Vitamin-C contents, reducing sugars, non reducing sugars and total sugars showed significant differences as compared to control. It was also observed that horticultural maturity of Kinnow was gained 15 days earlier compared to control with optimum quality. Overall results revealed that yield and quality of Kinnow can be improved with exogenous application of plant growth regulators.

Specified Source(s) of Funding: Higher Education Commission of Pakistan

10:00–10:15 am

Debris Accumulation in Loads of Mechanically Harvested Oranges

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The adoption of mechanical harvesting systems for processing oranges is a major goal of the Florida citrus industry. However, a number of issues have limited the extensive adoption of this new technology, among them being the amount of leaves and stems, or dead branches (collectively termed ‘debris’) which the shaking mechanism that effectively harvests mature citrus fruit can also remove during harvest. This debris makes its way into loads of fruit delivered to the processor, thereby increasing transportation and processing costs. The objectives of this research were to determine the amount and types of debris in mechanically harvested loads of sweet oranges and to determine if the use of the abscission compound 5-chloro-3-methyl-4-nitro-pyrazole (CMNP) could reduce the amount of debris. Mechanical harvesting was found to increase the amount of debris per load of fruit by as much as four times compared with hand harvested fruit. This translates into approximately 81.5 kg of debris per 27 t load compared with 30.5 kg for mechanically harvested and hand harvested fruit, respectively. Across harvesting method, leaves were the largest component of debris, accounting for approximately 60% of total debris, small stems (< 5 mm diameter) accounted for approximately 38% and the remaining 2% was large stems (> 5 mm diameter). In addition, the amount of soil particulate matter (sand) on the surface of mechanically harvested fruit was found to be approximately three times greater compared with hand harvested controls. The use of the abscission compound CMNP allows for less aggressive shaker operation to achieve the same level of fruit removal by selectively loosening mature fruit. We found that the reduction in shaker frequency associated with CMNP use reduced the amount of total debris per load to levels similar to hand harvested controls. The use of CMNP had a greater effect on the amount of leaf debris per load, such that leaf and small stem debris each accounted for 50% of the total debris; large stems were completely eliminated with the use of CMNP. The data from this study can be used in the refinement of debris elimination systems for mechanical harvesters to eliminate debris before the fruit are delivered to the processing plant and in economic analyses to determine the costs/benefits of mechanical harvesting.

10:15–10:30 am

Effect of Soil and Foliar Applied Fungicides on Production and Quality of ‘Blood Red’ Sweet Orange in Pakistan

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The current research studies involved a comprehensive study on effect of soil drenching of fungicides on yield and fruit quality of ‘Blood Red’ sweet orange. The experiment was performed on 13- 14-year-old sweet orange (*Citrus sinensis* Osbeck L. cv. Blood Red) trees grafted on rough lemon (*Citrus jambhiri* Lush.) rootstock, growing at Sq. No. 9 Experimental Fruit Garden, Institute of Horticultural Sciences, University of Agriculture, Faisalabad (Latitude 31°- 26' N and Longitude 73°- 06' E) Province Punjab, Pakistan. Two fungicides Alliette and Ridomil

Gold MZ and CuSO₄ were used alone, and in different combinations. The experiment was laid out in Randomized Complete Block Design (RCBD) with nine treatments including control with three replications. A single tree was taken as treatment unit hence data were collected from 27 trees. The experiment was performed for two years and data on fruit drop, fruit yield, and fruit quality including physical and biochemical characters were recorded. Physical characters of the fruit included average fruit weight, fruit diameter, peel thickness, number of seeds per fruit, seed weight per fruit, seed health, peel pulp, and juice ratio while biochemical characters were TSS, acidity, sugars profile, vitamin C. The results showed nonsignificant differences among treatments with to fruit drop and yield. Similarly all the treatments produced fruit of same quality of fruit except number of seeds per fruit which were significantly affected with different treatments. It was revealed from these two year studies that for such a field experiment, so short period was insufficient to get concrete results of fungicides application. However general health and vigour was improved which was attributed to better uptake of nutrients by improved health of diseased roots of the trees. Further it was evident from the results that best management practices could improve the production of sweet oranges in Pakistan for diversification of monoculture citrus industry of Pakistan through productivity enhancement of sweet oranges.

Specified Source(s) of Funding: PARB, Pakistan

Oral Session 17:

Jefferson A

**Crop Physiology/Physiology:
Growth Regulators**

Monday, 27 July 2009, 10:30 am–12:00 pm

Moderator: Thomas Davenport, tldav@ufl.edu

10:30–10:45 am

Comparative Analysis of Early Events in Tomato and Arabidopsis Brassinosteroid Signal Transduction

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Brassinosteroids (BRs) are essential plant hormones that regulate multiple aspects of plant growth and development. The identification of BR biosynthetic and insensitive mutants in tomato, rice, barley and pea, clearly extend the importance of these compounds from the experimental plant *Arabidopsis thaliana* to crop plants. While *Arabidopsis* is still the best model system for proteomic studies (which require a completely sequenced genome for optimum experimental efficiency), tomato is rapidly becoming an excellent model system for molecular studies of horticultural crops with an extensive genetic map, EST sequence database and a relatively efficient procedure for tomato transformation. Our experiments examined the conservation of molecular mechanisms between BR signaling in *Arabidopsis* and tomato. BRs are perceived at the cell surface by *BRASSINOSTEROID INSENSITIVE 1 (BRI1)* a member of the large family of leucine-rich repeat receptor-like kinases found in plants. The cytoplasmic kinase domains of tomato and *Arabidopsis* BRI1 are highly conserved (82% identical) and many of the Ser and Thr residues in *Arabidopsis* BRI1 occur in the same relative position in tomato BRI1, based on sequence

alignment. We expressed the cytoplasmic kinase domain of tomato BRI1 in *E. coli*, autophosphorylated the recombinant protein and determined the phosphorylation sites in tryptic peptides using a Nano Acuity Premier Q-ToF liquid chromatography-tandem mass spectrometry (LC/MS/MS) system. We identified 8 in vitro phosphorylation sites in tomato BRI1 compared to the 11 sites we previously identified in Arabidopsis. Interestingly, five of the tomato sites were conserved in Arabidopsis, but three were not, suggesting significant conservation but also possible differences in BRI1 downstream signaling between the two species. We also have bulked seeds of an advanced transgenic tomato line expressing full-length tomato BRI1-Flag and have begun in vivo phosphorylation site analysis by immunoprecipitation of BR-treated tissue followed by LC/MS/MS analysis. The successful identification of tomato BRI1 phosphorylation sites has allowed us to initiate a comparative functional analysis of BRI1 signaling in tomato and Arabidopsis in order to determine the inter-species conservation and divergence of receptor kinase mechanisms involved in BR signaling regulating plant growth.

Specified Source(s) of Funding: USDA/NRI

10:45–11:00 am

Do Pollinizer Cultivars Affect King Dominance of ‘Gala’ Apple?

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The phenomenon of metaxenia and its impact on apple fruit quality has been known for a long while. Several studies confirmed that hormones produced by seeds are responsible for it. Since seed hormones drive not only the evolution of fruit quality but also other physiological processes that may have an effect on fruit development, we assumed that pollinizers also affect king dominance. Cross-pollination treatments with pollen of ‘Elstar’, ‘Golden Delicious’, ‘Granny Smith’, and ‘Fuji’ cultivars were made on ‘Gala’ flowers. Open pollination of ‘Gala’ served as control. Fruit set of flowers in a cluster greatly varied with their position, flower number per cluster and pollination treatments; generally, king flower had significantly greatest fruit set regardless of flower number per cluster. Clusters with less than 4 flowers did not show any ability to set fruit. The highest probability was found for all clusters to set one fruit rather than more. Increasing number of flowers per cluster generally increased the number of fruit at harvest, however, close relationship was not found between flower number per cluster at bloom time and fruit number per cluster at harvest. Mean fruit weight decreased with fruit number per cluster. Significantly greatest fruit weight was usually measured for king fruit particularly for crosses of cultivars with strong king dominance (‘Granny Smith’ and ‘Fuji’). Decreasing tendency in fruit weight, however, did not necessarily follow the position of side fruits, i.e. their opening sequence in a cluster. Fruit weight of lateral fruits did not significantly differ from each other. Differences in fruit weight between king fruit and side fruits increased with increasing number of fruit per cluster. L:D ratio was usually the smallest for king fruit and greater for lateral ones in all treatments. Soluble solids, skin color and firmness were not significantly affected by cross-pollination treatments. Viable seed number per fruit, however, was greatly influenced by treatments. Seed count in fruit from ‘Golden Delicious’ pollination was greater than the open-pollinated ‘Gala’ control. ‘Elstar’, ‘Fuji’, and ‘Granny Smith’ had a reducing effect on seed number. Fruit position did not affect seed number, significant differences between king fruit and lateral fruits were not observed. Average seed number increased with increasing number of fruit per cluster. Gibberellic acid content in seeds (GA_3 , GA_4 , GA_7) was the greatest for king fruit but it was not

always significantly different from the second or third side fruit. GA content was not significantly affected by cross-pollinations.

Specified Source(s) of Funding: NCR SARE Grant

11:00–11:15 am

Plant Growth Regulators Improve Sweet Cherry Fruit Quality without Reducing Endocarp Growth

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Sweet cherry fruit growth is divided into three phases that are described classically as (1) cell division, (2) endocarp lignification, and (3) cell expansion. Negligible fruit size increase during stage II suggests that the endocarp is the dominant sink in the fruit at this stage. It is not known whether endocarp lignification competes with pericarp development for carbohydrate resources. We investigated this by attempting to reduce lignin accumulation and endocarp sink strength. Several plant growth regulators, include N-(2-Chloro-4-pyridyl)-N'-phenylurea (CPPU), GA_1 , GA_3 , $GA_{4/7}$, and fluridone (inhibitor of ABA biosynthesis) were applied in lanolin paste to ‘Bing’ fruit pedicels at the onset of stage II of fruit development. Fluridone (0.1%) alone or plus GA_1 (500 mL·L⁻¹) increased fruit size significantly (+ 15%) though these increases were not associated with a decrease in pit weight. Further, GA_1 alone did not increase fruit size, seed or endocarp weight, which suggests that ABA metabolism during pit hardening might be involved in mesocarp growth. Although GA_3 and $GA_{4/7}$ alone did not affect seed growth, they increased endocarp dry weight by 11%. CPPU did not increase fruit weight or pit weight, but did reduce seed growth and induced ca. 85% aborted seeds. Overall, final fruit weight was not correlated well with weight of pit, endocarp, or seed. These results demonstrate potential to manipulate sweet cherry fruit growth by manipulating hormonal balance.

Specified Source(s) of Funding: Washington Tree Fruit Research Commission, WSU ARC

11:15–11:30 am

Growth and Yield Response of Mango to Paclobutrazol Application Under Subtropical Climate

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Use of paclobutrazol has been recognized as potential growth regulator to increase fruit production. This research was conducted to evaluate different application method (soil drenching, collar washing, stem injec-

tion, or stem pitting) and doses (10 g or 15 g per tree) of paclobutrazol on mango trees under subtropical conditions of Pakistan. Paclobutrazol was applied at 10 g or 15 g per tree to eighteen years old mango trees (*Mangifera indica* L.) cv. Langra, grown under same agro-climatic and cultural conditions, located at Experimental Fruit Orchard, Institute of Horticultural Sciences, University of Agriculture, Faisalabad (Latitude 31°-26'N and Longitude 73°-06'E) Province Punjab, Pakistan. The parameters under study included: leaf nutrient contents (N, P, K, Ca); vegetative growth (flushing time, flushing intensity, canopy volume); reproductive growth (time and intensity of panicle emergence, floral malformation intensity, flower sex ratio, fruit setting, fruit number, fresh fruit weight, yield); and quality parameters (total carotenoids, TSS/TTA ratio, ascorbic acid, sugars, and organoleptic attributes). It has been presented that paclobutrazol application through stem injection method at 10 g per tree significantly affected N, P, K leaf contents with reduced vegetative growth (22% lower canopy volume) and improved reproductive growth (11% increase in fruit production) of the mango trees without adversely affecting mango fruit quality, while it also remarkably reduced threatening disorder of mango malformation (30%) of inflorescence.

11:30–11:45 am

Comparison of the Mango Florigenic Promoter Activity in the Subtropics and Tropics

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Research characterizing the florigenic promoter of 'Keitt' mango during cool, sub-tropical conditions demonstrated that ¼ leaf per stem was sufficient to induce flowering in 95% of initiating lateral shoots on deblossomed stems. In another experiment, three leaves on a donor stem were sufficient to induce flowering in 100% to 80% of initiating lateral shoots on the donor and five adjacent defoliated receiver stems, respectively. Similar experiments in the warm tropics of Colombia determined that four leaves per stem were necessary to induce 50% flowering shoots in 'Tommy Atkins' trees and 20% flowering in 'Keitt' trees. The reciprocal proportions of shoots in each case were vegetative. Five leaves on donor stems of 'Tommy Atkins' induced 70% to 20% flowering shoots on the donor and three adjacent receiver stems, respectively. The levels of FP made in 'Keitt' leaves during warm temperatures were estimated to be 3% of that produced in cool temperatures. The amount produced by 'Tommy Atkins' leaves in the tropics was about 8% that of 'Keitt' leaves in the subtropics.

11:45 am–12:00 pm

Effect of Sprayable 1-MCP (Harvista) on Preharvest Drop and Fruit Quality of 'McIntosh' Apples

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A sprayable formulation of 1-MCP (Harvista) was evaluated to determine its influence on preharvest drop and fruit quality of 'Gatzky McIntosh'/M.9 in 2007 and 2008. The proprietary formulation of AVG, ReTain, was included each year as an industry standard. Harvista was applied at rates of 77 and 152 ppm in 2007 and 60 and 120 ppm in 2008, using a backpack sprayer propelled with CO₂ at 40 PSI one week before the anticipated start of the harvest. A split application of Harvista of 60 ppm was also used in 2008. Silwet L-77 at 0.05% was included with the Harvista in both years and a 1% summer oil was used only in 2007. ReTain was applied with Silwet L-77 3 weeks before anticipated start of harvest at 106 ppm. The Harvista and ReTain treatments were applied to 2 sets of trees. Harvest evaluation and storage

samples were taken from one set of trees. No fruit were harvested from the second group of trees and they were used to assess treatment effects on preharvest drop. Harvista and ReTain controlled preharvest drop comparably and effectively through the third week of September. Harvista at both concentrations controlled drop more effectively than ReTain for an additional week. Harvista and ReTain delayed the onset of the climacteric and the development of red color, but they had little influence on fruit flesh firmness, soluble solids or starch rating. The split application of 60 ppm Harvista significantly lengthened the period when drop was inhibited. The only treatment that improved postharvest storage life of fruit was when trees received two applications of Harvista and the storage sample was taken immediately after the second Harvista application.

Oral Session 18:

Jefferson C

Horticultural Crops Culture and Management: Nursery Crops

Monday, 27 July 2009, 10:30 am–12:00 pm

Moderator: Brent Justin Markus, bjm27@cornell.edu

10:30–10:45 am

Altering Taproot Architecture of Black Tupelo (*Nyssa sylvatica*) to a More Fibrous Root System

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The demand for native plants in the urban landscape continues to increase. Traditional plant production methods in nurseries have had limited success in producing saleable plants from some of our native trees. One of the major difficulties relates to species that produce a taproot. I investigated alternate container production methods in a tree native to Illinois with multiple seasons of interest, the black tupelo (*Nyssa sylvatica*). Black tupelo is rarely found in the urban landscape because of a coarse root system rendering it difficult to transplant. Three existing root promotion techniques, air-root pruning, manual root pruning or auxin (K-IBA) dips, were used on container grown young seedlings and two-year-old transplanted liners. My objective was to alter taproot architecture of black tupelo and promote a more fibrous root system to alleviate transplant shock and facilitate field establishment. Results showed that superior root systems were produced using several air-root pruning containers that are also more economical than similar standard containers. Higher concentrations of auxin resulted in an increase in all plant parts measured, with an increase in survival after transplanting. Manual root pruning produced only minor benefit.

Specified Source(s) of Funding: IR-4 Program

10:45–11:00 am

A Photosynthesis-based Irrigation Model for Woody Plants

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Many techniques exist for estimating plant water use and refining irrigation requirements. However, grower adoption of existing irrigation technology is low. Development of an easily transferrable irrigation model could aid in grower adoption of irrigation technology. Previously, a photosynthesis-based irrigation model was developed for *Hibiscus* 'Cashmere Wind' under controlled-environment conditions. This model was based on the relationship between substrate moisture content and photosynthetic rate. A sigmoidal equation best fit the curve ($r_2=0.62$).

Photosynthesis was maintained at or near maximum rates from 100% container capacity to 62% container capacity. A distinct decrease in photosynthesis was apparent at 61% container capacity and this was used as an irrigation setpoint. Subsequent experiments showed that biomass and quality could be maintained equally among irrigation treatments so long as substrate moisture content was maintained above this setpoint. Additionally, a model was developed for two *Cornus* species under controlled environment conditions and exhibited similar characteristics. In order to determine the transferability of a photosynthesis-based irrigation model from controlled environment to outdoor conditions and to determine if different setpoints would be necessary among closely related *Cornus* taxa, the relationship between photosynthetic rate and container water content was measured for three related *Cornus* taxa (*C. florida* 'Cherokee Princess', *C. kousa* 'National', and *C. ×*Constellation) under outdoor, pot-in-pot conditions. Photosynthesis was measured as substrate moisture content decreased from well-watered conditions (90% or greater container capacity) to water deficit conditions. Again, a sigmoidal equation best fit the data ($r^2 = 0.70-0.74$), however, photosynthesis could not be maintained at near maximum levels over as wide range of substrate moisture contents as observed for greenhouse-grown plants. All three field-grown dogwood taxa showed a similar photosynthetic rate (near 80% of maximum) at 88% container capacity. Therefore, a revised model using this setpoint will be evaluated for its impact on water use and biomass accumulation in pot-in-pot dogwood production.

Specified Source(s) of Funding: UK New Crop Opportunities Center, UK Nursery Landscape Mini-Grant

11:00–11:15 am

Influence of Container Size, Insulation, Moisture Content, and Medium Type on Low Temperatures in Containers

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Despite the ubiquitous usage of containers for the production and marketing of woody plant material, little research has been conducted to determine the influence of container size, medium type, medium saturation, and location within the container on low root-zone temperature. In northern regions, growers must go to great expense to mitigate low-temperature induced root zone injury. Overwintering of containerized nursery stock is costly due to overwintering structure direct costs—the costs associated with a reduction in space use efficiency, increased labor, and mechanical damage resulting from increased plant movement. These costs make it difficult for nurseries in northern regions to compete with southern growers. Using controlled ultra-low temperature coolers, we studied how container size, insulation, medium type, medium saturation and location within the container influence root-zone temperatures. We found that peat and pine bark mixes significantly delayed freezing within containers compared to Stalite or sandy loam media. While the peat-based and pine bark mixes have substantially higher water holding capacities and lower thermal conductivities, following freezing they perform similarly to the other medium types. Following homogeneous solidification within the media due to freezing, all medium types cooled rapidly. During the phase change, the thermal diffusivity of the medium abruptly decreased as medium temperature reached slightly below 0.0 °C. This abrupt thermal diffusivity decrease remained for media with high water contents and low thermal conductivities—such as

pine bark mixes and peat mixes—for days compared to a few hours for sandy loam or Stalite.

Specified Source(s) of Funding: NYFVI (New York Farm Viability Institute), HRI (Horticultural Research Institute), John Z. Duling Tree Fund, J. Frank Schmidt Nursery

11:15–11:30 am

Effect of Postemergent Herbicide on Sucker Removal/Injury of Field Tree Liners

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Researchers at OSU have speculated that increased bark cracking in the nursery industry is due to the use of glyphosate products containing increased surfactants. The objectives of this study include: 1) to determine if various forms of glyphosate-containing products increase incidences of bark cracking and 2) to evaluate cold hardiness of trees subjected to various glyphosate-containing products. At The Ohio State University, Columbus, OH, four species of tree liners were planted in the field on October 5, 2003. The species evaluated were: *Acer ×freemanii* 'Jeffersred', *Malus* 'Prairifire', *Cercis canadensis* and *Quercus rubra*. The treatments were: Roundup Original, Roundup Pro, Kleen-up Pro, Scythe, mechanical, and a control. Trees had suckers removed mechanically in June 2007 and 2008 via hand pruners for corresponding treatments. Trees that lack suckers had an incision made 2.5 cm wide × 5 cm in length. After injury was made, plots had corresponding herbicide treatments applied. Cuttings were taken from terminal ends of shoots in January of 2008 and 2009 to assess cold hardiness. The plants were then frozen at nine temperatures every 3 °C from –6 to –30 °C in an ultra low chest freezer (Forma Scientific, Inc., Marietta, OH). There were three evaluation methods to determine cold hardiness: visual (amount of live tissue), starch (lugor stain), and electrical conductivity (EC). Data from 2008 indicated maple showed the greatest number of cracks over all treatments. This correlates with what is being observed within the industry. Roundup Original and Roundup Pro exhibited the greatest number of cracks between all Genus of trees, while the Kleenup Pro and Scythe exhibited less cracks. This could be attributed to the increased surfactant contained within the Roundup products. The browning data indicated that control and mechanical treatments were significantly more cold tolerant than Roundup Original and Roundup Pro. This is most likely due to the disruption of the shikimate pathway (Duke and Powles, 2008), decreasing phenolics; so therefore decreasing cold tolerance (Rivero et al., 2001). All trees showed a decline in hardiness across all treatments as temperature decreased with the browning observations. This study confirms Kuhns' (1992) study that glyphosate injury produces cracking in trees.

11:30–11:45 am

Effect of Irrigation and Nitrogen Fertilization on Growth and Foliar Chemistry of *Abies fraseri* (Pursh) Poir. Grown in Containers

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A two-year greenhouse study was established to investigate the effect of irrigation and nitrogen fertilization on the growth and foliar chemistry

of *Abies fraseri* (Pursh) Poir. The experimental setup was a factorial design with 4 irrigation levels (0.625, 1.25, 2.50, and 3.75 cm/week) and 3 fertilization levels (28, 56, and 112 kg/ha). Fertilizers were applied as top dress and weekly irrigation water divided into daily ration applied to each container 5 days a week. Parameters measured included morphological characteristics such as relative height growth (RHG), stem diameter growth (SDG), and leader bud density (LBD), and foliar nutrient content. Biomass partitioning response to the various treatments was also evaluated. In addition, a statistical numerical optimization was used to determine the optimal level necessary for each factor to achieve a simulated target response for morphological response and foliar nutrient content. After two years, the RHG response was significantly affected by irrigation in 2007 and 2008 ($P = 0.000$) and by fertilization ($P = 0.02$ and $P = 0.03$), but the interaction between the two variables was not statistically significant ($P = 0.579$ and $P = 0.465$). SDG positively responded to irrigation for both years ($P = 0.003$ and $P = 0.000$). The SDG response to fertilization was statistically significant in 2007 ($P = 0.016$), but not significant in 2008 ($P = 0.071$). The interaction between fertilization and irrigation was not significant for both 2007 and 2008. LBD data was statistically significant in 2007, but not significant in 2008. Biomass accumulation in roots was not significantly affected by fertilization and irrigation, however, stem and needle biomass positively responded to irrigation and fertilization. Needle nitrogen content was positively affected by nitrogen fertilization and negatively affected by irrigation. The statistical numerical optimization showed that for the target height growth of 10 cm/year, the combination of 3.75 cm/week irrigation and 28 kg/ha fertilization will be effective with a desirability factor of 91.0%. These results suggest that in difficult economic times, Fraser fir growers can achieve acceptable production goals with reduced fertilization applications and optimal irrigation.

11:45 am–12:00 pm

Effects of Soil Matric Potential on Fraser Fir (*Abies fraseri*) Growth and Water Stress Under Drip Irrigation in Michigan

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Fraser fir (*Abies fraseri*) is a major species for Christmas tree production in the eastern and Midwestern United States of America. However, the species is commonly raised out of its natural range in situations where environmental conditions are not suitable for optimal growth. As a result, supplemental irrigation is commonly provided to meet the physiological needs and enhance growth. This study investigated growth and crop water stress in response to irrigation based on soil matric potential. The experiments were conducted at two research locations in Michigan, where automated irrigation system triggered by soil matric potential levels (45 KPa, 35 KPa, 25 KPa, 15 KPa) and a non-irrigated controls were setup in Spring 2006. Tree height and caliper diameter growth were measured and correlated with soil matric potential levels to determine the optimal irrigation thresholds for *A. fraseri*. The effect of irrigation on tree water stress was evaluated based on crop water stress index, calculated from difference of canopy and air temperatures measured with infra red thermometers. The stem water potential was also measured using a pressure chamber. Initiating irrigation based on target soil matric potential values of 15KPa and 25 KPa significantly improved height and basal area growth of *A. fraseri* in smaller size classes. Soil matric potential of 15 KPa also reduced the CWSI, maintaining it within the range of 0.2–0.6 known as suitable for

most agronomic crops. Measurements of the stem water potential were more inconsistent across irrigation treatments for all size classes.

Oral Session 19:

Lewis/Clark

Horticultural Crops Culture and Management: Organic 1

Monday, 27 July 2009, 10:30 am–12:00 pm

Moderator: Erin Silva, emsilva@wisc.edu

10:30–10:45 am

Linking Plant Production Traits with Performance in Organic Systems

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Ease of establishment, vigor, plant canopy development, nutrient and water use efficiencies, and resistance to pests are traits that help determine the suitability of vegetable crops and varieties for commercial production. These traits are critically important in organic vegetable production, where most synthetic fertilizers and pesticides are prohibited and ecological-based management is standard. This project sought to determine the correlation between these traits, singly and cumulatively, on vegetable crop performance across a range of organic production environments. We tested eight varieties of corn, eight varieties of potato, and nine varieties of carrot on certified organic and organic-in-transition fields across a precipitation gradient ranging from North Dakota (semi-arid) to Wisconsin (subhumid), and on soils ranging from residual and coarse-textured (loamy sand), to geologically young and fine-textured (clay). Significant differences in variety performance existed for all crops. Data that were collected indicated several trends: 1) variety ranking with respect to yield changed across North Dakota and Wisconsin environments (i.e., there was a genotype by environment interaction); 2) crop yield improved as plant stand density increased, above-ground vegetative growth increased, or mid-season weed density decreased; 3) weed numbers and/or density declined as crop stand density, biomass, or plant height increased; and 4) insect feeding damage increased as macronutrient concentrations in crop tissue increased. Further research is needed to continue to evaluate these factors for a larger number of crops in order to provide information regarding these crucial production characteristics to organic growers.

Specified Source(s) of Funding: Organic Valley Farmers' Advocating For Organics

10:45–11:00 am

Cover Crop, Nutrient Amendment, and Crop Cultivar Affect Organic Cucumber and Tomato Production Systems in the Great Lakes Region

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Incorporation of cover crops, integrated nutrient and pest management strategies bear paradigm importance under organic production systems. Our study tested the use of cover crops (cereal rye alone or a mixture of rye and hairy vetch), dairy compost, monoculture, polyculture (growing alternate rows of cucumber and tomato) and crop varieties with relevance to crop yield, fruit quality and soil microbial population under organically managed cucumber and tomato production systems.

The two cucumber and tomato cultivars tested were 'Dasher-II' and 'Cobra', and 'Big Beef' and 'Mountain Fresh', respectively. There was no statistical difference and no interaction between variety and treatment for cucumber. Cover cropping with rye + vetch + compost combined with polyculture had the highest cucumber yield (18.8 kg/12 plants). The cucumber monoculture system did not perform well, primary because of higher cucumber beetle infestations and disease incidence (bacterial wilt). Observations from current study hint toward a potential use of polyculture as a crop insurance tool against cucumber beetles and other pests that pose a phenomenal threat to organic cucumber production in our region. There were significant interactions between tomato cultivars and the treatments. Higher yields were obtained from rye + vetch + compost treatments. Marketable yield for 'Big Beef' and 'Mountain Fresh' were 84.8 and 57.9 kg/12 plants, respectively. Both monoculture and polyculture treatments that received compost produced similar marketable yields. Compost treatment under rye cover crop exhibited the highest microbial biomass (197 $\mu\text{g C/g}$ soil after 7-day incubation). Plots which did not receive compost showed the lowest values. One of the biggest challenges experienced in this study was the ability to establish a decent stand of hairy vetch. With the unpredictable weather in the great lakes region, planting of hairy vetch late in the season after a tomato crop might not always provide enough time for the vetch to grow and accumulate sufficient biomass before winter. This leads to high mortality of hairy vetch when the seedlings are too young and cannot withstand the harsh winter. Therefore, for effective integration of hairy vetch into crop rotations in our region, hairy vetch should follow a crop with a shorter growth cycle than tomato. We found that integrating a cover crop mixture of cereal rye and hairy vetch supplemented with a sound nutrient management program (compost) is an effective way to stabilize yields, improve soil fertility, and build up a healthy soil for sustained crop production.

11:00–11:15 am

Nitrogen Availability from Liquid Organic Fertilizers

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Supplying adequate N for maximum crop productivity is often problematic in organic vegetable production. A number of liquid organic fertilizers are available for in-season use, but information on their N mineralization characteristics is limited. N availability of 5 commercial liquid organic fertilizers was quantified in an aerobic incubation experiment and a greenhouse bioassay. The fertilizers, containing either animal byproducts (fishery wastes and seabird guano) or plant extracts, ranged in N concentration from 26–60 $\text{g}\cdot\text{kg}^{-1}$. Soils from two organically-managed fields were brought to field capacity moisture content, fertilized at a rate of 100 $\text{mg}\cdot\text{kg}^{-1}$ N, and incubated at 15 °C and 25 °C. Fertilizer N availability was estimated as the increase in soil mineral N concentration of fertilized soil compared to unfertilized soil. Across soils and temperatures fertilizer N availability was quite rapid, with an average of > 70% of initial N content in mineral form after 1 week of incubation. Such quick N availability was attributed to substantial fertilizer $\text{NH}_4\text{-N}$ content (a mean of 38% of initial N across fertilizers) and rapid hydrolysis of simple N compounds. Soil and incubation temperature had modest but statistically significant effects on fertilizer N availability. High N availability was confirmed in a greenhouse experiment in which N uptake by fescue (*Festuca arundinacea* Schreb.) was evaluated. The N content of fescue clippings from pots amended with the organic fertilizers was compared with that from unfertilized pots, and from pots receiving an equivalent N rate from ammonium sulfate. Fescue N removal in 4 weeks of growth attributable to fertilization reached as high as 69% of the organic N applied, with the N uptake from all organic fertilizers at least equaling that from ammonium sulfate.

11:15–11:30 am

Mechanisms Explaining Sudangrass Interference and Defoliation Suppression of Canada Thistle

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Canada thistle (*Cirsium arvense*) has become the most problematic weed of sustainable and organic farmers in the Midwestern United States. Previous field studies found that sudangrass (*Sorghum sudanense*) and defoliation suppressed Canada thistle. Our objective was to understand the factors resulting in suppression of Canada thistle from defoliation and a cover crop of sudangrass. Defoliation (1 to 4 times) reduced Canada thistle shoot and root mass, root-to-shoot ratio, number of shoots, and final height compared to no defoliation. Canada thistle root mass was positively correlated with Canada thistle shoot mass and number. The combination of sudangrass interference, defoliation, and surface mulch suppressed Canada thistle suppression more than only defoliation, only interference, or the combination of interference and defoliation. Sudangrass grown so only allelopathy was possible did not suppress Canada thistle mass. Canada thistle decreased the Sudangrass root-to-shoot ratio. Overall, less Canada thistle photosynthesis from interference or shoot removal suppressed the weed. Additionally, we found that Canada thistle shoot mass and numbers may serve as a proxy for root mass and overall plant health, enabling managers to quantify the effectiveness of control strategies.

Specified Source(s) of Funding: Hatch Funds

11:30–11:45 am

Suitability of Biodegradable Plastic Mulches In Certified Organic Production

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Biodegradable plastic mulches are currently not likely to be allowed for use in certified organic production at the national level. Presently there are no biodegradable plastic mulch products allowable for use in organic production in the state of Washington or many other states. Petroleum-derived polymers which are included in most existing biodegradable mulch formulations currently render many mulch products unacceptable in certified organic crop production. To be acceptable, plastic mulches designed for biodegradability need to be derived from plant-based polymers like polylactic acid (PLA) and/or polyhydroxyalkanoates (PHA). Feedstock for plant-derived polymers also must be free of genetically modified organisms (GMO). Further, methodologies for creating the polymers, including resins or any additives, must be acceptable according to the National Organic Program (NOP) standards. The organic crop production industry needs to become familiar with the issues surrounding the definition of biodegradability and why many existing available products may not be eligible for such assignment. According to the American Society for Testing and Materials (ASTM), biodegradability must be defined by the system (composting, anaerobic digester, soil, marine, etc.), the timeframe (180–365 days

is considered optimal), and the complete utilization of the substrate carbon by microorganism naturally present in the system (as measured by the evolved CO₂). The relative ability of existing and emerging plastic mulch products to completely biodegrade in the soil environment needs to be researched and studies should include information on the presence or absence of residues and/or toxic by-products as well as physical and temporal impacts on soil ecology and plant health. It is essential for organic producers to conform to the current standards of their organic certifying agency regarding the use of biodegradable mulches, however, comprehensive studies on the long term impacts of biodegradation of plastic mulch products will help to promote new information and product development.

Specified Source(s) of Funding: USDA SCRI

11:45 am–12:00 pm

Solarization and Biofumigation for Organic Control of White Mold in High Tunnels

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The fungus *Sclerotinia sclerotiorum* causes white mold in lettuce and attacks a wide range of other cool-season crops commonly grown in high tunnels. It survives summer heat by producing heat-resistant soil-borne sclerotia that germinate when conditions favor the pathogen's growth. In 2006, 2007, and 2008 we conducted field studies in commercial organic high tunnels in Kentucky to test two organically-acceptable management tactics for their ability to prevent fall germination of *S. sclerotiorum* sclerotia. The first was solarization, laying clear plastic over the soil surface to trap solar energy and heat the soil. The second was biofumigation, soil incorporation of Brassica green manures to release volatile isothiocyanates toxic to some soil-borne fungi. In late July plots were randomly assigned to be untreated, solarized, biofumigated with 1 kg of Indian mustard (*Brassica juncea* cv. 'Pacific gold') per square meter, or solarized and biofumigated. Mesh bags of sclerotia were buried 0, 5, 10, and 15 cm below the soil surface at the center and edge of each plot prior to treatment, then retrieved 2, 4, and 6 weeks after treatment so that sclerotia could be incubated with moist soil at 16 °C for 6 weeks to stimulate germination. Soil temperature was recorded hourly at 0–15 cm throughout the 6-week treatment period. Surface temperatures in solarized plots reached an average daytime peak of 55 °C and stayed above 30 °C at night. Temperature swings were moderated with soil depth. Solarization for 4 weeks completely inhibited germination of sclerotia at the soil surface and 5 cm below the surface in all years. Inhibition varied between years deeper in the soil profile. Biofumigation did not inhibit germination of sclerotia.

Specified Source(s) of Funding: Southern SARE

Oral Session 20:

Laclede

Asexual Propagation

Monday, 27 July 2009, 11:00 am–12:00 pm

Moderator: Khalid Ahmad, Graduate,
khalidmasood@bzu.edu.pk

11:00–11:15 am

***Symplocos tetragona* Chen Ex Y.F. Wu and Its Cutting Propagation**

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Tetragonal sweetleaf (*Symplocos tetragona* Chen ex Y.F. Wu) is a new woody ornamental plant. Since it was discovered in 1996, this small evergreen tree attracted gardeners by its dense, gloss dark green foliage and pyramidal habit. The plant could be distinguished from other species by its yellowish green, tetragonal branchlets. Its fragrant white flowers usually bloom from March to December. The plant grows well from full sun to shade and tolerates various soil types. No injury was observed under –12 °C (Zone 7). To promote this new plant for commercial use, stem cuttings were collected on 7 August 2008 and treated with IBA and NAA at the concentrations of 1000, 3000, and 8000 mg·L⁻¹. All cuttings were inserted into 32-cell flats with perlite:peatmoss mix (3:1 by volume) and placed under a mist system. Rooting rate (%) and total root-ball volume were measured 18 weeks later. Rooting hormones significantly increased the root percentage from 40% (control) to 61 to 100%. Hormodin rooting powder yielded the highest rooting rates from 87 to 100%, regardless of its concentrations. Higher concentrations (3K and 8K) of K-IBA also produced commercially acceptable rooting rates of 87 and 73%. Double dips with KIBA+Hormodin and KNAA+Hormodin did not show any advantage. Hormodin rooting powder also greatly improved the root quality, which indicated by the total rootball volume. The highest rootball volume, 315.1 cm³, was obtained under the treatment of Hormodin #1. Cuttings treated with Hormodin #2 produced the second highest rootball volume of 268.0 cm³. Both cuttings treated with the lower K-IBA and K-NAA also showed the nice root system of 206.6 cm³ or higher. Stem cuttings of tetragonal sweetleaf could be produced commercially with 1,000 and 3,000 mg·L⁻¹ Hormodin rooting powder. Donglin Zhang is also a guest professor at the Central South University of Forestry and Technology.

11:15–11:30 am

Developmental Stage and Hormone Concentration Differentially Affect Vegetative Propagation of Select Baldcypress Clones

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In previous studies baldcypress [*Taxodium distichum* (L.) L.C. Richard] clones were selected for improved field tolerance to alkaline soils, drought, or foliar or soil salinity exposure, and/or their ornamental traits. Objectives of the current research were to 1) determine the clonal responses to K-IBA (potassium salts of indole-3-butyric acid) across seasonal developmental stages of cuttings, and 2) to determine if rooting rates (percentages) and rooted cutting quality (root number,

length, and mass) would be sufficient for commercial production if the clones were released to industry. Cuttings were taken from 24 clones at 3 developmental stages of stem growth (softwood, semi-hardwood and hardwood). Three concentrations of K-IBA were tested (0, 7500, and 15,000 mg·L⁻¹) on each clone at each stage. Rooting percentages ranged from approximately 94% (clone MX1MD33) at the softwood stage to 0% for several clones at the hardwood stage. Some clones, such as MX5MD17 rooted at 88% and 83% in the softwood and semi-hardwood stages, respectively, while others such as 479-16 rooted at low levels (< 20%) in all stages. In some cases, significant ($P \leq 0.05$) interactions occurred between growth stages and clones, such as that exhibited by clone 492-14 which rooted at 59% at the softwood stage but only 37% at the semi-hardwood stage. Root number and length exhibited three way interactions ($P \leq 0.05$) among clones × developmental stages × K-IBA concentrations. For example, mean total root length ranged from 2 cm per cutting on MX2MD31 at the semi-hardwood stage with no hormone to 81 cm per cutting on TX8DD38 at the softwood stage with 7500 mg·L⁻¹ K-IBA. Mean root length varied from 2 cm found in several clones at the semi-hardwood stage to 11 cm on MX2MD31 at the softwood stage treated with 15000 mg·L⁻¹ K-IBA. Most frequently, the greatest rooting percentages across K-IBA concentrations for clones were at the softwood stage and across rooting stages for most clones were at either 7500 or 15000 mg·L⁻¹ K-IBA. None of the clones rooted well as hardwood cuttings and 15000 mg·L⁻¹ sometimes induced basal stem damage.

Specified Source(s) of Funding: J. Frank Schmidt Family Charitable Trust and TREE Fund

11:30–11:45 am

Micropropagation of *Ilex glabra* (L.) A. Gray

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Inkberry (*Ilex glabra* (L.) A. Gray) is a popular native evergreen shrub with glossy green foliage for ornamentals. To mass produce inkberry for the nursery market, nodal segments containing one axillary bud (1–1.5 cm) were disinfested using 10% bleach and established on MS medium without hormone at 27 °C and 16 h photoperiod. The sprouted shoots (~1.0 cm) were cultured on MS medium supplemented with 6-Benzylaminopurine (BAP), Kinetin (KT) or Zeatin (ZT) at 0.5, 1.0, 2.0, or 4.0 mg·L⁻¹. After 38 days, BAP and ZT significantly induced multiple shoot formation with multiplication rates of 4–6, while the multiplication rate of KT was less than 2. Shoots cultured on ZT grew significantly faster than that of BAP and KT. The height of the longest shoots treated with ZT was 4.6 cm, which was 1.6–2.2 times greater than those treated with BAP or KT. To induce rooting, shoots (~2 cm) were subcultured on ¼ strength MS medium containing either IBA or NAA at 0.5, 1.0, or 2.0 mg·L⁻¹. Adventitious roots formed after 3–4 weeks in cultivation. IBA, at 1.0 or 2.0 mg·L⁻¹, produced the best rooting compared to other treatments. After 38 days, 66.7% and 100% of shoots were rooted at 1.0 and 2.0 mg·L⁻¹ IBA, respectively. The average number of roots per shoot was about 15, which was 1.6–3.1 times as much as that of other treatments. All rooted plantlets were then transplanted into a mix of peat moss: perlite (1:1 v/v) and acclimated in a mist system. About 73.6% of the plantlets survived after grown for 35 days. This micropropagation procedure could be used for commercial mass production of newly bred inkberry cultivars.

11:45 am–12:00 pm

In Vitro Regeneration of Venus Fly Trap (*Dionaea muscipula* Ellis) from Leaf Explant

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Dionaea muscipula Ellis commonly known as Venus fly trap is an important carnivorous plant with medicinal importance. It contains certain secondary metabolites like naphthoquinones and is used in anti-aids and anti-cancer drugs and other medicines called as “Carnivora”. Increasing interest and use as an ornamental and medicinal plant and have put it in an endangered state. Development of in vitro techniques for the preservation of germplasm that is on the brink of extinction is highly demanded. A regeneration protocol for the multiplication and micropropagation of *Dionaea muscipula* Ellis was established. In vitro regeneration potential of leaf explants in different concentrations and combinations of plant growth substances was investigated in this study. Leaf disc explants were excised and cultured under aseptic conditions on nutritional medium containing half strength Murashige and Skoog (MS) mix with combinations of 1.0–20.0 μM BA, 2.5.0 μM IBA, 1.0–10.0 μM 2iP and 0.1–0.5 μM TDZ. The cultures were kept in growth cabinet with cool white light (40–60 m·mol·m⁻²·s⁻¹) under 16-h photoperiod. Regeneration was recorded after 60 days with the intervals of 15 days based on the degree of shoot organogenesis and somatic embryogenesis. 1/2 MS + 0.1 TDZ appeared to be efficient for somatic embryogenesis and simple 1/2 MS for direct shoot organogenesis. 1/2 MS combined with 2iP appeared to be efficient for regeneration either by direct shoot organogenesis or by somatic embryogenesis. Plants were rooted well in Cape Cudew medium and all of the plants were acclimatized and survived in greenhouse conditions. These investigations will aid in the development of a model system for clonal mass propagation and in vitro regeneration of *Dionaea muscipula* Ellis.

Specified Source(s) of Funding: Higher Education Commission of Pakistan

Oral Session 21:

Lewis

Teaching Methods 2

Tuesday, 28 July 2009, 8:00–9:00 am

Moderator: Tina Marie Waliczek, tc10@txstate.edu

8:00–8:15 am

Use of Virtual Field Trips to Enhance the Educational Experience

Kimberly Moore*

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Field trips are an important component of many horticulture courses. Daytime field trips to botanical gardens, arboretums, nurseries, greenhouses, and other horticulture operations are difficult to schedule and many students are not able to attend due to scheduling conflicts. Furthermore, as more courses are developed for on-line (web) delivery, we lose the opportunity to show students real-world examples via the field trip. The development of Virtual Field Trips (VFT) using DVD video as a course aid would enable those students that do not have

the flexibility to attend daytime fieldtrips to watch well produced and informative videos as well as assist them in learning more about plant growth, identification, production, and use. This presentation will outline some of the challenges and benefits of using VFT as well as present student feedback on VFT.

8:15–8:30 am

Exploring Undergraduate Interest in Organic Agriculture Curriculum

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The University of Florida launched the organic and sustainable agriculture minor program in Fall 2005 and the organic agriculture undergraduate degree program in Fall 2006. Both the minor and major programs are administered by the horticultural sciences department. Currently there are 21 students enrolled in the major program, accounting for 43% of the undergraduate enrollment in the department. To well identify the student interest in the new organic agriculture curriculum and further assist curriculum enhancement, an in-class survey was conducted in Fall 2008 among students in the ‘Principles of Organic and Sustainable Crop Production’ course, one of the capstone courses developed for the organic agriculture programs. Out of 21 students who responded to the questionnaire, there were 12 students in the horticultural sciences department and 9 students from other majors including economics, political science, anthropology, zoology, aerospace engineering, animal science, food science, journalism, and wildlife ecology and conservation. Such a diverse range of student background presented a critical challenge for course content development. All the students believed that organic farming was better for the environment compared to conventional agriculture and a majority of them perceived that organic foods were healthier and safer than their conventional counterparts. Over 50% of the respondents indicated their support to small and local farms by purchasing organic foods. Regarding the sources where students learned about this organic production course, the course list posted online seemed to be rather effective. About 76% of the students were aware of other courses with a focus on sustainable agriculture offered by other departments. Despite the requirement for their major or minor, students preferred this course because it was more interesting while prerequisites were not needed. Integration of more practical information and experiential learning into the course was suggested by many students.

8:30–8:45 am

Will Hybrid Course Formats Attract Additional Enrollment?

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Hybrid course formats combine online and face-to-face learning. Two hybrid format undergraduate courses were offered by the Department of Horticultural Science, of in Fall 2008. In both courses, lectures and lecture-related exercises were delivered online for asynchronous student access with a weekly refresh cycle, while laboratory sections met weekly in a traditional face-to-face manner. Plant Propagation is a 1000-level course required of Horticulture majors and also chosen by students across the university to fulfill a required liberal education

credit in the biological sciences. Vines and Wines is a 1000-level elective course restricted to students who have attained the age of majority because sensory evaluation exercises in the laboratory sessions involve wine consumption. The purpose of this study was to determine, based on end-of-course surveys, whether the hybrid course format itself, or other factors, were determinants for students choosing to enroll in these courses. This information could be useful in developing strategies for increasing enrollment in horticulture courses. Seventy-seven percent of Plant Propagation students agreed (A) or strongly agreed (SA) that the hybrid nature of the course positively influenced their decision to enroll in the course. Eighty-two percent (A+SA) of these students noted that the scheduling flexibility afforded by the hybrid course was important to their decision. Limiting the face-to-face laboratory sessions to one per week (68% A+SA), and holding these sessions in the evening (64% A+SA) were also important factors promoting enrollment in the hybrid course. In contrast, most Vines and Wines students (56%) felt that the hybrid format of the course neither encouraged nor discouraged their decision to enroll, however 28% (A+SA) noted that the hybrid nature was a positive factor. Scheduling flexibility was important to many Vines and Wines students (47% A+SA), but a similar number of students were neutral (44%). Like the Plant Propagation students, Vines and Wines students agreed that limiting the face-to-face sessions to one per week (75% A+SA) held in the evening (78% A+S) were important factors in their decision to enroll. The availability of face to face, hands-on laboratories was one of the strongest factors encouraging student enrollment in Plant Propagation (77% A+SA) and Vines and Wines (87% A+SA), although likely for different reasons. The laboratory section in Plant Propagation is essential for students to obtain liberal education credit in the biological sciences, while the Vines and Wines laboratory highlights sensory evaluation of wine.

8:45–9:00 am

The Benefits of Integrating Service Teaching and Learning Techniques Into the Undergraduate Horticulture Curriculum

Tina Marie Waliczek*

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Service learning is a technique in which instructors integrate community service into their semester curriculum in order to enhance the learning experience. Universities often promote the use of service learning techniques since it can lead to better community relations. Instructors expound on the benefits of using service learning which include improved hands-on learning, a chance for students to experience “real-life learning experiences,” opportunities for students to learn civic responsibility, and students experiencing the benefits of community involvement. Additionally, service learning teaching strategies naturally fit into teaching horticulture and landscape design, since hands-on laboratories are often integrated into the curriculum. However, the benefits of service teaching and learning in horticulture classes have not been evaluated in research. For this study, students in an undergraduate Landscape Design class were taught the process of landscape design using service learning activities within the community. Projects included developing designs for a campus garden, the city post office, a neighborhood park, the campus childcare center, a city median area and the city women’s shelter. A survey tool was developed from other existing surveys to measure how students felt about service learning as a means to learn skills in class, as well as how they felt about volunteering and community service in general. The survey was formatted as a retrospective reflective instrument in order to evaluate students’ feelings before they were participating in the class, and how they felt afterwards. Currently enrolled students were surveyed, as well alumni from 5 classes of students taught in previous years in a similar manner. Data was entered and analyzed using SPSS. Results from

the study will help educators observe the value of integrating service learning teaching and learning strategies into the curriculum.

Oral Session 22:
Horticultural Crops Culture and Management: Plant Nutrition 2
Tuesday, 28 July 2009, 8:00–9:30 am

Jefferson C

Moderator: Dharmalingam Pitchay, dharmapitchay@gmail.com

8:00–8:15 am

Vermicompost Extracts Influence Growth, Total Carotenoids, Phenolics and Antioxidant Activity in Pak Choi (*Brassica rapa* cv. Bonsai, *Chinensis* group) Grown Under Vermicompost and Chemical Fertilizer

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Multiple studies have reported on the effect of compost tea on suppression of certain plant diseases. However, relatively little work has been done to investigate the effect of compost teas on yield and nutritional quality of vegetable crops and even fewer studies have addressed the relationship between extraction methods, chemical and biological characteristic of tea and subsequent plant response. Two greenhouse experiments were conducted to determine the effects of extraction methods on compost tea quality and the independent effects and interaction between compost tea type and fertilizer regime on plant growth, mineral nutrient concentration, phytonutrient content and antioxidant activity. Aqueous extracts of chicken manure-based vermicompost employing three different extraction methods were applied to pak choi plants under organic (vermicompost) and synthetic (Osmocote) fertilization. They were: non-aerated compost tea (NCT); aerated compost tea (ACT); aerated compost tea augmented with microbial enhancer (ACTME). Aerated water served as a control. Dissolved oxygen was lower and pH and mineral nutrients were higher in ACTME compared with the other teas, but total microbial population and activity in compost tea did not differ with extraction method. All compost teas similarly enhanced plant production, mineral nutrient content and total carotenoids in plant tissue, and this effect was most prominent under organic fertilization. Antioxidant activity and total phenolics were higher in plant tissues under organic compared to synthetic fertilization. Compost teas generally decreased phenolics under organic fertilization, and increased them under synthetic fertilization. Overall, the compost tea effect on crop attributes was attributed largely to a nutrient effect. The lack of significant differences among extraction methods on plant growth and nutrient concentration within fertilizer regimes suggests that aeration and additives were not necessary for growth promotion and nutrient quality under the conditions reported here.

Specified Source(s) of Funding: University of Hawaii GSO grant and WSARE project fund

8:15–8:30 am

Nutrient Requirements and Monitoring Options for Drip-irrigated Processing Tomato Production

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Increasing use of drip irrigation in processing tomato production worldwide, and concern over nutrient loss to the environment, makes the development of both effective and efficient fertigation management practices essential. A total of 4 high-yield drip-irrigated processing tomato fields in California were monitored in 2007–08. Above-ground biomass and macronutrient content was determined every 2–3 weeks, with the final sampling occurring near commercial harvest stage. On each sampling date soil, whole leaves and petioles were also collected and analyzed for NO₃-N (soil), total N, P, and K (whole leaves) and NO₃-N, PO₄-P, and K (petioles). Total fruit yield ranged among fields from 131–160 Mg·ha⁻¹. Mean seasonal uptake averaged 296, 43, and 388 kg·ha⁻¹ N, P and K, respectively. More than 70% of macronutrient uptake occurred between 5–11 weeks after transplanting, encompassing the period between early fruiting and first red fruit. Regression analysis of nutrient uptake revealed that during the middle of that period daily nutrient uptake peaked at approximately 6, 0.6, and 7 kg·ha⁻¹ N, P and K, respectively. Seasonal N application averaged 216 kg·ha⁻¹, close to the mean N removal in fruit (208 kg·ha⁻¹). In-season soil NO₃-N monitoring proved problematic due to stratification of NO₃-N in the wetted root zone. Current petiole nutrient sufficiency guidelines appeared to be higher than necessary for drip-irrigated production, while whole leaf sufficiency standards were generally appropriate.

8:30–8:45 am

Reduced Nitrogen Rates in Combination with Acadian *Ascophyllum nodosum* Seaweed Extract Effects on Yield and Nitrate Levels in the Petioles of Watermelon

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The agricultural soils of Maryland are relatively sandy resulting in an environmental concern about nitrate leaching into the sensitive ecosystem of the Chesapeake Bay. Improved efficiency in the use of available nitrogen may lead to reductions in run-off and leaching, and be financially advantageous to growers. This research examines effects of nitrogen applied at reduced rates in combination with Acadian *Ascophyllum nodosum* seaweed extract on yield and nitrate levels in the petioles of watermelons. Replicated trials on Crimson Sweet watermelons were established at the Lower Eastern Shore Research and Education Center (LESREC near Salisbury, MD, soil type: Fort Mott loamy sand), and the Central Maryland Research and Education Center (Upper Marlboro, MD, soil type: Adelphia fine sandy loam) using a randomized complete block design with 5 replications. Treatments included nitrogen applied at planting at rates of 100 and 150 pounds/acre, with and without Acadian *Ascophyllum nodosum* seaweed extract applied at 1.5 quarts/acre 2 weeks after transplanting, at bloom, at fruit set, approximately two weeks after fruit set, and 4 weeks after fruit set. Nitrate-N petiole-sap measurements were taken with a Cardy meter starting near fruit set and every 7–10 days until harvest. Yield data consisted of melon weight and number. Nitrate petiole sap measurements in 100 lbs. N+seaweed extract treatment were similar to

those from 150 lbs. N treatments. Treatments with 100 lbs N and the addition of seaweed extract showed yield results similar to those from the 150 lbs. N plots. *Acadian Ascophyllum nodosum* extract treatments allowed for reduced nitrogen applications while maintaining yields in watermelon.

8:45–9:00 am

Effects of S Fertilization Rates and Irrigation Programs on Tomato Growth and Yields

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There has been a renewed interest in sulfur (S) deficiencies because of the reduction in atmospheric depositions. Sulfur deficiencies are often confused with other deficient elements such as nitrogen (N). Tomato production in Florida is typically on deep Spodosols (fine sand) with low organic matter (>2%) and therefore inherently low in organic and inorganic S. Previous studies have found a positive response to the addition of S to fertilizer programs, regardless of source or form. Two studies were conducted in 2008 to determine the influence of S fertilization rates and irrigation programs on tomato growth and yield. The irrigation programs were 3528, 5292, and 7056 gallons of water per acre per day. The S rates were 0, 25, 50, 100, 150, and 200 lbs S per acre. Irrigation program increased vigor early in the season before fruit set, but did not continue to influence visual vigor ratings as the fruit were set. Chlorophyll content was not influenced by irrigation program or S fertilization rates. In the first study, the first harvest of tomatoes, the rate of 25 lbs/A S increased yield by 26% over the non-treated control. Increasing the S rate beyond 25 lbs/A S had less yield than 25 lbs/A S, but more than the non-treated control.

9:00–9:15 am

Phytoremediation of New Orleans Soils Using Urban Horticulture Plants

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Historically, some soils in the historically developed Midtown neighborhoods in New Orleans have been identified as containing elevated Pb levels. These soils were re-evaluated following inundation of these soils by Hurricane Katrina flood waters. The objective of this study was to determine if landscape species could be used to remediate soils with elevated Pb levels. Soil contaminated with Pb quantities exceeding 300 ppm was used in a greenhouse study. Mustard green, sunflower and common bermudagrass were selected as potential accumulators of Pb. Plants successfully grew in the alluvial clay and produced acceptable growth for all species. Mustard greens, sunflowers, and common ber-

mudagrass accumulated Pb in dried biomass, respectively. These species do show potential for phytoremediation of elevated Pb levels.

Specified Source(s) of Funding: Hatch Funds

9:15–9:30 am

Cellular Analysis of Ca, B, and Ca, and B Deprivation

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Root and shoot apical meristems are specialized areas where cell proliferation and organogenesis take place. The role of Ca and B in the root development, and the interactions between Ca and B deficiency in nuclear morphology, cell proliferation and primary root growth were investigated. The absence of Ca, B, or both Ca and B greatly reduced primary root growth relative to control root growth within 12 hours. Nuclei in both Ca and Ca\B deficiency treatments showed a significant decrease in volume. Boron deficiencies initially resulted in an increased mitotic index (MI), concurrent with root apical meristem (RAM) distortion. Most of the increase in root diameter could be explained by an increase in the number of cell files in the cortex. Ca and B deficiencies together reduced both the MI and root tip distortion. Because calcium increased cell death but did not promote cell division, while boron increased cell division, the combination of Ca and B deficiencies appeared to attenuate symptoms of nutrient deficiency.

Oral Session 23:

Field

Topics of Concern in Human Issues and International Horticulture

Tuesday, 28 July 2009, 8:00–9:45 am

Moderator: Amy L. McFarland

8:00–8:15 am

Graduate Student Use of Campus Green Spaces and the Impact on Their Perceptions of Quality of Life

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Researchers have found that students' perception of their overall academic experience and the campus environment is related to academic accomplishment, and that the designed environment of the university can influence the degree of stress students may feel. Past research found that undergraduate student use of campus green spaces and perceptions of quality of life were related to each other. The main objective of this

study was to investigate the relationship between graduate student use of campus green spaces and their perceptions of quality of life at a university in Texas. A total of 347 out of 3279 (approximately 10%) of the graduate student body received e-mails with information regarding the incentive for participation and instructions on accessing an on-line survey. The survey included questions that related to student use of campus green spaces, overall quality of life statements, an instrument to measure the quality of life of university students, and demographic questions. A total of 79 (22.8% response rate) graduate student questionnaires were collected and analyzed to compare levels of quality of life of university students and the level of usage of campus green spaces. Demographic information collected allowed controlling for student gender and ethnicity. Frequency statistics determined that, unlike undergraduates who were primarily "high-users" of campus green spaces, graduate students experienced an approximately equal split between low, medium, and high-users of the campus green spaces. However, graduate students still ranked their quality of life highly. Finally, this study found that, unlike undergraduates, graduate students did not have a statistically significant relationship between green-user scores and perception of quality of life scores. It may be that graduate students do not have time to spend in outdoor spaces, yet still meet their quality of life needs through other means such as their academic achievements.

Specified Source(s) of Funding: none

8:15–8:30 am

Growing Minds: Evaluating the Effect of Gardening on Quality of Life in Older Adults

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Older adults represent a growing part of the population of the United States. Due to decreased physical activity, dietary changes, and alterations in metabolic rate, this population is susceptible to a decrease in quality of life, especially when related to health. The Nutrition and Life Satisfaction Survey was used to investigate gardening as a possible preventative health intervention for older adults. The Life Satisfaction Inventory A (LSIA) compared older (age 50+) gardeners and nongardeners perceptions of personal life satisfaction. The LSIA measures five components of quality of life: zest for life, resolution and fortitude, congruence between desired and achieved goals, high physical, psychological, and social self-concept, and a happy optimistic mood tone. This questionnaire was developed by Neugarten in 1961, and is known to be a valid and reliable instrument. The survey was posted online as a part of the Aggie Horticulture website in Spring 2005. Respondents differentiated themselves as gardeners or nongardeners by responding positively or negatively to the question "Do you garden?" Overall quality of life scores were higher for gardeners when compared to nongardeners, and four individual quality of life statements demonstrated significantly more positive answers for gardeners. Personal reports of physical activity were significantly higher among gardeners and gardeners reported a more positive perception of personal health. Evaluation of these results indicates that gardening programs can be used to assist older adults in achieving their full potential in life satisfaction. Interest in social life or leisure activities provides incentives for gardening programs to fill social/leisure gaps in many older adult lives through actively engaging in healthy lifestyle practices.

8:30–8:45 am

The Effect of Gardening Activities on Motor Skills Development of Pre-K and Kindergarten Students

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Fine and gross motor skills play a very important part in childhood development. The famous educator, Maria Montessori, believed that children must exercise their "various coordinated movements" (i.e. motor skills), and realized that working in the garden and carrying out its related chores could actually improve motor development. There are definitely physical exercise and coordination components involved in gardening. However this connection has not been evaluated. This study investigated the relationship between gardening and motor skills in pre-k and kindergarten-aged children by quantitatively measuring students' levels of motor development in both a control population and one that had participated in gardening activities. The study integrated a pre-test/post-test design that used treatment (gardening) and control (non-gardening) groups of pre-k and kindergarten students. Students in the treatment group participated in the Cylinder Gardening Program which was presented through the Texas AgriLife Extension Service. The Beery Test of Visual Motor Integration (VMI) was used to test students' motor skills. Classrooms of students were tested at the beginning and end of their Spring 2009 semester. A brief general and demographic questionnaire was also sent home to parents to provide clues into other factors that may have contributed to students' motor development and to provide a means for sorting data. Results will be used to promote outdoor activities including gardening programs for children.

8:45–9:00 am

The Effect of Tree Cover and Vegetation on Incidence of Childhood Asthma in Regions of Texas

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Childhood asthma is the most common chronic disease in children. Increases in the number of cases occurring in industrialized countries are directly linked to many factors including air pollution. Although air pollution is not believed to be a direct cause of children developing asthma, there is growing concern that air pollution triggers symptoms in those who suffer from asthma, causing an increase in incidence and severity of asthma in children. It is known that the leaves of trees can take up pollutants in the air such as ozone, nitrogen dioxide, ammonia, sulfur dioxide and particles such as aerosols and dust. The main objective for this study was to determine if childhood asthma rates in regions of Texas were related to vegetation and tree cover in city and county areas. The state of Texas was broken down into 25 different Metropolitan Statistical Areas (MSAs) for the purposes of demographic and statistical analyses. Children's asthma data was collected from the Center for Health Statistics and the Texas Department of State Health Services for the years 2001–2006. Of the 25 MSAs, data on childhood asthma rates were available for 14. The asthma rates for each MSA was 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 SPSS. The study compared vegetation rates and asthma rates in metropolitan areas to observe whether vegetation and tree cover led to higher or lower incidences of childhood asthma rates. Results will be used to evaluate the value of green spaces and the urban forest in city areas.

9:00–9:15 am

Urban Youth: Effects of a Summer Agriculture, Cooking, and Nutrition Program

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Studies have shown that nutrition education coupled with a gardening program can impact youth's nutrition choices and snack preferences. An 8-week study was administered over two summers (2007 and 2008), in cooperation with a local church, LSU A&M, and LSU AgCenter. The program curriculum was a combination of agriculture, cooking, nutrition, business and leadership components. The study subjects were McKinley High School students, who reside in a primarily low-income, urban, "food desert" in East Baton Rouge Parish. Students grew vegetables on university land and also gleaned produce from local farmers to sell at a weekly farm stand in their neighborhood. In addition they produced a high-quality, value-added hot sauce product, and learned cooking and nutrition one day a week on the university campus. Students were taught to cook healthy, seasonal recipes using vegetables and herbs they grew and harvested. Students (n=34) were given pre and post tests to measure their attitudes and snack preferences toward fruit and vegetables and nutrition knowledge at the start of and at the end of the 8-week program. The program also evaluated the impact on students' leadership skills development, environmental responses, and science literacy. The results of the fruit and vegetable preference survey will be presented. Qualitative data, in the form of student journals and evaluation forms, expressing the positive effects of the program on the youth's cooking, business, leadership, and life skills will also be presented.

9:15–9:30 am

Proposal for the Establishment of a Mutually Beneficial Botanical Staff Exchange Program Between China and the United States

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With the vast diversity of China's flora and its similarity to that of North America's, the interest in study and botanical collaboration has continued in both countries despite changes in regulations and bureaucracy. This study investigated the potential development of a Sino-American horticultural staff and educational exchange program modeled after the Garden Club of America's Interchange Fellowship/Martin McLaren Scholarship. Both the Chinese and American

perspectives were investigated. In China, interviews were conducted during July 2008 at 11 botanical gardens in seven provinces/provincial level cities with directors and/or upper management. The American perspective was documented through surveys, interviews, focus groups, and case studies; data was collected and examined from the American Public Gardens Association, Garden Club of America, the North American China Plant Exploration Consortium, and key public gardens engaged in collaboration with China. Data indicate that an ongoing exchange partnership of this type will have several important and potentially valuable benefits to the horticulture professions. Considering China's relationship-based culture and previous Sino-American collaborative experiences, greater staff and educational exchange will nurture cross-cultural professional relationships and increase cultural understanding. Greater personnel exchange will also increase awareness among students in both countries of potential intern and graduate study opportunities, best practices, and industry standards. A system of ongoing staff exchange will create a resource network available to non-associated individuals or institutions wishing to collaborate. Additional benefits include increased exchange of scientific techniques and cultural practices; cultivar and germplasm exchange; and greater access to type specimens and wild species populations for studies of vicariance, disease resistance, invasiveness/weed control, and agronomic uses.

Specified Source(s) of Funding: The Longwood Foundation

9:30–9:45 am

Classic Islamic Influence in Garden Design: Legend or Fact?

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What do we owe to classical Islamic culture in terms of garden design? Many of us have read, or heard in a lecture, that the view of a garden as an earthly paradise may be attributed to the Islamic religious culture. To what degree is this a tenable explanation? Is there any truth at all to it? It is all myth? Western history does show us that the walled garden, with a central water feature, has been repeated for a millennium throughout the Middle East and North Africa, in Spain, and even in India. In all these locations, the garden design has been associated with Islamic rulers and culture. But if it did not come from Islam, then where *did* this concept originate? In many ways, it is reasonable to believe that cultures from arid lands would tend to appreciate the visual comfort of running water and lush, green plantings. In contrast to the harsh landscape outside the walls, these gardens do provide a quiet, tranquil vision . . . in some ways, an escape from reality. And, since the Middle Ages, western culture has more or less equated the cultures of the arid Middle East and southwest Asia with Islam. But it was not always so. Islam as a political and cultural force is a relative newcomer to the region. By the 4th and 5th centuries BCE, a millennium before Islam's rise across the region, the great Persian rulers Xerxes, Darius, and Alexander had spread their culture from the Bosphorus to the Indus Valley. This was the culture which actually promoted the walled garden, rich with plantings and water features throughout the realm . . . called at that time "the whole known world." So while almost all of our existing examples of the gardens representing paradise date from the reigns of Islamic rulers in the 10th through 15th centuries, these are just the most recent and best preserved examples of a tradition more than 2,000 years old. And, so far as we may determine, there was originally no religious significance to the gardens . . . and the idea of a "paradise on earth" may be more a cultural than a religious concept.

Moderator: Todd Dalotto, dalottot@onid.orst.edu

8:00–8:15 am

Effect of Timing and Duration of Blue Light Exposure on the Anthocyanin Content of Red Leaf Lettuce Cv. Outredgeous Grown Under Light Emitting Diodes

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Future space missions beyond Low Earth orbit will expose crew members to higher doses of cosmic radiation than currently received onboard Space Shuttle or the International Space Station. A diet rich in bioactive phytochemicals is a potential radiation countermeasure to both reduce the effective radiation dose and induce in situ repair of radiation damage during these long-duration space missions. It has been shown that light quality can be used to increase the anthocyanin content, and thus, anti-oxidant value, of the salad crops. The use of solid state light emitting diodes (LEDs) to provide plant lighting systems is being evaluated for use during long duration space missions. A series of experiments were conducted to determine the effect of timing and duration of narrow band blue light (440 nm) on the concentration of anthocyanins in *Lactuca sativa* cv. Outredgeous (a red, loose-leaf type). Lettuce was grown in controlled environment chambers (EGC M-36, Environmental Growth Chambers, Chagrin Falls, OH) at 23 °C, 65% RH and 1200 ppm CO₂. An 18 h light/ 6 hr dark photoperiod was maintained under light emitting diodes (LEDs) at 300 μmol·m⁻²·s⁻¹. Two control treatments, red LEDs only (640 nm) and 270 μmol·m⁻²·s⁻¹ red (640 nm) / 30 μmol·m⁻²·s⁻¹ blue (440 nm) were applied. All treatments had red light throughout development [0–21 days after planting (DAP)]. Timing experiments consisted of blue for 0–14 DAP, 14–21 DAP, 7–14 DAP or 7–21 DAP. Lettuce was harvested at 21 DAP and dry mass, leaf area, plant height, anthocyanin content, and oxygen radical absorbance capacity (ORAC) value determined. Results clearly showed that blue light was required for the induction of anthocyanin production in Outredgeous. Continuous exposure (0–21 DAP) to blue light had little additional effect on ORAC, although total anthocyanin content was more than double. Removing blue light from days 14–21 DAP resulted in significant reduction of both anthocyanin and ORAC values. In marked contrast, applying blue light for the final 7 days of growth (14–21 DAP) increased anthocyanin levels over 4-fold and resulted in ~24% increase in ORAC values. These data indicate that anthocyanin production is under blue light photoregulation in lettuce and that bioprotective and nutraceutical value can be enhanced by selective management of light spectra during development.

Specified Source(s) of Funding: Support provided by Core Technical Capability (CTC) Program at NASA's John F. Kennedy Space Center, FL. FÁS (Foras Áiseanna Saothair), Ireland's Training and Employment Authority Science Challenge Program provided funding for G. Newsham.

8:15–8:30 am

Antioxidant Activity of an Italian Heirloom White Fleshed Sweetpotato

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Sweetpotato (*Ipomoea batatas* L.), one of the most cultivated vegetables worldwide, is well known and studied especially for genotypes with colored flesh. In Italy this crop is a niche crop mainly grown in the North. As a consequence in Italy it has never been considered as a staple crop but recently the interest began to increase even though little is known about both growing techniques and its nutritional features. Moreover some researches indicated that leaves and vines are particularly rich in antioxidant compounds and that can be considered a good and cheap source for extraction industry. The aim of this study was to quantify and characterize the antioxidant activity of 2 heirloom sweetpotato, grown in North Italy characterized by different leaf shape [heart-shaped (HS) and lobed (LS)]. Heirloom plants were grown in contiguous plot using same techniques by a farmer in Anguillara Veneta – Padova – Italy (45° 13'N – 11° 88'E) in 2008. Biomass collected during the growing cycle and at commercial harvest (11, 26 Aug. and 22 Sept.) was analyzed at the Department of Environmental Agronomy and Crop Science of the University of Padova within 48 hr from sampling. During growing cycle leaf blade, petiole/vine, stem and roots (not yet, partially (up to 100 g) and completely (more than 100 g) swollen) were analyzed to determine total antioxidant activity (AOA), total phenols (TP) and vitamin C (VC) content. At harvest only roots were considered after grouping in four caliber classes (0–100, 100–200, 200–400 e > 400 g). Results showed, on average, that HS biomass had higher AOA, TP and VC than LS with no differences among sampling times with the exception of VC whose content in the first sampling data was lower than in the others. Within the plants AOA and TP were higher in leaves blade followed by stem, petiole/vine, small, medium and fully enlarged roots. VC content showed an opposite trend than AOA and TP. Weight classes did not show any difference in term of AOA, TP and VC in both lines even though a late harvest (8 days of delay) induced a reduction of VC content in all the groups. As a conclusion it is possible to state that, nevertheless its lower content of antioxidant compounds as compared with the colored flesh, also the less studied white fleshed potato could be considered a healthy functional food.

8:30–8:45 am

Comparison of Characteristic Flavor and Aroma Volatiles in Melons and Standards Using Solid Phase Microextraction (SPME) and Stir Bar Sorptive Extraction (SBSE) with GC-MS

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Stir bar sorptive extraction (SBSE) is a technique for extraction and analysis of organic compounds in aqueous matrices, similar in theory to solid phase microextraction (SPME). SBSE has been successfully used to analyze several organic compounds, including food matrices. When compared with SPME, considerably higher recoveries have been reported yet, we find no SBSE for melon and fresh-cut melons. Several articles indicate that roughly 1 h exposure for SBSE delivers an optimized analyte recovery. We previously used 12.5 min adsorption time in fruit juices held at 40 °C in order to attain reliable volatile headspace recovery via SPME-GC-MS, whilst not inducing substantial flavor compound changes due to sampling. Here, we evaluated differences in 30 compounds in Proteo cantaloupe and honeydew melons [propyl acetate, ethyl 2-methyl propanoate, isobutyl acetate, methyl 2-methyl butanoate, (Z) 3-hexenal, ethyl butanoate, ethyl 2-methyl butanoate, (E) 2-hexenal, 3-methyl 1-butyl acetate, 2-methyl butyl acetate, methylthiobutyrate, ethyl (methylthio) acetate, ethyl hexanoate, (Z) 3-hexenyl acetate, hexyl acetate, eucalyptol, (Z) 3-octenol, ethyl 3-(methylthio) propanoate, (Z) 6-nonenal, (E,Z) 2,6-nonadienal, (Z) 3-nonenol, (E,Z) 3,6-nonadienol, (E) 2-nonenal, benzyl acetate, (E,Z) 2,6-nonadienol, (Z) 6-nonenol, octyl acetate, 3,6-nonadienyl acetate, and (E,Z)-2,6-nonadienyl acetate] via mixed external standards (0.05, 0.1, 1, 10, 50, 100, 500, and 1000 ppb) by SBSE. Occasional comparisons were drawn between SBSE and SPME in subsample groups. An internal standard (amyl isovalerate) was used. Thirty, 60, and 90 min SBSE exposure at 37.5 °C did not appear to deliver consistent trends across all 30 volatiles analyzed. While comparing SBSE to SPME with 12.5- or 25-min exposures at 37.5 °C, a standard gradient yielded similar results for several compounds (e.g. 2-methylbutyl acetate, hexyl acetate and eucalyptol), whereas occasionally the SPME recovery exceeded SBSE linearly (e.g. amyl isovalerate). Due to the impressive amount of polydimethylsiloxane (PDMS) loaded onto a SBSE as compared with SPME, an occasional compound of interest (e.g. butyl acetate) was not resolved due to siloxane impurities. Data analysis continues since certain volatile standards were recently acquired and verified, resulting in changes to our MS quantification ions and calculation methods. Data for various melons, based on authentic standards, per SBSE and/or SPME will be presented.

Specified Source(s) of Funding: credit card

8:45–9:00 am

Effect of Location and Age of Plantation on Organoleptic Characteristics of a Typical Italian Asparagus Crop

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Asparagus is a very common and important vegetable in the Veneto region especially in the areas of Treviso, Vicenza, and Padova provinces, where it is also a typical and historical product. Recently the demand for high of quality produce (nutritional value) has been increasing dramatically. For green asparagus, and in particular for typical cultivar grown in Northern Italy, the information on these issues are limited. For these reasons experiments have been carried out in order to evaluate nitrates, nitrites, polyphenols and pigments contents and antioxidants activity of marketable product of green asparagus cv Eros, grown in

two areas of Veneto region. The qualitative analysis in green shoots, were performed in 2008 at the Department of Environmental Agronomy and Crop Science of the University of Padova on samples coming from the 2 areas (Pd and Ba). The first asparagus plantation considered was three years old and the second one eight years old. During harvest (from April till May), six sampling were collected. After each harvest, shoots were calibrated, washed and placed at 4 °C till next day. For qualitative analysis only extra class shoots (diameter >16 mm) were used. Shoots were weighted and then cut to 270 mm from the apex in order to separate not marketable portion from the commercial one. The latter fraction was cut in 3 parts 90 mm long [apical (A), intermediate (I) and basal (B)] to evaluate quality characteristics of each part. Results showed that asparagus from Pd had a lower content of dry matter but a greater weight. The nitrate content, which was always far below the recommended WHO limits, was not influenced by location, while considering the part of shoot, as expected, a decreasing trend from the base to the apex was observed. For nitrites there were no significant differences between locations and among shoot parts. The pigments content increased during the advancing of the harvest season in Pd that showed the highest values. The content of these compounds strongly increased moving from the base to the top of the shoot and the chlorophyll *a* content was higher than the chlorophyll *b* and the pool xanthophylls + carotenoids. The antioxidants activity and polyphenols analysis showed that the upper part is the richest in these compounds mainly because directly exposed to stress situations (light) caused by the shoot emergence through the soil and by the increasing of xanthophylls and carotenoids content.

9:00–9:15 am

Purification and Fractionation of Phenolic Compounds in Medicinal Herbs and Evaluation of Their Anticancer Activities

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Many herbs have been long used in folk medicines for the treatment of a number of disease conditions. More and more recent studies have supported the potential health benefits of herbs. The objectives of this study were to evaluate the anticancer activity of five herb species and identify their major active ingredients. The herb species evaluated include: thyme (*Thymus vulgaris*), sage (*Salvia officinalis*), rosemary (*Rosmarinus officinalis*), peppermint (*Mentha piperita*), and spearmint (*Mentha spicata*). The anticancer activity was assessed under in vitro conditions using a SW-480 colon cancer cell line. Phenolic compounds were extracted and further purified using a Buchi flash chromatography system with a fraction collector and a UV photometer. Results have shown that herb extracts can significantly inhibit cancer cell growth. Among the crude extracts, sage showed the highest inhibitory effect with a 50% inhibition observed at the level of 36 µg/mL. Phenolic compounds in sage were further separated and purified. The anticancer activities of major phenolic fractions were screened under in vitro conditions. The fraction with the highest bioactivity was identified.

9:15–9:30 am

Total Phenolics, Antioxidant Activity, and Organic Acids Compositions of 38 Varieties of Hot Peppers

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Thirty eight varieties of hot peppers were grown in the field to commercial maturity. Samples of mature pods were harvested, freeze dried, and analyzed for total antioxidant activity using the 1,1-diphenyl-2-picrylhydrazyl (DPPH) and 2,2'-azinobis(3-ethylbenzthiodiazoline-6-sulfonic acid (ABTS), phenolics analyzed spectrophotometrically according to the Folin-Ciocalteu colorimetric method, and organic acids analyzed using high pressure liquid chromatography. Total antioxidant activity, total phenolics, and organic acids were different among the cultivars, however, the difference were not correlated to degree of hotness. Total phenolics were highest in Bangalore torpedo, Scottish bonnet, and Habanero chocolate. In contrast to total antioxidants, total phenolics were different among the different colors with chocolate color Habanero has higher total phenolics than Habanero white, mustard, or orange colors. Malic, tartaric, ascorbic, succinic, and fumaric acids represented the highest organic acids in hot peppers. Organic acids content followed similar pattern as total antioxidant activity, especially DPPH. Changes in total antioxidant activity, total phenolics, organic acids, and other health promoting compounds will be examined in relation to color and total hotness of these cultivars

Specified Source(s) of Funding: USDA Competitive

9:30–9:45 am

Variation of Phenolics in Anthocyanin- and Nonanthocyanin-fruit Tomatoes

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Phenolic and flavonoid compounds are known to have biological activity with beneficial effects on human health. Fruit of cultivated tomatoes (*Solanum lycopersicum* L.) are a major source of phenolics and flavonoids in the U.S. diet because this crop is the second most widely consumed vegetable on a per capita basis, but actual levels are low compared to other fruits and vegetables. Anthocyanins are an important class of flavonoid phytonutrients known for their antioxidant properties and novel purple color. Tomato fruits do not normally possess anthocyanins, but we have developed lines which express up to 80 mg/100 g FW in the fruit peel. We wished to quantify levels of total phenolics and anthocyanins in anthocyanin expressing tomato fruit in different production systems and compare to total phenolic content of normal tomatoes. Epidermis and pericarp tissue of three advanced breeding lines of anthocyanin-fruit tomatoes and three lines of nonanthocyanin-fruit tomatoes were assayed by Folin-Ciocalteu method for total phenolics and by pH differential using a spectrophotometer for total monomeric anthocyanin content. A replicated set of the experimental lines were grown in organically and conventionally managed systems and were compared for total phenolics. The mean phenolic concentration of the highest-ranking anthocyanin-fruit line was 73 mg/100g FW and significantly greater than that of the highest-ranking nonanthocyanin-fruit line at 43 mg/100g FW. The highest anthocyanin concentrations were more than 10 mg/100g FW (whole fruit basis), with conventional tomato lines having no anthocyanin production.

Anthocyanin concentrations varied among the three anthocyanin-fruit breeding lines. While higher, total phenolics in tomatoes from the organic production system was not significantly different from that of a conventional production system.

Specified Source(s) of Funding: Vegetable Breeding Program at Oregon State University, ER Jackman Internship Support Program

9:45–10:00 am

Risk Management for Field-grown Tomatoes: Comparing Source of Spray Water on the Potential for Food-borne Human Pathogens

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A relationship has been shown to exist between water quality and the bacterial loads on the surface of produce. Water can serve as a vector for pathogenic bacteria by introducing potentially pathogenic bacteria to the phyllosphere environment of the crop. We proposed to test the water quality of two agricultural water sources: surface water and groundwater, to characterize the impacts water source has on microflora on tomatoes. *Enterobacteriaceae*-specific petrifilms, total coliform petrifilms, and RapidChek Salmonella assays were used to test for potentially pathogenic bacteria in water samples and “washes” taken from tomato fruit surfaces. Libraries of 16S rRNA gene fragments were also assembled for each sampling point to provide more taxonomic information about the microflora present in water and tomato phyllosphere samples. The experiment was conducted in field plots of tomatoes at the Wye and Salisbury Research and Education Centers (WREC and LESREC) on Maryland’s Eastern Shore. Ten plots were sprayed on a ten-day pesticide schedule with fungicides and insecticides mixed into groundwater or surface water. Groundwater was used for trickle irrigation as needed. Enumeration of *Enterobacteriaceae* and total coliforms was also conducted on ripe tomatoes at twice during the 2008 growing season. Five replicate fruit samples of each treatment were taken at each date. No samples tested positive for *Salmonella* and levels of coliform bacteria in groundwater samples were undetectable. In contrast, the surface water samples maintained a higher bacterial load with an upward seasonal trend in total coliforms. An increase in bacterial load appeared to be due to increasing surface water temperature during the growing season. Bacterial counts of *Enterobacteriaceae* and total coliforms on tomato fruit phyllosphere paralleled the results seen in direct water enumerations. Tomatoes treated with surface water contained the highest bacterial load whereas groundwater treated fruit had lower bacterial counts. In both cases, counts increased between the two sampling dates demonstrating that water source and harvest date are both important when considering water used for vegetable production. The results of the gene sequencing are currently being interpreted for significant differences in bacterial phyla between the groundwater and surface water treatments.

Oral Session 25: **Jefferson C**
Horticultural Crops Culture and Management:
Controlled Environments
Tuesday, 28 July 2009, 9:45–10:45 am

Moderator: Gioia Massa, gmassa@purdue.edu

9:45–10:00 am

Effects of High Tunnel Production on Florida Strawberry Cultivars

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United States is the main grower of strawberries in the world an area of 22,300 ha, where California grows 60% of the strawberry production and Florida 15%. In the U.S. and in Latin America, open-field production is the main production system used, while in Europe protected agriculture, such as high tunnels, is widely used. High tunnels are unheated, plastic covered, solar greenhouses, with passive ventilation through roll-up side walls. Among the potential benefits of growing strawberries in tunnels are yield improvement, fruit quality enhancement, protection from rain damage and early damage promotion. In spite of the popular use of high tunnels and protected agriculture in other countries; it is still necessary to investigate their effects in the Florida strawberry production, due to the differences on climates, cultivars grown and production systems. The objective of this study was to assess the effects of high tunnels on strawberry production, versus the open field production in Florida. The cultivars ‘Strawberry Festival’, ‘Winter Dawn’, and ‘Florida Elyana’ were tested inside of 16-ft. high tunnels and in open fields during the 2007–08 and 2008–09 seasons. Resulting data showed that plant diameter was higher inside the tunnel compared with outside for all cultivars at 11 and 15 weeks after transplant. The total yields of ‘Strawberry Festival’, ‘Winter Dawn’ and ‘Florida Elyana’ increased by 39%, 87%, and 85% in the tunnels in comparison with the open fields in the 2007–08 season, when early freeze temperatures occurred. Strawberry sugar content was not significantly different among environments; ‘Florida Elyana’ had the higher sugar content, followed by ‘Strawberry Festival’ and ‘Winter Dawn’ with values of 7.4%, 6.1%, and 5.2%, respectively.

Specified Source(s) of Funding: Florida Strawberry Growers Association and North America Strawberry Growers Association

10:00–10:15 am

Cultural and Environmental Improvement of Three Strawberry Cultivars Grown in Controlled Environments for Long Durations

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Strawberry is an economically valuable small fruit that is high in sugars and antioxidants and has promising potential for crop production in controlled environments. Strawberry cultivars were evaluated for

growth in controlled environments with a goal of long-term, continuous fruit production. The day-neutral cultivars ‘Tribute’, ‘Fern’, and ‘Seascape’ were evaluated in growth chambers set to three different day lengths (14 h, 17 h, 20 h) to examine the least amount of light energy per 24-h period that would not significantly reduce fruit production. All cultivars produced the same fruit fresh weight (FW) over a study period of 217 days. However, fruit number and berry size varied by cultivar, and yield rate changed over time. Additionally, during the same experimental period, three pollination methods were tested for efficacy in a greenhouse environment. Again, cumulative fruit FW depended more on production time than other parameters, however vibrating-wand pollination was selected as the most efficient method to produce uniform fruit. Fruit were also evaluated for organoleptic characteristics such as sweetness, tartness, aftertaste, and overall appeal. Following those studies, further experimentation was performed on ‘Seascape’, the most promising cultivar. Plants were grown under 10-h, 12-h, or 14-h photoperiods for 234 days, with other environmental conditions similar to the previous study. Fruit were harvested, counted, weighed, and evaluated organoleptically. Productivity of ‘Seascape’ plants appears independent of photoperiod over the experiment duration, but some flavor characteristics are responsive to photoperiod. This study indicates that ‘Seascape’, a cultivar with large, highly acceptable fruit, can be grown effectively in controlled environments over long production periods independently of the photoperiods tested.

Specified Source(s) of Funding: NASA: NAG5-12686

10:15–10:30 am

Efficacy of End-of-day Far-red Light in Controlling Tomato Rootstock Height

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Pre-plant soil fumigants are used widely to combat soil-borne pathogens in open-field vegetable production. Recently, vegetable grafting was introduced to North America as a potential alternative with the benefit of increasing yields. Grafted tomato seedlings, however, are small in size and the position of graft union is sometimes too close to the ground when transplanted, and may expose the vulnerable scion to pathogens. Preparing rootstock seedlings with a longer hypocotyl length will allow higher positions of the graft union. End-of-day far-red (EOD-FR) is known to induce hypocotyl elongation. To apply this knowledge in rootstock preparation in greenhouse environments, we need to know the plant requirement of the FR light quality (i.e., Red to Far-Red ratio or R:FR) and the minimum FR dosage for maximum response to induce hypocotyl elongation. In the first experiment, ‘Aloha’ and ‘Maxifort’ tomato rootstock seedlings were subject to EOD-FR light treatment at $2.5 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ FR photon flux for 12 minutes for fourteen days, using two FR light sources (unfiltered incandescent light with 0.5 R:FR and filtered incandescent light with 0.05 R:FR). EOD-FR treatment with unfiltered incandescent light was unable to induce hypocotyl elongation compared to the untreated control for both cultivars. However, filtered incandescent light significantly increased the hypocotyl length by 24% for ‘Maxifort’ and 47% for ‘Aloha’ compared to the respective untreated control seedlings. In the second experiment, ‘Aloha’ and ‘Maxifort’ rootstock seedlings were subject to EOD-FR treatments for two different durations (6 or 12 minutes) at two FR photon fluxes (1.3 or $2.5 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$) at the same R:FR (0.05). The four treatments generated a range of FR dosages between 0 (darkness control) and $1.7 \text{mmol}\cdot\text{m}^{-2}$. Hypocotyl lengths of the both cultivars increased in a near-linear fashion with increasing FR dosage. This confirmed that both EOD-FR treatment duration and magnitude of FR photon flux

are factors determining the degree of EOD-FR response in tomato rootstock seedlings. Having a low R:FR in EOD-FR treatment was critical in inducing hypocotyl elongation in tomato rootstock seedlings, suggesting a possible application of FR light emitting diodes (LED) as effective EOD-FR light source. Hypocotyl length also increased with FR dosage in the EOD-FR treatment. The minimum dosage for maximum response, however, has yet to be found at a dosage range greater than 1.7 mmol·m⁻².

Specified Source(s) of Funding: Department of Plant Sciences, University of Arizona

10:30–10:45 am

Storing Seedlings at Low Temperature as a Key Technology to Introduce Vegetable Grafting in North America

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Low temperature storage of seedlings is a technique to suppress their growth while preserving their transplant quality, in an attempt to accommodate the concomitant rapid growth of transplant production industries. Much research has been done for environmental requirements (air temperature, light, and gas) to store vegetable seedlings (e.g., Kubota, 2003). Our research objective is to use this technology to help North American propagators to establish a large capacity of labor intensive vegetable grafting. While grafted seedlings have been used in hydroponic greenhouse production for increasing yields over years, introduction of the technology to conventional open-field cropping system is still limited. A barrier preventing wider use of grafting is the small undeveloped propagation capacity relative to potential demand. We believe that incorporation of short term storage of vegetable seedlings enables distributing necessary labor over time to produce large number of seedlings (>100,000 plants per shipment), while manual grafting processes only 1000 - 2000 grafts per day per worker. However, environmental requirements for grafted seedlings, which often consist of two species with different temperature responses, have not been studied. Some rootstocks for cucurbits are known to add the chilling tolerance to the scions, which may be advantageous in storing grafted seedlings when scion is chilling sensitive and therefore difficult to store. Over two years of repeated experiments, we stored grafted and non-grafted muskmelon seedlings (scion *Cucumis melo* cv. 'Olympic Gold'; rootstock *Cucurbita maxima* × *Cucurbita moschata* cv. 'Tetsukabuto') at 9 °C, 12 °C, or 15 °C under ~100% relative humidity and 12 μmol·m⁻²·s⁻¹ (400-700 nm) continuous light up to 4 weeks. The results showed that grafted 'Olympic Gold' seedlings can be stored at 12 °C for 4 weeks without affecting marketable visual quality, photosynthetic capacity, post-storage growth or development. Non-grafted seedlings were susceptible to low temperatures of 9 °C and 12 °C, and lowered the visual quality to unmarketable level after 4-week storage. Storing grafted seedlings at 15 °C accumulated dry mass and induced a greater magnitude of elongation during the storage. Use of rootstock tolerate to chilling extended the storability of cantaloupe-type muskmelon when grafted to such a rootstock. However, due to the vigor of rootstock at low temperature, 'Olympic Gold' scion of grafted seedlings elongated more than did the non-grafted seedlings. Although further optimization of storage conditions is needed, low temperature storage was shown as a promising technology to help propagators to produce the larger number of grafts required for open-field transplanting.

Specified Source(s) of Funding: USDA–CSREES

Oral Session 26:

Lewis

Genetics/Germplasm/Plant Breeding: Ornamental Crops

Tuesday, 28 July 2009, 9:45–11:45 am

Moderator: David Zlesak, zles0001@umn.edu

9:45–10:00 am

Potential for Domestication of *Shepherdia rotundifolia* (Roundleaf Buffaloberry)

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Shepherdia rotundifolia is an attractive, drought-tolerant shrub endemic to southern Utah/northern Arizona, and is desired by native plant growers for low-water landscaping. However, it is difficult to grow and establish in urban landscapes due to limited seed availability, seed dormancy, and sensitivity to over-watering. The objectives of this study were to: 1) characterize natural habitats of *S. rotundifolia* for selection of a more adaptable plant for the urban landscape; and 2) hybridize with the related species, *S. argentea*, which better tolerates wet soils. *Shepherdia rotundifolia* has been found in diverse habitats in southern Utah from 1219 to 2743 meters. The species is adapted to extremely well-drained soils with varying amounts of organic matter. Typically found in open areas, we found a unique population beneath the shade of Ponderosa pine (75% relative light intensity) at 2743 meters. The diversity in natural habitat of this species could provide a source of germplasm useful for selection of an adaptable form for the urban landscape. In Summer 2008, *S. argentea* was reciprocally crossed by hand with *S. rotundifolia* in its natural habitat in Torrey, Utah. Only female *S. argentea* crossed with male *S. rotundifolia* produced fertile seeds. Hybrid plants are morphologically intermediate to the parents; the hybrid is more vigorous. Diurnal stomatal conductance measurements of the hybrid showed similar patterns on sunny and cloudy days, with the highest value at 1000 HR. Stomata of the hybrid were more sensitive to PPFD than either of the parents, exhibiting higher stomatal conductance than the parents on sunny days. Responsiveness of the hybrid to light intensities was closer to that of *S. argentea*. *Shepherdia rotundifolia* adapted to high light intensity by closing stomata, showing lowest stomatal conductance on sunny days. These data suggest that the hybrid might be more tolerant to over-watering than *S. rotundifolia*. This study suggests the possibility of selecting a more adaptable form of *S. rotundifolia* for urban landscapes, particularly from the ponderosa pine understory population. Study of physiological responses in their natural habitats, and greenhouse studies of *S. rotundifolia* from different populations may support this hypothesis. The hybrid is another potential source of germplasm, combining the outstanding form of *S. rotundifolia* with the capacity of *S. argentea* to tolerate wetter soils.

Specified Source(s) of Funding: Utah Agricultural Experiment Station

10:00–10:15 am

Field Assessment of Black Spot Resistance in Roses in a Hot Humid Climate

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A replicated rose evaluation trial was planted in Spring 2006 at the Texas A&M University Horticulture Farm in College Station, Texas. This trial was systematically evaluated for black spot resistance and landscape quality over 3 years. The roses evaluated included a wide range of classes including Hybrid Teas, Polyanthas, Shrub roses, Chinas, Teas, and ground covers as well as various experimental breeding lines. Among the roses evaluated, some maintained excellent health and good landscape quality such as Belinda's Dream and Knockout. Unfortunately, there were also some roses, most notably New Zealand, that were so highly susceptible to black spot that they died within the first year. It is noteworthy to mention that a German line 91/100-5, a rose genotype with the Rdr1 black spot resistance gene, initially appeared very resistant to black spot but by the third year showed considerable black spot infection whereas breeding lines involving *Rosa wichurana* 'Basye's Thornless showed no black spot development beyond an occasional infected leaf.

Specified Source(s) of Funding: Basye Endowed Chair of Rose Genetics

10:15–10:30 am

Evaluation of Landscape Roses from the Earth-Kind® Trials: Race-specific Black Spot (*Diplocarpon rosae* Wolf) Resistance and Ploidy

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The Earth-Kind® program, created at Texas A&M, serves to unify research and extension/education efforts that support sound environmental stewardship in the ornamental landscape. Regional, replicated cultivar trials of selected landscape roses are an ongoing component of Earth-Kind® research. These trials identify and promote the most adapted cultivars and are conducted without fertilizers or pesticides. Black spot (caused by *Diplocarpon rosae* Wolf) is the most serious disease of outdoor-grown roses worldwide due to the potential for rapid leaf yellowing and defoliation. The 17 Earth-Kind designated cultivars for the Southern U.S. region, 30 cultivars in the Earth-Kind Brigade (Mid-U.S.), and 20 cultivars in the Northern Earth-Kind Rose Trials (58 cultivars total; some are represented across groups) were challenged with three races of *D. rosae* previously characterized (races A, B, and C) at the University of Minnesota from isolates collected across Eastern North America. Detached leaf assays were used in humid chambers on newly expanded leaves. Lesion size was measured for susceptible reactions and ploidy was determined using root tip squashes. Diploid ($n = 14$), triploid ($n = 21$), and tetraploid ($n = 23$) cultivars were identified. Race specific resistance was found in two of the 17, 14 of the 30, and 13 of the 20 cultivar groups, respectively. To our knowledge, this is the

first widespread screen of rose cultivars using characterized races of *D. rosae*. Cultivars resistant to all three races include: 'BAline' (Yellow Submarine™), 'Radbrite' (Brite Eyes™), 'Radcon' (Pink Knock Out®), and 'Radrazz' (Knock Out®). 'Radyod' (Blushing Knock Out®), interestingly, is a sport of 'Radrazz' and is susceptible to race A. Generalized trends for race specific resistance were found among germplasm groups based on breeding program; e.g. many Buck roses were resistant to race B and many Explorer® roses were susceptible to race C. Variation in lesion size for susceptible reactions was found. The application of this data includes: 1) comparing lesion size data from this study with a growing body of field resistance data from Earth-Kind field trials where inoculum is not controlled or quantified; 2) employ detached leaf assays as a method for pre-screening roses prior to inclusion in Earth-Kind field trials; 3) better understand races present in rose gardens based upon infection patterns on plantings of cultivars from this study differing for race specific resistance; and 4) provide breeders with important resistance and ploidy data which can be used to effectively pyramid race specific resistances and develop additional resistant cultivars.

Specified Source(s) of Funding: Minnesota Garden Calendar Grant, Minnesota North Central Region-Sustainable Agriculture, Research, and Education Mini-grant, University of Minnesota, and the Minnesota Agricultural Experiment Station

10:30–10:45 am

Utilizing Flow Cytometry for Quantitative Estimations of Nuclear DNA in Over 50 Penstemon Species

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Pressures to restrict water use are increasing in the Southwestern United States in response to drought conditions. The San Diego Water Department reported that as much as 50% of water usage is allocated for landscape use. Utilizing drought tolerant plants within a landscape is a simple strategy for reducing water use. The Intermountain West is a rich resource for plants that have evolved to xeric conditions. *Penstemon* offers vast genetic diversity and is the largest genus of herbaceous perennials endemic to North America. Breeding programs have already begun and selected improved cultivars using traditional breeding techniques. Our work has utilized flow cytometry to analyze nuclei size and quantitatively estimate the DNA content of more than 50

species. Of the species tested to date *P. fasciculatas* has been estimated to be smallest genome sizes at just over 764 Mb while *P. digitalis* has been found to contain nearly 17,775 Mb. Although breeding work has already begun to improve these attractive perennials, expanding our knowledge of these plants on a genetic level will enhance our ability to effectively breed for superior cultivars.

Specified Source(s) of Funding: Brigham Young University

10:45–11:00 am

Pollen-mediated Gene Flow from *Coreopsis tinctoria* to *Coreopsis leavenworthii*: Detection, Effects of Planting Distance, and Insect Pollinators Involved

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Coreopsis tinctoria and *Coreopsis leavenworthii* are closely-related and can produce interspecific hybrids in controlled pollinations. This has caused concerns that insect pollinators may transfer pollen from *C. tinctoria* to *C. leavenworthii* in the field, resulting in gene flow from the former to the latter. Similar concerns exist in other native wildflowers when used for seed production and mass plantings. Such pollen-mediated gene flow can cause genetic and ecological consequences, such as gene pool contamination and outbreeding depression. The objectives of this study were: 1) to confirm the inheritance pattern of the maroon spot of *C. tinctoria* and its reliability in detecting gene flow; 2) to assess the effects of planting distance on pollen-mediated gene flow from *C. tinctoria* to *C. leavenworthii*; and 3) to identify insect pollinators that may be involved in the gene flow. Segregation of the maroon spot in F_1 , F_2 , and backcross populations was examined, and all results confirmed our previous findings: the maroon spot is dominant over non-spotting and is controlled by one gene, and the maroon spot can be used reliably as a morphological marker to detect gene flow from *C. tinctoria* to *C. leavenworthii*. *C. leavenworthii* plants were planted 5, 10, 25, 50, 100, 150, 200, 250, and 300 ft. from *C. tinctoria* plants in three blocks in each of two seasons. Interspecific hybrid plants were identified in plots 5 to 200 ft. and 5 to 50 ft. from *C. tinctoria* in the first and second seasons, respectively. In both seasons, the percentage of interspecific plants decreased as the planting distance increased. All insects visiting *Coreopsis* flowers were Hymenoptera belonging to six families and genera. Three species of insects were found on both *Coreopsis* species. These results suggest that *C. tinctoria* and *C. leavenworthii* plantings should be separated by at least 250 ft. away from each other to avoid natural pollen-mediated gene flow.

Specified Source(s) of Funding: Florida Wildflower Foundation

11:00–11:15 am

Unreduced Gametes and Polyploidization in *Lantana camara*

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Polyploidization is common in plants and has been one of the major driving forces in plant evolution. A wide range of ploidy levels, ranging from diploid to hexaploid, exists in *Lantana camara*, and tetraploids are more frequently found in naturalized *Lantana* populations than native

ones. It has been an important, but yet to be addressed, question what was the mechanism of polyploidization in *Lantana*. The distribution of ploidy levels in more than 500 progeny from self-pollination of ‘Gold’, ‘Lola’, and ‘Pink Caprice’ and more than 350 progeny from open-pollination of ‘Carlos’, ‘Cream’, ‘Dallas Red’, ‘Gold’, ‘Irene’, ‘Lola’, and ‘Pink Caprice’ were analyzed in this study, and the results showed occurrence of unreduced gametes in some cultivars while absence in other cultivars. More than 40 controlled crosses were made between these two groups of cultivars over four seasons, and the ploidy level distribution in these progeny confirmed the variation among cultivars in their ability to produce unreduced gametes. Further studies showed that the trait could be transmitted from one generation to the next and it appeared to be controlled by nuclear genes. When unreduced gamete-forming cultivars were present, we observed a wide range of polyploidy levels (triploid to hexaploid) in open-pollinated progeny, which strongly suggests that the occurrence of unreduced gametes contributed to polyploidization in *Lantana*. This phenomenon may also explain the unexpected fertility of some *Lantana* triploids. Additionally, it indicates a need to avoid unreduced gamete-producing diploids and tetraploids in inter-ploidy crosses designed to produce triploid *Lantana* for genetic sterilization and invasiveness control.

Specified Source(s) of Funding: Southwest Florida Water Management District and Tampa Growers Association

11:15–11:30 am

Pollen Stainability and Seed Production of 32 *Lantana mamara* and 2 *Lantana montevidensis* Cultivars

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While it is a popular ornamental plant well known for its attraction to butterflies, tolerance to abiotic stresses, and adaptation to environmental conditions, *Lantana camara* has been listed as an invasive species in south and central Florida and in a number of countries in the world. *L. camara*'s invasive potential comes primarily from its ability to produce large amounts of seed and/or its ability to cross-pollinate native *Lantana* species. The objectives of this study were to assess the pollen stainability and seed set of 32 *Lantana camara* cultivars and compare them to *Lantana montevidensis* cultivars and to understand the relationships between ploidy levels and pollen stainability and seed set. For pollen stainability assessment, anthers were collected before flower dehiscence and stained in aniline blue for 24 hours at 60 °C. Over 160,000 pollen grains were then examined and scored as stained or unstained. For seed set assessment, 20 seed heads on a plant were randomly selected and seeds were counted. Seed collection and counting were repeated every 5 weeks for four times. Pollen stainability among the *L. camara* cultivars ranged from 0.8% (‘New Gold’) to 75.9% (‘Pink Caprice’), i.e. nearly 100-fold difference between cultivars. An even greater difference (>1000-fold) was observed among cultivars in seed set, from 0.13 seeds in ‘Athens Rose’ to 143.5 seeds in ‘Pink Caprice’. *L. camara* cultivars showed higher pollen stainability and seed set than *L. montevidensis* cultivars. Among the various ploidy levels in *L. camara*, triploids were the most sterile, with an average pollen stainability of 10.0% and an average seed set of 14.5. However, some triploids had rather high pollen stainability (e.g. 21.8% in ‘Landmark Peach Sunrise Improved’) or produced quite a number of seeds (e.g. 27.6 in ‘Samson *Lantana*’). Tetraploids were found to be quite fertile: pollen stainability ranged from 31.0% in ‘Gold’ to 75.9% in ‘Pink Caprice’, with an average of 48.6%, and seed set from 11.5 in ‘Dallas Red’ to 143.5 in ‘Pink Caprice’, with an average of 47.4. In pollen

stainability, diploids averaged slightly higher than tetraploids (76.8%), but in seed set, diploids produced fewer (7.6) than tetraploids. These results indicate that there are a wide range of variation among cultivars and ploidy levels in pollen stainability and seed set and highly sterile cultivars can be found and used as alternative to replace those highly fertile, invasive cultivars.

Specified Source(s) of Funding: Southwest Florida Water Management District and The Tampa Growers Association

11:30–11:45 am

Morphological and Histological Evaluations of Flower Development in *Elliottia racemosa*

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Elliottia racemosa is a rare, woody species restricted to Georgia's coastal plain. Seed set can be low or nonexistent and no sexual recruitment has been observed in the wild. Our previous work shows that stigmatic receptivity in *Elliottia racemosa* is not optimal for pollen germination and tube growth until flowers are fully open and petals are abscising. Stigmas are non-papillate and develop a raised and textured central surface surrounding a clefted opening to a stylar canal. The objective of this study was to evaluate stigma and stylar development throughout seven defined stages of floral development ranging from small unopen buds to flowers with abscised petals. In early stages, the style is solid and stylar canal formation occurs in later stages. Exudate is secreted into a clefted region of the stigma where pollen is captured, and facilitates germination and tube growth through the hollow canal. Stylar canal structure and development was observed, and the mode of exudate formation and secretion discerned. Histochemical staining was conducted to visualize structures and characterize stigmatic exudates and stylar secretions, i.e., to detect the presence of a cuticle (Auramine O), polysaccharides (Periodic acid-Schiff), proteins (Coomassie blue), and lipids (Sudan black).

Oral Session 27: Chouteau
Tomato Culture, Management, and Plant Breeding
Tuesday, 28 July 2009, 10:00 am–12:00 pm

Moderator: Xin Zhao, zxin@ufl.edu

10:00–10:15 am

Tomato Fruit Quality in Response to Reduced Water Application

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The study was designed to (a) help small-scale growers understand water stress management, (b) assess water stress effect on tomato fresh fruit quality, and (c) document water savings strategies. It includes five

incremental irrigation treatments, based on CIMIS (California Irrigation Management Information System) evapotranspiration (ET) data: 0, 25, 50, 75, and 100% ET. Tomato variety 'Early Girl' was used since it has proven adaptable to water deficient treatments. Eight-week-old plants were transplanted to the field and watered for 10 days before drip irrigation regimes were imposed. The 100% ET treatment received all the water needed to satisfy its ET needs, while the other treatments received decreasing increments of water. Each plot consisted of 40-foot long bed spaced at five feet. All treatments were watered at the same time. Data collection included fruit yield and yield components, sensory evaluation, and chemical analyses. Yield data revealed that 'Early Girl' showed remarkable elasticity to water stress. Treatments biological yields did not significantly vary. Marketable yield fell by 15% to 20% in the driest treatments. However, 100% and 75% ET treatments netted more of extra-large fruit, 21% to 23% respectively relative to their marketable yield. At the same time, 0% and 50% ET resulted in more medium and small fruit. Similarly, combined blossom-end-rot (BER) and sunburned (SB) fruit incidence were higher in the drier treatments (25% to 29%) than in the well-irrigated plots (12% to 13%). The two driest treatments also resulted in the highest percentages of rejects due to insect and disease presence. Ripened fruit color was good (hue values of 37.4 to 39.3) for all treatments with no significant differences. Skin toughness showed very little difference due to water stress. Taste panels generally favored fruit produced in the stressed plots over those receiving 100 and 75% ET. Some reported some skin toughness especially in well-watered fruit. In general, stressed plots produced fruit that tasters favored in terms of flavor, aroma, appearance, texture, and overall fruit quality. Laboratory analyses confirmed most of these sensory preferences. Sugar glucose and fructose, concentrations were highest in the 0% and 25% ET fruits (48 and 47 mg/L, respectively) and significantly decreased as water input increased. The dry weight and soluble solids showed similar trends. Lycopene content increased from 5mg/g FW at 100% ET to 7 μ g/g at 0% ET. Fruit Ascorbic acid content, pH, and titratable acidity were not significantly different among treatments

Specified Source(s) of Funding: Specialty Crops USDA and Small Farms

10:15–10:30 am

Breeding Tomato for Increased Fruit Phenolics

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The purpose of this research was to develop tools and germplasm for the production of tomatoes (*Solanum lycopersicum* L.) with high fruit phenolics without the use of genetic engineering. A candidate gene analysis was undertaken to identify the genes *Anthocyanin fruit tomato (Aft)* and *Purple Smudge*, which regulate anthocyanin biosynthesis in tomato fruit. Previously, we demonstrated that *Aft* co-segregated with a DNA polymorphism in a Myb transcription factor (*SIAn2*) similar to *Petunia An2*. Expression analysis of the *SIAn2* gene using semi-quantitative reverse transcription PCR showed a close correlation between transcript levels of *SIAn2*, the anthocyanin biosynthetic gene dihydroflavonol 4-reductase (DFR), and anthocyanin expression. Expression of anthocyanin in fruit of *Aft* and *Purple Smudge* genotypes was associated with increased expression of *SIAn2*. Expression analysis of the related Myb transcription factor *SIAn1* showed poor correlation with anthocyanin expression in the fruit, indicating that *SIAn2*

is a better candidate gene for the *Aft* and *Purple Smudge* genes than *SlAnt1*. Phylogenetic analysis of the predicted amino acid sequences of tomato *SlAnt1* and *SlAnt2* indicated that they are orthologous to potato *StAn1* and *StAn2*, respectively. To create a high flavonol tomato line, an elite high anthocyanin line with the genes *Aft* and *atv* was crossed to a tomato line with the gene *anthocyanin without (aw)*, which encodes a non-functional DFR. *Aft/atv/aw* F₃ segregants had fruit with levels of rutin and chlorogenic acid that were significantly higher than in the cultivar 'Legend' under greenhouse conditions. Total phenolics levels in fruit of *Aft/atv/aw* F₃ segregants were not significantly different from an elite *Aftatv* line under field conditions. However, small amounts of anthocyanin were unexpectedly found in *Aft/atv/aw* fruit. In order to identify and introgress additional genes that would increase total phenolics or result in novel phenolic compounds in tomato fruit, we screened a core collection of *Solanum lycopersicum* var. *cerasiforme* Dunal. Several *S.l. var. cerasiforme* accessions with good horticultural quality and significantly higher levels of total phenolics in fruit were identified. Some of the *S.l. var. cerasiforme* accessions also contained novel polyphenolic compounds not detected in cultivated tomato fruit. These *S.l. var. cerasiforme* accessions have been crossed to elite high anthocyanin and high flavonol tomato lines and will be extensively genotyped by the SolCAP project, facilitating the introgression of genes from them.

Specified Source(s) of Funding: Baggett-Frazier Endowment, Hatch Project 49

10:30–10:45 am

The Grafted Heirloom Tomato System for Organic Production in High Tunnels: Are There Advantages in the Absence of Diseases?

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Tomato grafting is widely practiced in Asia, the Mediterranean, and large hydroponic greenhouses in North America but has not been field tested in the U.S. to any great extent. It is practiced elsewhere to confer resistance to soil borne diseases and abiotic stressors. It is unclear, however, whether there is a yield advantage or penalty for the utilization of grafting in the absence of soil borne diseases or stressors such as high salinity. In a study using organic practices, conducted at the Center for Environmental Farming Systems (CEFS) in Goldsboro, NC in 2007 and 2008, we compared yields, fruit quality and time to harvest for the heirloom 'Cherokee Purple' grafted on both 'Maxifort' and 'Beaufort' rootstocks with non-grafted and self-grafted (re-attached to own roots, 2008 only) plants. We also compared optimum planting dates of each system in order to maximize the spring/summer production period. In 2007, tunnel plantings were 20 March, 3 April and 19 April (date of field planting). In 2008, tunnel plantings were 4 March, 18 March and 17 April (date of field planting). For planting dates 1 month earlier in the high tunnels, peak harvests were 21 days earlier compared to the field system in both 2007 and 2008. Overall, minimum, maximum, average, and soil temperatures were higher in the tunnels, but differences were greatest in March and April. Total yields were greater for plants grown in tunnels compared to field-grown plants in both years,

with the highest yields for those planted earliest. Yields were greater for plants grafted on commercial rootstocks compared to non-grafted and self-grafted plants (2008 only) across both years. In 2008, the highest yielding treatment was high tunnel plants grafted on 'Maxifort' rootstock. Overall insect damage was higher in the field compared to the high tunnel system while cat-facing (rough fruit) and blossom-end rot incidence were higher in tunnel crops compared to the field. The yield response to grafting was greater in the tunnel plantings than in the field in 2008. No major soil borne disease problems were present during the study period but there was foliar disease pressure, tomato spotted wilt virus and gray leaf spot (*Stemphylium* spp.). In 2008, both gray leaf spot incidence and tomato spotted wilt virus was greater in the field than the tunnel plantings.

Specified Source(s) of Funding: SR-SARE

10:45–11:00 am

Response of Tomato Growth Characters to Soil Amended with Vermicompost

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The addition of vermicomposts to soils improves soil structure, enhances the microbial population and activity, increases water retention capacity, and in some cases, reduces crop susceptibility to plant pathogens. Vermicompost materials are becoming increasingly popular as a soil amendment due to the developing interest in sustainable production methods. Therefore, a field experiment was conducted to determine the effect of vermicompost additions at 0, 4.0, 8.1, 16.2, 32.4, and 65.0 Mg·ha⁻¹ on various growth parameters (leaf area index, chlorophyll content, and marketable and cull fruit yield) of 'Mountain Fresh Plus' tomato. Leaf area index and plant height both increased in a quadratic manner with increased additions of vermicompost; and, plant heights increased up to approximately 32 Mg·ha⁻¹ vermicompost. The increase in marketable and total tomato yield (number and weight per ha) typically began around 16 Mg·ha⁻¹ vermicompost, with linear and quadratic models, respectively, best describing the relationships. Our results indicate that vermicompost additions to soil can improve both tomato vegetative growth and yield parameters in a minimal input production system.

Specified Source(s) of Funding: Illinois Department of Agriculture, Sustainable Agriculture Grant program

11:00–11:15 am

Screening Varieties for Resistance to Tomato Yellow Leaf Curl Virus

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Tomato yellow leaf curl virus (TYLCV) is considered the worst to-

mato virus worldwide. The disease is induced by a number of closely related begomoviruses transmitted by the whitefly *Bemisia tabaci* (Gennadius). TYLCV infection may result in up to 90% flower abscission and highly reduced yields. Foliar symptoms include shortened internodes and dwarfed leaves, which are cupped, thick, and rubbery with chlorotic margins. Management of the whitefly vector and TYLCV rests primarily on insecticides and host-free periods, but insecticide resistance is creating the need for TYLCV resistant varieties as an alternative management tool. A replicated variety trial was conducted in spring 2007 at Immokalee, FL with eight potential TYLCV resistant varieties. Whitefly and disease pressure was heavy with average 9.9 ± 0.38 (mean \pm SE) adult whiteflies per leaf and with most susceptible symptomatic plants for TYLCV. Total marketable yields ranged from 58 to 23.9 t/ha among varieties. The highest yielding TYLCV resistant varieties were 'HA 3078' (31.3 and 58.0 t/ha) and '3074' or 'Inbar' (27.8 and 56.5 t/ha) as compared with the 'FL 47' a susceptible variety that yielded 9.2 and 23.9 t/ha extra-large fruit and total marketable yield respectively. The firmest fruits were 'Tygress' and 'HA 3075' ('Ofri'), but 'Tygress' had a low color rating. There were no differences among 'FL 8580', 'HA 3074' ('Inbar') and '3075' ('Ofri') than 'FL 47' in total unmarketable fruit. Most unmarketable fruit caused by sunscald and yellow shoulder scar due to the reduced foliage. Thus, the highest yielding TYLCV varieties were 'HA 3078' and '3074' ('Inbar') for first harvest extra-large, total extra-large and total marketable yield and the low amount of unmarketable fruits although performance of 'HA 3075' ('Ofri') and 'Tygress' was also satisfactory.

11:15–11:30 am

Evaluation of Eliminating Fall-timed Subsoil Tillage in Processing Tomatoes Production

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The development of conservation tillage systems for many agronomic crops is a response to both economic (for example, rising price of fuel) and environmental (dust pollution to carbon loss) concerns. For processing tomato production in California, two types of irrigation are practiced, 1) semi-permanent buried drip and 2) furrow. As processing tomato growers in California invest in semi-permanent buried drip irrigation, reduced tillage practices are adopted. To protect the drip tapes buried 10 to 12 inches below the bed surface near the plant line, off-season, broadcast tillage operations such as deep ripping can no longer be practiced. Drip irrigation is more common in the southern San Joaquin Valley. However, the majority of processing tomatoes in California today are produced using furrow irrigation. The conventional tillage practice for furrow irrigation employs fall bed preparation with several high horsepower tractors to pull implements such as stubble disks, subsoil shanks, landplanes, rollers and bed listers. The development of minimum tillage systems is challenged by economic risk, weed issues that traditional soil incorporated herbicides and cultivation have controlled, the need to maintain weed-free and deep furrows for irrigation and the requirement to have a soft bed top to operate mechanical harvesting equipment. We chose to study a reduced fall-timed tillage system that compared a bed cultivator with shallow tillage operation to

that of a conventional broadcast tillage. The bed cultivator, Wilcox Performer®, was operated twice, in opposing directions and was preceded by a flail mower following the tomato harvest. The conventional system used eight passes, including a bed lister to create beds to overwinter. Our two years of field research at the University of California, Davis campus indicates reduced bed tillage yield outcome was similar to the conventional broadcast fall tillage system. Substantial yield gains were observed in the second year of our monocrop of tomatoes when a single chisel shank in the bed center during the fall was included in the reduced tillage system. Irrigation is by surface furrow.

Specified Source(s) of Funding: California Tomato Research Institute

11:30–11:45 am

Evaluating Rootstocks for Greenhouse Tomato Production

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Grafting technique has been increasingly adopted in greenhouse tomato production especially with soilless cultural systems to achieve extended harvest and increased yield. This study was conducted in a passively-ventilated high-roof greenhouse to investigate the effects of rootstocks and rootstock-scion interactions on tomato yield and fruit quality. Two indeterminate greenhouse tomato cultivars 'Compari' and 'Westland' and a determinate field tomato cultivar 'Tasti-Lee' were grafted onto two popular rootstock cultivars including 'Maxifort' and 'Beaufort', using the splice grafting method. The six grafting combinations were compared with non-grafted scion plants in a randomized complete block design with four replications. After grafting and healing process, all the plants were transplanted on 10 September into 3-gal plastic pots filled with aged pine bark while nutrients were supplied by a computerized recycle system. Marketable yield varied significantly among tomato scion cultivars as reflected by differences in average fruit weight and fruit number. Rootstock effect was dependent on rootstock-scion combinations. In general, grafted tomato with 'Maxifort' exhibited enhanced growth vigor and improved productivity as compared with non-grafted controls, particularly in 'Compari' and 'Tasti-Lee' toward the mid to late growing season. Grafted tomato with 'Beaufort' demonstrated a significant reduction of early yield in 'Compari' and 'Tasti-Lee'; however, it seemed to be ameliorated from mid to late harvests. Overall, fruit size was increased as a result of grafting. It was also observed that 'Maxifort' appeared to improve water uptake of tomato plants under low night temperatures. Leaf tissue analysis indicated great variations of macro- and micronutrient status in tomato plants as affected by rootstocks and rootstock-scion interactions. Interestingly, Na^+ concentrations in tomato leaves were significantly lower in all the grafted treatments than that of the non-grafted plants, suggesting a unique mechanism of Na^+ uptake by interspecific rootstocks and possible improvement of salt tolerance in grafted tomato. Analysis of fruit quality attributes revealed significant varietal differences with 'Tasti-Lee' having the highest levels of total soluble solids and lycopene, whereas grafting did not alter fruit quality from non-grafted tomatoes.

11:45 am–12:00 pm

Grafting as an Alternative to Methyl Bromide in Field Tomato Production

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Vegetable grafting has evolved into a unique component of sustainable vegetable production in Asia and many Mediterranean countries for soilborne disease management and yield improvement. Research efforts have recently taken place to explore the use of grafting as a potential alternative to methyl bromide in open field production of tomato in the U.S. Experiments were carried out in Summer and Fall 2008 in Live Oak, Florida, to investigate the feasibility of grafted tomato production using disease resistant rootstocks in the absence of soil fumigants. A determinate heat tolerant tomato cultivar 'Bella Rosa' was grafted onto a commercially available interspecific rootstock 'Multifort' which has been recommended for open field production. Grafted plants and the controls of non-grafted 'Bella Rosa' and self-grafted 'Bella Rosa' were grown under three soil conditions including non-treated soil, soil treated with preemergent herbicides, and soil fumigated with methyl bromide: chloropicrin (50:50), in a split plot design with four replications. In the summer experiment, grafted 'Bella Rosa' with 'Multifort' showed improved growth vigor in both treated and non-treated soils; however, the yield of grafted tomato was compromised by mismanagement of suckers grown from the rootstock. Disease pressure due to soilborne pathogens and nematodes was considered relatively low during the fall experiment, however, marketable yield of tomato from the fumigated plot was significantly higher than that from the non-treated and herbicide-treated plots. Despite the soil treatment, grafting with 'Multifort' significantly increased the marketable yield of 'Bella Rosa' in contrast to non-grafted and self-grafted plants. Moreover, grafted plants grown in non-treated or herbicide-treated soil yielded similarly as compared with non-grafted plants grown in fumigated soil. Yield improvement by the rootstock was attributed to the increase of fruit number but not fruit size. Fruit quality was not affected by grafting with the interspecific rootstock. Further studies are warranted to update the economic analysis of costs and returns associated with use of grafted transplants and to select rootstocks for solving targeted on-site disease problems.

Oral Session 28: **Jefferson A**
Crop Physiology/Physiology: Postharvest 2
Tuesday, 28 July 2009, 10:30–11:45 am

Moderator: Jinhe Bai, jinhe.bai@ars.usda.gov

10:30–10:45 am

Effect of Chilling and Heating Treatment on Production of Volatiles from Lipids via Oxidation in Tomatoes

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Major tomato volatile aromas are formed from lipids through the lipoxygenase pathway to *cis*-3-hexenal, *trans*-2-hexenal, hexanal, *cis*-3-hexenol, and hexanol. The objective of this research was to determine the responses of volatile production and lipoxygenase pathway to chilling and heating treatments in tomatoes. 'Sanibel' tomatoes harvested at the mature-green stage were stored at 20 °C until ripe. Fruit were then treated with either chilling, hot water, or not treated as the control. Fruit samples were taken directly after treatment or after 4 days of storage at 20 °C. For each sample, pericarp from 2–4 fruit were pulverized in liquid N₂, and stored at -80 °C. For enzymatic activity assays, samples were extracted using Tris-HCl buffer, and for analysis of GC volatiles, samples were homogenized with saturated CaCl₂. Both chilling and heating treatments remarkably reduced *cis*-3-hexenal and *trans*-2-hexenal as well as other major aldehyde volatiles, and their related alcohol volatiles. The volatiles, however recovered after 4 days storage at 20 °C. Lipoxygenase activity increased due to heat treatment even after 4 days storage. The incompatible trends between the C-6 aldehyde concentrations and LOX activity indicate that the LOX isozymes measured included 9-LOX, rather than only 13-LOX, which is the isozyme that leads to tomato aroma production. Activity of hydroperoxide lyase was suppressed by both chilling and heating treatments and somewhat recovered after 4 days. The results indicate that the production of tomato aroma may be regulated by controlling HPL activity. Alcohol dehydrogenase activity was suppressed immediately after both treatments, however recovered after 4 days storage. ADH activity increased in chilled compared to control samples after 4 days storage.

10:45–11:00 am

Comparative Evaluation of Physiological Postharvest Root Deterioration of 25 Cassava Accessions: Hydroxycoumarin Fluorescent Accumulation Versus Visual Analysis

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Cassava (*Manihot esculenta*) is the most important root crop in the tropics and is consumed by 500 million people daily. Due to its drought tolerance, ability to grow in poor soils, and resistance to herbivory cassava is well suited for cultivation by subsistence farmers particularly in Africa. However its use and expansion is constrained by rapid physiological postharvest deterioration (PPD), which often starts within 24 hours after harvest, renders the root unpalatable and affects the crop's economics value significantly. PPD is a complex process that involved changes in metabolic process and accumulation of secondary metabolites. Those metabolites include hydroxycoumarins, such as scopoletin, esculin and

scopolin. The quantification of their emitted fluorescent has been proposed as an objective tool to evaluate PPD response in cassava. Traditionally, the evaluation of PPD has been performed by more subjective methods based on the analysis of deterioration visually. Here we present data on the use of a standard visual methodology in comparison to an image analysis of hydroxycoumarins fluorescent accumulation. Ten month old storage roots from the Puerto Rican cassava germplasm which comprise of 25 accessions from Africa, Caribbean, Central America and South America, grown in 'coto' soil in the Northwest Puerto Rico were analyzed for PPD. After five days of storage at room temperature, six 0.2- to 0.5-mm transversal sections at 15%, 30%, 45%, 60%, 75%, and 90% of total length from the proximal end were cut and analyzed using the two methodologies. Our findings suggest that there was no correlation ($r = 0.14$) between the fluorescent accumulation of hydroxycoumarins and the visual symptoms five days after harvest. We concluded that the accumulation of hydroxycoumarins is not a reliable marker for evaluation of PPD response. Furthermore we were able to identify the accessions with high- and low-levels of PPD in the Puerto Rican cassava germplasm based on visual symptoms.

11:00–11:15 am

Effects of Season and Cultivar Selection on External Maturity Indicators in Personal-size Seedless Watermelons

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Personal-sized watermelons (*Citrullus linatus*) are frequently harvested before or after sufficient ripeness has been achieved. Traditional methods of determining commercial maturity at harvest have often proven unreliable when employed across the spectrum of commercially available cultivars. The current 2-year study (2006–08) examined the effects of season and cultivar selection on two external ripeness indicators (tendrill senescence and groundspot color) in predicting maturity in personal-size watermelons. Personal-size watermelon cultivars 'Valdoria' and 'Vanessa' were harvested at 20, 30, 40, 50 days post anthesis. At each harvest, number of proximal senescent tendrils and groundspot color values (Hunter L a* and b*) were determined for each cultivar. Sugar: acid ratio was analyzed as a predictor of maturity at harvest. Correlations between sugar: acid ratio and both external indicators were determined. Season significantly affected groundspot Hunter a* ($P \leq 0.04$) values and number of senescent tendrils ($P \leq 0.001$). In season two, there was a linear relationship between groundspot Hunter a* and sugar: acid ratio ($P \leq 0.0008$). Senescent tendril number was linearly related to sugar: acid ratio in season one ($P \leq 0.0001$) and two ($P \leq$

0.0004). Cultivar selection did not affect groundspot color or senescent tendril number. Groundspot Hunter b* and Hunter L did not sufficiently predict sugar: acid ratio. The current study suggests that the degree of success in correlating tendril senescence and groundspot color with sugar: acid ratio is dependent on season. Further studies are needed to provide accurate predictors of maturity at harvest.

11:15–11:30 am

Ecophysiology of Plant Growth Regulators in Inducing and Modulating Root Bulking in Cut and Peel Carrots

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The Individually Quick Frozen (IQF) carrot industry is expanding in North America. Recently, IQF cut and peel carrots have been developed as a high-value product with a great market potential. Obtaining uniform and highest quality baby-grade roots is critical for optimizing root quality thereby favoring industry expansion. Root grades are under the control of the root bulking process, which is possibly signaled and modulated through endogenous hormonal levels in response to genetic and ecophysiological parameters. Current research on the bulking physiology of cut and peel carrots are limited. Understanding the interrelationships between the hormonal, physiological and environmental factors in the root bulking process would uncover bulking physiology and help to optimize the root grades. It is hypothesized that agro-ecosystem management practices alter endogenous ethylene and polyamine(s) and thereby, the root bulking. Experiments were conducted to quantify endogenous levels of ethylene and polyamines in the roots and shoots as altered by genotypes, crop competition and nitrogen rates. The changes in the root grades as affected by changes in the canopy photosynthesis, ethylene evolution *in situ* in response to certain agro-ecological factors were determined and the relationship among these factors and root bulking affecting the final root grades are discussed.

11:30–11:45 am

Loss of Aroma Volatile Compounds in Fresh-cut Carrots

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Flavor loss during marketing is a major quality concern for fresh-cut fruits and vegetables. To identify factors contributing to flavor loss, changes in nine volatile terpene compounds that contribute to carrot flavor, including the two most abundant terpinolene and caryophyllene, were monitored during the storage of fresh-cut carrots. Freshly harvested carrot roots were washed and cooled. Roots were then cut into 2.5-, 10-, or 30-mm wide slices and 40-g samples were placed into 4-L glass jars. Jars were sealed with Teflon lids and vented with a single hypodermic needle (static) or flushed continuously with 140 mL/min humidified air. Following 0, 3, 7, or 14 days at 5 °C, carrot slices were frozen in liquid nitrogen and held at –25 °C. The volatile

content of carrot slices were analyzed using heated headspace GC-MS. Slice thickness, flushing, and storage time all affected the content of volatile terpenes. The 2.5-mm wide sliced carrots tended to have the greatest loss of terpenes. Concentrations of β -pinene, β -cymene, limonene, γ -terpinene, terpinolene and bornyl acetate in 2.5-mm carrot slices were 30%, 25%, 37%, 42%, 49%, and 89% less, respectively, than that of the 10-mm slices. Slicing had no significant effect on the loss of caryophyllene or humulene. Carrot slices held in the continuous flow of air had a higher loss of the more volatile compounds than slices held in the static jars. Concentrations of α -pinene, β -pinene, β -cymene, limonene and γ -terpinene in carrot slices from the flushed jars averaged 36%, 60%, 45%, 26%, and 36% less, respectively, than slices from static jars. Flushing had no significant effect on the loss of terpinolene, bornyl acetate, caryophyllene, or humulene. During storage, volatile concentrations changed and were lowest after 7 days of storage. Interestingly, there was little loss of volatiles between 7 and 14 days, but rather a slight increase was observed for most compounds. Results suggest that a portion of the loss of flavor volatiles during storage of fresh-cut carrots is a result of diffusion and compound volatility.

Oral Session 29: Jefferson C
Horticultural Crops Culture and Management:
Viticulture and Small Fruits 2
Tuesday, 28 July 2009, 11:00 am–12:00 pm

Moderator: Lailiang Cheng, lc89@cornell.edu

11:00–11:15 am

The Effect of Foliar Nitrogen Application on Juice Yeast Available Nitrogen in ‘Riesling’ Depends on Vine Nitrogen Status

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Insufficient yeast available nitrogen (YAN) is a major cause of sluggish fermentation in wine production, and is also associated with a wine disorder called “atypical aging”. The objective of this study was to determine if foliar application of nitrogen can be used to improve YAN in grape must. Three levels of foliar N (0, 3, 5 times of foliar N sprays) in combination with three levels of soil N (0, 25, or 50 lb. actual N/acre) were tested on field-grown ‘Riesling’/3309 in a factorial design over two years. For soil N treatments, two split applications, 25 lb N at 2 weeks before bloom and 25 lb. N one week after bloom, were made for the 50 lb. N treatment, whereas all N was applied at 2 weeks before bloom for the 25 lb. N treatment. Foliar N sprays (5.5 lb. of urea/100 gal. water) were centered on veraison at weekly intervals. Foliar N applications significantly increased juice YAN during the 2004 wet season, and 3 times of foliar spray appeared to be as effective as 5 times of foliar spray treatment whereas soil N application didn’t have any effect. In the 2005 warm and dry season, vine background N status and juice YAN were significantly lower than in 2004. Foliar N sprays were more effective in increasing juice YAN compared with 2004. Soil N application also improved vine N status and slightly increased juice YAN. These results indicate that there is a greater need for foliar N application in a dry year and the effect of foliar N spray on juice YAN is larger in a dry year.

Specified Source(s) of Funding: USDA Viticulture Consortium and New York Wine/Grape Foundation

11:15–11:30 am

Selecting Wine Grape Cultivars for the Very Cool Mesoclimates of Maritime Western Washington

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The maritime region of western Washington includes a wide range of mesoclimates that can range from averages of below 1200 Growing Degree Days (GDD) up to 2200 GDD. A major factor in determining fruit maturity in the region is titratable acid (TA). In 2000 two studies were established at the Washington State University Mount Vernon Northwestern Washington Research and Extension Center to identify cultivars that would grow in a cool mesoclimate with emphasis on those that would produce acceptable wine at the cooler end of the spectrum. The research site is located in the Skagit Valley floodplain, 3 miles from the Puget Sound, has an average of 1693 GDD and represents one of the coolest mesoclimates in the region. The first study included 28 self-rooted cultivars planted in 3 replications with 5 plants per plot in a randomized complete block design. This provided enough fruit to make 5 gallons of wine for most cultivars when fruit from like plots were combined. The second study was observational and included 40 cultivars, clones or selections planted in 3-plant plots. The data taken in both studies included juice analysis of brix, pH, titratable acids, and whenever possible, yield. The purpose of the studies was to identify cultivars that would grow in a cool mesoclimate with emphasis on those that would produce acceptable wine at the cooler end of the spectrum. Values for titratable acid below 1.0 were considered acceptable for white wine cultivars and values of 1.0 and below were considered acceptable for red wine cultivars. In these studies there were 8 white and 8 red cultivars that produced wines of good to acceptable quality at this site where GDD got below 1600 GDD. Red wine cultivars were Dornfelder, Garanoir, Leon Millot, Muscat of Norway, Pinot Noir Precoce, Agria, Regent, and Zweigeltrebe. White wine cultivars were Auxerrois Blanc, Burmunk, Madeleine Angevine, Ortega, Schoenburger, Pinot Gris (early strain), Sylvaner, and Siegerrebe. In a separate study we found that for some cultivars when grafted to either Couderc 3309 or Millardet et de Grasset 101-14 rootstock, they produced lower titratable acids earlier in the season when compared to self rooted plants. This suggests that grafting may enable a varietal to attain acceptable wine quality earlier in the season, thereby reducing the amount of GDD needed to attain maturity, and that more varietals may be suitable for production in the coolest mesoclimates if grafted onto appropriate rootstocks.

Specified Source(s) of Funding: Washington Wine Advisory Board

11:30–11:45 am

Ballerina Training System Improves Yield and Maintains Fruit Quality of ‘Cabernet Franc’ Grapevines

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In 2005, excessive vine size (~2.7 kg/vine) was produced on each of four clones of ‘Cabernet Franc’ (CF) grapevines planted at 1100 vines/ha in 2002 on a fertile clay loam soil in a commercial vineyard in Southern Illinois. Therefore canopy division was investigated as a means of controlling the excessive vine vigor. The main plot treatments consisted of vertical shoot positioning (VSP) and the Smart-Dyson

ballerina canopy training system. The four clones CF 1, CF 4, CF 8, and CF 214 were the subplots. The canopy division treatments were imposed for three years (2006–08). Shoot density was maintained by thinning to less than 20 shoots per m linear canopy. There were no interactions between training system and clone for yield/ha, crop size or vine size. The ballerina training system produced 11.5 mt/ha annual yield compared to 5.7 mt/ha on the VSP control vines averaged over the three years. Fruit composition was not affected by training system treatment. Although both training systems produced an average vine size of 2.3 kg per vine, the ballerina system produced an average annual vine size of 0.3 kg/m canopy compared to 0.9 kg/m on the VSP. The ballerina training system produced \$8000 more farm gate revenue per ha than the VSP. The CF clone had minimal impact on yield and fruit composition over the course of the experiment.

Specified Source(s) of Funding: Illinois Department of Agriculture

11:45 am–12:00 pm

A New Self-Watering Technique for Container-Grown Grapevine—Capillary Wicking Water Cultivation (CWWC)

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Self-watering containers represent a relatively new gardening concept in annual herbaceous plants, including vegetables and flowers. However, little information about self-watering technique is available for perennial fruit trees since the relative large root system and canopy, which usually grown in drylands, such as grapevine. In this study, we designed a new self-watering system for container-grown grapevine according to the principle of capillary wicking water, and investigated the feasibility for grape production. This system consisted of a container with two holes on the wall, which is placed over a nutrient solution reservoir. Two nonwoven fabric sheets covered with polyester across the holes on the wall, respectively. A stock tank provided the nutrient solution for the above reservoir through plastic tube and the volume of water was remained a stable level. The bottom end of sheets immersed into the nutrient solution and the upper end of sheet was set around the root system. Nutrient-enriched water is wicked up from the reservoir into the potting soil by the nonwoven fabric sheets for grapevine growth. In 2008, two-year-old potted 'Pione' grapevines with two branches were transplanted into the above mentioned containers with 22 L volume and defoliated in middle September. After treatment with hydrogen cyanamide, the self-watering grapevines were placed in growth chambers. The full bloom is 15 October, and version stage started from 14 December. The mean length of primary shoot and lateral shoot were 142.7 cm and 39.8 cm, respectively. Berries with good color were harvested at 10 January 2009. Mean berry weight and total soluble solution (°Brix) were 9.1 g and 24.5, respectively. The amounts of nutrients uptake by the grapevine for N, P, K, and Ca were 5.4 g, 2.5 g, 8.5 g, and 3.5 g, respectively. The results showed that besides satisfied yield and good berry quality can be obtained, the self-watering system also can increase water and fertilizer use efficiency, reduce soil surface transpiration, and avoid the environment contaminated by the lead compared with the irrigation for conventional container.

Oral Session 30:

Lewis

Horticultural Crops Culture and Management: Floriculture Crops 3

Tuesday, 28 July 2009, 1:00–2:15 pm

Moderator: Guihong Bi, gb250@msstate.edu

1:00–1:15 pm

Effects of Chemical Defoliants, Urea, and GA on Defoliation and Plant Performance of Hydrangeas

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Hydrangea macrophylla 'Merritt's Supreme' plants were used to study the effects of foliar sprays of Def-6 (Def, 2500, 5000, 7500, and 10000 ppm), gibberellic acid, (GA, 50 ppm), copper-EDTA (CuEDTA, 0.5% and 1.0%), Florel (F, 2000 ppm) and urea (U, 3%) on defoliation in the autumn, and growth and flowering performance during forcing. Compared to controls, spraying plants with U or GA alone had no influence on defoliation or plant performance during forcing, and spraying plants with Florel alone had no influence on defoliation but decreased total flower dry weight during forcing. Combining urea with Florel sprays decreased the adverse effects of Florel on plant quality and combining GA with Florel improved defoliation. Increased concentrations of Def and CuEDTA increased defoliation. Compared to controls, plants sprayed with CuEDTA were more defoliated, had necrosis to buds and leaves, and produced less flower dry weight during forcing. Combining urea with CuEDTA sprays decreased the adverse effects of CuEDTA on plant quality. Compared to controls, spraying plants with Def increased defoliation, caused no visible damage to plants, and had no adverse effects on plant quality during forcing. Adding urea to sprays containing Def decreased or had no influence on the efficiency of defoliation and improved plant quality compared to Def alone. Adding GA to sprays containing Def increased the efficiency of defoliation without adversely influencing plant quality.

1:15–1:30 pm

Long Day Promotes Growth and Flowering of Dwarf Purple Loosestrife

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Dwarf purple loosestrife (*Lythrum salicaria* L.) is a Korea native plant, which has a long flowering period for two months in hot summer. This dwarf type plant has a potential to use for potted flowering plant as well as ground cover plant. For a potted flowering plants, the proper photoperiod condition in greenhouse is required to control growth and flowering. To determine the optimum photoperiod for flowering, seedlings (3–5 cm plant height) of dwarf purple loosestrife with 8 leaves were grown under 10, 12, 13, 14, 16, and 24 h daylength, and night interruption (NI, provided by 5 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ three-wave lamps from 2200 to 0200_{HR}) in a greenhouse. Secondly, to evaluate

the effect of short day treatment (SD, 10 h) followed by long day treatment from NI (LD), plants were grown under SD for 1, 2, 3, 4, 5, 6, 7, and 9 weeks after sowing, and then were moved to LD. The number of lateral shoots and plant height were increased as daylength increased. Though the highest number of inflorescences was obtained in 24 h daylength, there was no significant difference in the number of inflorescences among 16, 24 h, and NI. Plants when grown in NI flowered 90%, while plants grown under 14, 16, and 24 h daylength flowered 24, 76, and 71%, respectively. Plants grown under 10, 12, and 13 h daylength did not flower until the end of the study. While the number of nodes was not influenced by photoperiod, plant height and the number of lateral shoots decreased as SD exposure after sowing increased from 1 to 9 weeks. Continuous SD exposure inhibited the growth of dwarf purple loosestrife and remained vegetative rosettes throughout the experiment. These results suggest that seedlings should be grown under LD with NI after germination to promote vegetative growth and flowering for potted flowering plants. *T 82-2-880-4571, green17@snu.ac.kr*

Specified Source(s) of Funding: Ministry of Education, Science, and Technology, South Korea

1:30–1:45 pm

Effect of 6-Benzylamine and Cyclanilide on Growth of Poinsettia ‘Early Cortez’ and ‘Mars Red’

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Poinsettia production requires considerable labor to pinch the crop. This study evaluated plant growth regulators (PGRs) as an alternative to a manual pinch. ‘Early Cortez’ and ‘Mars Red’ cuttings (Syngenta Flowers, Boulder, CO) were potted into 15cm azalea pots in Sunshine Mix 1 on 22 August, 2008, and grown under long day conditions until 1 October. Treatments were arranged in a completely randomized design with 5 replications and were applied on 10 September. Treatments included a pinched control, a non-pinched control, 6-benzylamino-purine (BA); 40, 80, 120 mg·L⁻¹; Configure™; Fine Americas, Walnut Creek, CA), Cyclanilide (10, 20, 30 mg·L⁻¹; Bayer Environmental Science, Research Triangle Park, NC), and BA/Cyclanilide tank mix (40/10, 40/20, 40/30, 80/10, 80/20, 80/30, 120/10, 120/20, 120/30 mg·L⁻¹). B-Nine/Cycocel (2,500/1,500 mg·L⁻¹; Chemtura Corp. Middlebury, CT/OHP, Inc., Maryland, PA) was sprayed on 10 October for height control. Data was collected on plant height, width, and inflorescence diameter of the top three inflorescences on 16 December. All the PGR treatments produced taller plants than the pinched control except 20 mg·L⁻¹ Cyclanilide and 40/30 mg·L⁻¹ BA/Cyclanilide on ‘Mars Red’. No PGR treatment had an effect on plant width of either cultivar. On ‘Early Cortez’, all the treatments except 40/30 mg·L⁻¹ BA/Cyclanilide produced a larger terminal inflorescence compared to pinched treatment. All the PGR treatments produced significantly larger secondary inflorescences than pinched treatments except Cyclanilide alone or 40/10 mg·L⁻¹ BA/Cyclanilide. All the PGR treatments produced smaller tertiary inflorescences compared to pinched treatment. On ‘Mars Red’, all the PGR treatments had similar sized inflorescences compared to pinched treatment.

1:45–2:00 pm

Light and Cooling Requirements for Vernalization of Two Hybrid Nobile Dendrobium Orchids

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The nobile dendrobium (hybrids of *Dendrobium nobile*) must be exposed to moderate temperatures to induce flowering initiation. The objective of this study was to determine if light is required for vernalization and how light and cooling duration interactively affect flowering. Mature *D. Sea Mary* ‘Snow King’ and *D. Red Emperor* ‘Prince’ plants in 10-cm pots were subjected to 10 °C to induce flower initiation beginning 15 Sept. 2008. Treatments were factorial consisting of two light intensities (300 - 350 μmol·m⁻²·s⁻¹ photosynthetic photons and darkness) and four cooling durations (2, 4, 6, and 8 weeks). Following treatment, plants were moved to a greenhouse at 25 °C day/20 °C night. Time to anthesis, total flower count, flower size and flower longevity were determined to assess flower quality. For *D. Red Emperor* ‘Prince’, interaction between light level and cooling duration was significant for time to anthesis, flowering node percentage, total flower count, and aerial shoot formation. For all durations, only 45% of the plants cooled in darkness flowered, compared to 98% of those vernalized with light. For *D. Sea Mary* ‘Snow King’, the interaction between light level and cooling duration was not significant with one exception, flower number per flowering node. Regardless of light intensity, cooling for 2 weeks resulted in increased time to anthesis (54 vs. 47 days) and reduced total flower count (19 vs. 26) compared to 4, 6, or 8 weeks. For all cooling durations, when cooled in the dark, time to anthesis (52 vs. 46 days in light) and flower size (7.7 vs. 7.4 cm in light) increased while the percentage of nodes bearing flowers (48% vs. 75% in light) and total flower count (19 vs. 30 in light) decreased. For both cultivars, flower longevity increased by 10 days at 2 or 4 weeks cooling duration compared to 6 or 8 weeks. The results suggest that light is not required for flower induction in both clones, but may be needed for more complete flowering. However, for *D. Sea Mary* ‘Snow King’, vernalizing in darkness may delay flowering. Although increasing cooling duration shortens the time to reach flowering following cooling, it results in decreased flower longevity.

Specified Source(s) of Funding: Department, College, State and/or HATCH, Private (Association, Foundation, Industry) Department of Horticultural Sciences, Texas A&M University, Matsui Nursery

2:00–2:15 pm

Production of Kolkwitzia ‘Dreamcatcher’ as a Greenhouse Crop—Influence of Cooling and Photoperiod

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Plants that did not receive any cooling but were subjected to 9- or 12-hr photoperiods were never marketable whereas non-cooled plants that received a 15-hr photoperiod and NI were marketable. Plants that received no cooling, or those that received 9- and 12-hr photoperiods required more time on the bench than plants that received at least 6 weeks cooling, or 15 hr and night interruption (NI). In general, as the number of weeks of cooling increased, the amount of time on the bench decreased. Once plants were subjected to at least 6 weeks cooling, all plants were marketable however they required less bench time as

photoperiod increased. Being cooled for greater than eight weeks had little influence on marketable time for all photoperiod treatments except 15 hr. In general, plants subjected to 9- and 12-hr photoperiods required longer bench time than those that received 15 hr and NI, regardless of cooling duration. If provided with a photoperiod of 15 hr or NI, plants were marketable regardless of cooling duration. The data suggest that *Kolkwitzia* must receive at least 6 weeks of cold if the photoperiod is less than 12 hr., but if subjected to long photoperiods (15 hr., NI), cooling is not required.

Specified Source(s) of Funding: Spring Meadow Nursery, Proven Winners Inc.

Oral Session 31: Jefferson A
Horticultural Crops Culture and Management:
Ornamental/Nursery Crops
Tuesday, 28 July 2009, 1:00–2:15 pm

Moderator: Gladis Zinati, zinati@aesop.rutgers.edu

1:00–1:15 pm

Extensive Green Roof Species and Soilless Media Evaluations in Semi-arid Colorado

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In the high elevation, semi-arid climate of Colorado, green roofs have not been scientifically tested. This research examined alternative plant species, soilless media blends and plant interactions on an existing, modular-extensive (shallow, 10 cm deep) green roof in Denver, Colorado. Six species were evaluated for potential use in green roof systems. *Antennaria parvifolia*, *Bouteloua gracilis*, *Eriogonum umbellatum*, *Opuntia fragilis*, and *Sedum lanceolatum* are natives of shallow, rocky, well-drained locations in Colorado and *Delosperma cooperi* is native to similar conditions in South Africa. Media blends evaluated include Green Grid® media (Weston Solutions, Inc.) and Green Grid® media plus various percentages of ZeoPro™ H-Plus (ZeoponiX, Inc.) to increase water and nutrient holding capacity. Media blends were evaluated for plant species growth performance and water holding capacity. Plant species used in the media study included *Sedum acre*, *S. album*, *S. spurium* ‘Dragons Blood’ and *S. spurium* ‘John Creech’; these species were already in use on the existing green roof. The plant interaction study utilized the six alternative species plus *Allium cernuum* and *Sempervivum* species in mixed plantings in trays that contained the Green Grid® media or a 1:1 mixture of the Green Grid® media and ZeoPro™ H-Plus. All experiments were in a randomized complete block design (trays for experiments on the green roof were mixed in with the existing trays). The alternative species study had species as a whole-plot effect and date as a repeated measures effect, while the soilless media study had media as a whole-plot effect, species as a split plot effect and date as a repeated measures effect. Data collected included photographs to measure plant area covered, three dimensional plant size measured by hand, and soil moisture. Soil moisture was measured with a ML2x ThetaProbe (Delta-T Devices Ltd). Data was analyzed using the STAT/GLIMMIX procedure in SAS and multiple comparisons of alternative species and/or media at each of two dates. While all of the alternative species tested survived, results showed *D. cooperi* being the largest in size at the end of the growing season.

Incorporating a percentage of ZeoPro™ H-Plus into the soilless media enhanced the growth of the *Sedum* species.

1:15–1:30 pm

Seed Production and Viability of Eight Porterweed Selections Grown in Northern and Southern Florida

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Blue porterweed (*Stachytarpheta urticifolia*) has been classified as a Florida Exotic Pest Plant Council (FLEPPC) Category II invasive. The native porterweed (*Stachytarpheta jamaicensis*) and its closely related species may offer possible landscape alternatives to blue porterweed. Eight selections of porterweed were planted in north and south Fla., and evaluated monthly for visual quality and flowering. Mature inflorescences were counted and removed from each plant each month for seed viability and germination tests; and at 0 and 28 weeks, the perpendicular plant widths and heights were measured to generate growth indices. Pre-germination viability from south Fla. seed ranged from 0% (*S. mutabilis* ‘Violacea’) to 93% (*S. jamaicensis*). After 28 days at 30/20 °C, germination was 5% or less for *S. mutabilis* (1%), *S. mutabilis* ‘Violacea’ (0%), *S. ‘Naples Lilac’* (1%), *S. speciosa* ‘J.P.’s Pink’ (5%) and *S. speciosa* ‘Red Compact’ (5%). Germination was greatest for *S. jamaicensis* (85%) and *S. urticifolia* (69%). *Stachytarpheta urticifolia* also had high germination under a wider range of temperatures (20/10, 25/15, 30/20, and 35/25 °C) with or without provision of light. Visual quality and flowering varied among cultivars and sites. Regardless of site, *S. ‘Naples Lilac’* and *S. speciosa* ‘Red Compact’ had exceptional flowering and form, respectively, throughout most of the study. After 28 weeks, north Fla. plants were 1.2 to 1.8 times larger and produced 1.2 to 4.7 times more flower spikes than south Fla. plants. Ploidy analysis using flow cytometry indicates that all of the selections evaluated in this study are polyploids, with the exception of *S. speciosa* ‘J.P.’s Pink’ and *S. speciosa* ‘Red Compact’, that are diploids. Efforts to determine sexual compatibility between *S. jamaicensis* and *S. urticifolia* through artificial hybridizations are currently underway.

1:30–1:45 pm

Integration of Natural Mycorrhizae in Production of Container-grown Nursery Crops

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New Jersey’s nursery growers participated in developing protocols and implementing schemes of using natural mycorrhizae to produce container-grown nursery crops including: ‘Harvest Moon’ Echinacea, ‘Karen Purple’ azalea, ‘Pee Wee’ oakleaf hydrangea, ‘Forever & Ever Double Pink’ bigleaf hydrangea, and ‘Golden Mop’ chamaecyparis. The plants were grown in 2-gallon containers containing growers’ media mixes and were fertilized with grower’s standard Nutricote fertilizer rate. Each participating grower grew two sets of plants, where one set was inoculated with natural mycorrhizae that corresponds to specific plant type and the second set did not receive mycorrhizae (control) in four replications. Mycorrhizal inoculated Echinacea plants significantly had 48%, 79%, and 100% spent, open, and closed flowers, respectively,

when compared to non-inoculated plants. Top biomass was significantly pronounced in mycorrhizae-inoculated Echinacea plants and to a lesser degree in all other tested plants except for chamaecyparis. There was no difference in root biomass in any treatment, however, there was a significant higher arbuscule abundance in inoculated compared with non-inoculated plant roots at the 1% level.

Specified Source(s) of Funding: NE-SARE

1:45–2:00 pm

Substrate Media, Fertilizer Rate, and Mycorrhizal Inoculum Source Affect Azalea Plant Root Mycorrhizal Colonization and Severity of *Phytophthora cinnamomi* Infection

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Liners of two azalea cultivars Delaware Valley White 'DVW' and Silver Sword 'SS' were container grown in bark- or peat-based substrate media fertilized with Nutricote at full (FR, Control) and half rate (HR) using commercial and natural mycorrhizal sources for each treatment. They were compared to FR and HR treated plants. Two sets of treated plants were arranged in a RBCD with four replications at two commercial nurseries in southern New Jersey. One set was infected with the pathogen *Phytophthora cinnamomi* after plant establishment, and the other set was left without infection for comparison. Both sets were irrigated using overhead irrigation during the growing season. Plant top and root biomass of both 'DVW' and 'SS' cultivars was reduced in plants infected with *P. cinnamomi* and was more pronounced in 'DVW' plants that were grown in bark-based substrate media with FR fertilizer irrespective of the mycorrhizal inoculum source. The incorporation of natural mycorrhizae not only improved 'DVW' plant biomass at HR fertilizer in comparison to other treatments but also reduced the severity of pathogen root infection. Overall mycorrhizal colonization of DVW roots was greater than for SS. There was little difference between mycorrhizal colonization between fertilizer treatments as all plants became mycorrhizal. However, it appears that natural inoculum (containing a complete mix of mycorrhizae and bacteria) had a more stimulatory effect on plant growth than commercial inoculum.

Specified Source(s) of Funding: NE-SARE

2:00–2:15 pm

Quantifying Winter Discharge of Controlled Release Fertilizers to Determine Environmental Impact and Plant Uptake

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It is widely believed in the nursery industry that controlled release fertilizers (CRF) release nutrients only when temperatures are greater than $\approx 4^{\circ}\text{C}$ (40°F). Research recently conducted in Southern California reported CRF continued to release nitrate and phosphorus throughout the winter months. We suspect that CRF used in the Pacific Northwest also release throughout the winter months since atmospheric temperatures remain above freezing and soilless substrates are able to warm quickly on sunny days. Though release may be less than in California, environmental impact may be greater since reduced plant growth rate may reduce nutrient uptake resulting in high phosphorus and nitrate concentration in runoff. With reduced plant uptake and increased rainfall, nitrate and phosphorus from CRFs have greater potential to leave nursery sites and degrade water quality. The three objectives of the project were to: 1) determine the extent of nutrient release from CRF throughout winter months in Oregon's Willamette Valley; 2) evaluate uptake of nutrients of deciduous and evergreen plants; and 3) assess environmental impact on experimental nursery sites located in Aurora, OR. In October 2007 one-gallon (4L) deciduous and evergreen Ilex and Rhododendron were potted in three-gallon (11-L) containers using a Douglas-fir bark substrate. A 12 month complete, homogenous CRF was applied at the recommended medium rate (48g 19N-2.6P-10K). Plants were grown under normal irrigation conditions until experiment was initiated on November 1, 2007. At this time nutrient content of plants, CRF, and substrate were determined by grinding dry plant tissue and extracting nutrients from CRF and substrate. Nursery leachate/runoff was measured weekly from simulated nursery sites to determine nitrogen and phosphorus concentration. In April 2008 plant root and shoots were harvested and ground to determine plant nutrient concentration. Nitrogen and phosphorus were extracted from CRF to determine remaining nutrient content. Substrate daytime temperatures remained higher than ambient air temperature. In January substrate daytime temperatures were 14°C (58°F) while daytime air temperature remained around freezing. These elevated substrate temperatures in the container contributed to nutrient release detected in the runoff. There was negligible net nutrient uptake by either deciduous or evergreen plants regardless of taxa. Runoff nitrogen and phosphorus concentration averaged 4.0 and 0.4 $\text{mg}\cdot\text{L}^{-1}$, respectively. Ammonium accounted for $\approx 20\%$ of total nitrogen. Maximum nitrate concentration detected was 7 $\text{mg}\cdot\text{L}^{-1}$. Over the course of the five month period average effluent nutrient content per container was 254 mg N, 67 mg P, and 890 mg K.

Specified Source(s) of Funding: Horticulture Research Institute, Oregon Department of Agriculture, USDA-ARS (SCA# 58-3607-8-714)

Oral Session 32: Chouteau Horticultural Crops Culture and Management: Water Utilization and Weed Control Tuesday, 28 July 2009, 1:00–2:30 pm

Moderator: Sangjoon Kim, kimjun7710@yahoo.com

1:00–1:15 pm

Development of Bi-layer Hydrogels for Horticultural Applications

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Hydrogels are hydrophilic polymers that have the ability to absorb large amounts of water and nutrients while still retaining the solid state. This has made them attractive as growth media to provide optimal control of

the growth environment of plants, particularly in horticulture. However, hydrogels have several drawbacks. While they have excellent water absorption properties, they are also prone to rapid dehydration when exposed to air or dry soil. They are also extremely fragile and breakup easily which further accelerates their dehydration. Plant growth studies with commercially available hydrogels suggest little if any benefit from their addition to soils. In this study we are developing a novel bi-layer hydrogel to address these problems. The larger, inner core of this bi-layer materials is made up of the highly water absorbent, but quite fragile, polyacrylamide (PAAm) hydrogel. This core is encased by a thin layer of polyurethane (PU) polymer which provides the mechanical strength for the material. More significantly, the outer polyurethane layer provides a low permeability aqueous barrier for the water-laden polyacrylamide core. We have also developed methods to adjust the porosity of the polyurethane layer by varying the synthesis conditions for it. This has allowed for the preparation of various PU-PAAm materials with different dehydration rates lasting from several days to well over a week. However, characterization of this material shows that the dehydration rate strongly depends on temperature and humidity, which means that the properties of the material needs to be adjusted based on the growth conditions. Additionally, strength measurements done on the material show that it has excellent mechanical properties, making it suitable for deployment as growth media.

Specified Source(s) of Funding: USDA

1:15–1:30 pm

Irrigation Optimization Based on Physiological Response of Potted *Chrysanthemum morifolium* Under Greenhouse Conditions

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Optimal moisture content for growth is specific to cultivar and growing media. Studies of physiological and growth response as well as substrate behavior under different irrigation regimes are essential to the future development of automated irrigation technology. A greenhouse study was conducted in Fall 2008 to quantify growth and physiological responses of potted *Chrysanthemum morifolium* (aka *Dendranthema grandiflora* Ramat.) under five different irrigation programs. Five cuttings per 6-inch pot were grown in a 70:30 peat-coir mix. Treatments were imposed by irrigating plants to saturation, using a zero runoff sub-irrigation system, with successive irrigation events triggered as substrates reached 40%, 30%, 20%, 15%, and 12% volumetric moisture content minimums. Harvests were conducted at 2-week intervals to determine fresh and dry weights. Leaf stomatal conductance (gs) and photosynthetic rate were measured at the end of weeks 9 and 11 to evaluate treatment effects at growth progression intervals and throughout week 12 to evaluate long-term effects on carbon fixation. Lower gs occurred in the drier treatments (12% and 15%) at week 11, with no differences in week 9. A 6-day trial conducted during week 12, revealed declines in gs as treatment minimums were approached. Chlorophyll fluorescence was measured at 2-week intervals to estimate possible damage to photosynthetic apparatus as a consequence of water stress. Substrate analysis revealed air-filled porosity of 13.9% and an oxygen diffusion rate of $140 \times 10^{-8} \text{ g O}_2 \text{ cm}^{-2} \text{ min}^{-1}$ at container capacity of 78%. Oxygen content in the substrate was monitored during week 13 to evaluate treatment effect on root zone oxygen levels. Electrical conductivity and pH of substrate effluent were also measured during harvests. Optimizing irrigation management that is specific

to both cultivar and substrate could increase the amount of biomass produced per liter of transpired water, thus reducing irrigation inputs during crop production.

Specified Source(s) of Funding: Ontario Centres of Excellence

1:30–1:45 pm

Fruit Quality Response to Irrigation of ‘Royal Gala’ Apple in Semi-arid Climate

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Australia and the state of Victoria in particular, are experiencing a prolonged drought (>10years) that has drastically reduced irrigation allocation. Irrigation is an obligatory practice for apple growing in northern Victoria so growers have purchased “temporary” irrigation at substantial cost from other agricultural users. Understanding the correct irrigation volumes to continue producing a high quality crop is fundamental for orchards to remain viable. The aim of this experiment was to determine the optimal irrigation volumes to produce apples of high quality and high health properties. A commercial orchard of ‘Royal Gala’ in the Goulburn Valley near Shepparton, Victoria, Australia, was selected in 2008 and five irrigation treatments, ranging from 160 mm to 690 mm per season, were applied in a randomized block design by using drippers with different emission volumes on the existing irrigation line. The amount used for commercial irrigation in the 2008–09 growing season was approximately 425 mm. Shoot and fruit growth during the season and trunk circumference were measured. Crops were harvested twice based on fruit color. Fruit number and total yield per tree were recorded for each harvest. A sample of 20 fruit per tree for each harvest was collected. Fruit background and blush color, dimensions, weight, total soluble solid content (SSC), firmness, starch index, ferrous reducing action potential (FRAP), and total polyphenols (TPP) were measured to determine fruit quality and health properties. There were no appreciable differences between the two harvests for the measured variables, therefore data were pooled. Average fruit weight and fruit diameter were significantly depressed at the two lowest irrigation volumes, but no differences were recorded under the other treatments. There was a noticeable trend observed among most of the variables measured that separated the data into two distinct groups depending on irrigation volumes. Groups could be defined as low volume, between 160 and 210 mm and high volume, between 315 and 690 mm. Low volumes resulted in reduced fruit size, weight and seasonal growth, compared to high volumes. There were no clear trends and distinctions between irrigation volumes for firmness and starch, while SSC showed an inversely proportional trend to irrigation volume. Antioxidant status of the fruit is currently being analyzed, but appears to increase with decreasing fruit size. This experiment showed that it is possible to reduce the current irrigation volume in Victoria and potentially increase ‘Royal Gala’ fruit quality and health attributes.

1:45–2:00 pm

Grass–Legume Cover Crop Mixtures and Manure Affect Weed Seed Production and Legume Nodulation

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Summer legume cover crops can improve soil health and reduce the economic and environmental costs associated with N fertilizers in production of many horticultural crops. However, adoption is often constrained by high seed costs and ineffective weed suppression compared to non-legume cover crops. We hypothesized that mixtures of cowpea and soybean cover crops with sorghum–sudangrass or Japanese millet would reduce the risk of weed seed production and increase nodulation relative to legume monocultures, and that these benefits would be greatest under lower N fertility. In field experiments conducted in North Central NY, legumes and grasses were grown either alone or in various grass-legume combinations with or without composted chicken manure. Under hot, dry conditions in 2005, both cowpea and soybean were severely suppressed by weeds in monoculture and by sorghum–sudangrass in mixtures, resulting in low legume biomass, and poor nodulation. Treatments involving sorghum–sudangrass produced 8 MT/ha dry weight and suppressed weed biomass and seed production by over 90% compared to the no cover crop control, but seed production among suppressed Powell amaranth exceeded 20,000 seeds/m². Under more typical temperature and rainfall conditions in 2006, all cover crop treatments produced substantial biomass (4–8 T/ha), and suppressed weed biomass by over 95% compared to the no cover crop control. However, mean Powell amaranth seed production was 1,100 seeds/m², equivalent to 3–5 times the estimated initial Powell amaranth seed bank. In 2006, cowpea mixtures with Japanese millet stimulated cowpea biomass production and nodulation compared to monoculture, but soybeans were suppressed in mixtures with both grasses. Composted chicken manure shifted competition in favor of weeds at the expense of cowpea (2005), stimulated weed and grass biomass production (2006), and suppressed nodulation of soybean (2006). In a complementary on-farm trial, cowpea mixtures with sorghum-sudangrass produced over 7 MT/ha and suppressed weed biomass by 99% compared to the no-cover crop control; however, hairy galinsoga growing beneath the vigorous cover crop canopy was able to produce sufficient seeds (600 seeds/m²) to replenish the existing weed seed bank. Results suggest that 1) mixtures of cowpeas with grasses can increase legume biomass; improve nodulation; lower seed costs; and reduce the risk of weed seed production; 2) soybean is far less compatible with either grass in mixture; and 3) future costs of weed seed production must be weighed against potential benefits of soil health and reduced fertilizer costs in determining optimal choices of cover crops.

Specified Source(s) of Funding: Toward Sustainability Foundation

2:00–2:15 pm

Efficacy of Four Preemergence Herbicides Declines Over Time

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Lack of longevity of weed control using preemergence herbicides is a problem during containerized plant production, especially in situations where irrigation and rainfall amounts are high and weed seed germination extends over a long time period due to dormancy and/or reintroduction. Four preemergence granular herbicides containing the active ingredients flumioxazin (BroadStar), oxyfluorfen + oryzalin (Rout), trifluralin + isoxaben + oxyfluorfen (Snapshot) or trifluralin +

dimethenamid-P (Freehand) were applied to containers filled with a pine bark:peat:sand growing medium. Untreated containers served as controls. Containers were held outdoors, fertilized with controlled-release fertilizer, and watered daily using overhead irrigation. One-third of the containers in each treatment were inoculated with 20 weed seeds of either *Chamaesyce maculata*, *Commelina benghalensis*, *Eclipta prostrata* or *Parthenium hysterophorus*, two containers per weed, one day before the herbicides were applied. At both 28 and 56 days after treatment (DAT), another third of the containers were inoculated in the same manner. Successful germination and percent coverage of the medium surface were visually evaluated bi-weekly. At 90 DAT for the first weed seed sowing, *Chamaesyce* control was good (80% to 100%) with FreeHand and Rout, and fair (60% to 79%) with BroadStar and Showcase. Control of *Chamaesyce* from the second sowing was only acceptable (~60% or greater) with BroadStar and FreeHand at 90 DAT. Control was unacceptable for all herbicides at 90 DAT when the weed seeds were sown 56 DAT. Control at 90 DAT for *Commelina* from the first sowing was fair using FreeHand and good with BroadStar. BroadStar control was also good for seed from the second sowing. None of the other treatments provided acceptable control for 90 days, regardless of sowing date. For *Eclipta* from the first sowing, control was good with BroadStar and Rout at 90 DAT; however, control was unacceptable for *Eclipta* from the later sowings for both products and also for the other treatments for all three sowings. At 90 DAT, *Parthenium* control from the first sowing was still good for all herbicides except FreeHand. None of the herbicides provided effective control of *Parthenium* seeds from the second and third sowings. These results demonstrate the need for correct herbicide selection depending on weed species and the need to prevent subsequent weed seed contamination after herbicides are applied.

Specified Source(s) of Funding: Florida Agricultural Experiment Station, Industry

2:15–2:30 pm

Weed Management in Sweet Corn: What's Working and What's Not?

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During the latter half of the 20th century, weed management systems changed dramatically in North America with widespread development and adoption of selective herbicides. Relative to many other horticultural crops, sweet corn benefits from having a number of herbicides registered for use on the crop. How close are we to optimizing weed management in sweet corn? Recent surveys of growers' fields indicate that while weed frequency and density in fields have declined in recent decades, weed interference continues to cause yield losses in a majority of fields. Use of interrow cultivation has declined considerably, crop rotations largely lack diversity needed to disrupt weed life cycles, and weed management systems are dominated by a single, at best two, applications of herbicides. Atrazine, one of the oldest herbicides registered in sweet corn, is by far the most widely used. Some of the most abundant weeds have been problems for decades, including common lambsquarters (*Chenopodium album*), velvetleaf (*Abutilon theophrasti*), and fall panicum (*Panicum dichotomiflorum*). Of limited concern 20 years ago, wild-proso millet (*Panicum miliaceum*) ties with giant foxtail (*Setaria faberi*) as the second most abundant weed in sweet corn. An analysis of the weed community, management tactics and environmental conditions during crop growth revealed several characteristics associated with improved weed management in today's production. First of all, weeds need to be managed for the long-term; weedier fields receive some of the greatest herbicide use but these additional inputs do not protect yields relative to fields with less of a weed problem. Secondly, aim for maximum herbicide activity; adequate

precipitation or irrigation dominates weed control potential. Finally, a less obvious finding was that the extent to which weeds are a problem in sweet corn are affected by planting date and latitude within the north central U.S. production region.

Oral Session 33: **Jefferson D/E**
Horticultural Crops Culture and Management:
Vegetable Crops 1
Tuesday, 28 July 2009, 1:00–3:00 pm

Moderator: Kurt Nolte, knolte@ag.arizona.edu

1:00–1:15 pm

Yield and Quality of Pathogen-free Horseradish
(*Armoracia rusticana*) Planting Stock:
Implications for a Certification Program

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Illinois hosts the most concentrated production of horseradish (*Armoracia rusticana* P. Gaertn., B. Mey. & Scherb.) and horseradish products in the United States. However, the overall quality and yield of Illinois horseradish roots has declined significantly within the past few years, and is believed to be related to the build up of soil- and insect-borne diseases, including viruses. Horseradish is propagated asexually from root cuttings, which can lead to additional pathogen-build up issues. Horseradish is plagued by many pathogens, but the most detrimental virus is thought to be *Turnip mosaic virus* (TuMV) and the most important fungal pathogen species are thought to be *Verticillium dahliae* and *V. longisporum*. To free horseradish plants of TuMV and *Verticillium* species, plantlets were subjected to meristem culture in vitro. Apical meristem explants, small enough to be free of leaf primordia (ca. ½ mm in length), were excised and grown in vitro. Meristem culture resulted in the regeneration of TuMV- and *Verticillium*-free horseradish planting stock. To screen for the presence of these two pathogens, the meristem-derived plants were assayed using RNA reverse transcriptase and polymerase chain reaction (RT-PCR) and PCR, respectively. Horseradish plantlets that were determined to be TuMV- and *Verticillium*-free were designated “pathogen-free”, or PF. PF plants were acclimated, propagated in a greenhouse, and transplanted into the field to examine yield and quality differences in commercial production areas. Three formerly productive, disease-susceptible horseradish cultivars were used in two geographically separated locations. Within each location, two fields were selected based on their planting history. One field had no history of horseradish, and the other field had been planted to horseradish within the past two years and/or had a history of disease. Under field conditions, PF horseradish plants were more vigorous and productive than plants propagated by sets in the traditional manner (control). PF planting material produced higher yields than the control in all fields (history and no history). In many cases, PF plants produced two to three times the yield of the control. Additionally, 90% of the PF plants remained symptom-free (marketable) after at least one season in a field with a history of horseradish. Based on these data, we outline a field-based production protocol for rapid and cost effective propagation of PF horseradish sets. Using PF plants combined with complementary

cultural modifications growers can regain yields and quality of roots, even into a second growing season.

Specified Source(s) of Funding: Illinois Council on Food and Agricultural Research (IL C-FAR); University of Illinois College of Agricultural, Consumer, and Environmental Sciences (U of I ACES); Horseradish Growers of Illinois (HGI).

1:15–1:30 pm

Evaluation of Horseradish Cultivars in Illinois

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Horseradish (*Armoracia rusticana* Gaertn., Mey. & Scherb.) is a major horticultural crop grown in the St. Louis metro east area in Illinois. It is asexually propagated from root cuttings, called sets, that are saved from the previous years crop. All cultivars used by Illinois growers result from a breeding program that was initiated about 50 years ago in the state. The objective of this research was to evaluate 23 horseradish cultivars over the 2006 to 2008 growing seasons at grower locations in the Caseyville/Collinsville, Ill. area for yield, set production, root quality and resistance to internal root discoloration (IRD). Horseradish cultivars that provided high primary root yields included 405, 406, 1573, 1590, D25E2, and ‘German,’ while those with high set production (> 4 sets per plant) were 15K, 1573, and D25E2. Horseradish cultivar root quality as well as the incidence and severity of IRD were inconsistent over the three growing seasons. Those cultivars that generally provided high root quality characters (e.g., smooth, non-hairy roots) were 405, 15K, 1573, 1038, D25E2, and ‘German.’ Internal root discoloration is a soil-borne disease complex that is currently the biggest challenge facing the Illinois horseradish industry. Horseradish cultivars with low incidence of IRD included 15K, 402, 405, and 22C, while those with low severity of IRD were 330, 405, 7586, 9705, 15K, and 22C. These results indicated that the horseradish cultivars 405 and 15K consistently provided high quality characters, IRD tolerance and yield.

Specified Source(s) of Funding: Horseradish Growers of Illinois

1:30–1:45 pm

Determining Optimum Planting Dates for
Inter-cropped Cucumber, Squash, and Muskmelon
with Strawberry

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Three separate field trials were conducted to determine the most appropriate planting dates for intercropping cucumber (*Cucumis sativus*), summer squash (*Cucurbita pepo*), and muskmelon (*Cucumis melo*) with strawberry (*Fragaria xananassa*), and their effect on ‘Strawberry Festival’ strawberry yields. ‘Straight Eight’ cucumber, ‘Crookneck’ summer squash, and ‘Athena’ muskmelon were planted every 15 d from 25 Jan. to 23 Mar. None of the three intercropped species affected strawberry yield up to 60 d before the end of the season on 25 Mar.

Cucumber yield responded quadratically to planting dates, rapidly increasing from 25 Jan. to 23 Feb. and declining afterwards. Warmer temperatures favored summer squash yield with the highest yields when planted on 23 Feb. or later. Muskmelon yields decreased as air temperatures increased and the best planting dates were between 25 Jan. and 9 Feb. In summary, cucumber and summer squash seemed to be favored by planting under warmer temperatures, whereas muskmelon thrives under cooler weather.

1:45–2:00 pm

Broccoli [*Brassica oleracea* (Plenck) Var. *Italica*] Plant Growth and Yield as Affected by Colored Plastic Film Mulches

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Few studies report on the utilization and benefits of plastic film mulches on broccoli. The objectives of this study were to determine the effects of colored plastic mulches on broccoli plant growth and yield. Broccoli ('Packman') plants were grown on plastic film mulch and drip irrigation during two fall and one spring seasons. The treatments consisted of colored plastic film mulches and bare soil. Root-zone temperature (RZT) was measured at 10 cm below the mulch and the soil surface. Plastic film mulches affected broccoli plant growth and yield as well as RZT. The differences in yield among mulches were greater in the spring than in the fall. Broccoli yield was little affected when mean seasonal RZT was below 21 °C, but increased with increasing mean seasonal RZTs above 21 °C. Mean RZTs were highest under dark-colored mulches (blue, black, red, and gray mulches) and lowest under light-colored mulches (silver and white mulches). Thus, broccoli plant growth and yield responded more favorably to dark colored mulches than to light colored mulches, suggesting that broccoli benefited from increased soil warming.

Specified Source(s) of Funding: University of Georgia, Ampacet, and Lewis Taylor Farms.

2:00–2:15 pm

Development of a PCR-based Protocol for in Planta Detection of Pathogens in Asymptomatic Horseradish (*Armoracia rusticana*) Tissues

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Horseradish (*Armoracia rusticana* P. Gaertn., B. Mey. & Scherb.) is grown for its white, fleshy, and pungent roots. Approximately half of the total commercial production of horseradish in the United States occurs in Illinois. However, this situation is currently unstable due to yield declines. These declines are due to a disease complex, and the primary causal agents are thought to be *Verticillium dahliae*, *V.*

longisporum, and the Potyvirus, *Turnip mosaic virus* (TuMV). Each plays a role in horseradish decline: *Verticillium* is related to internal root tissue discoloration and TuMV is related to yield decreases. In this study, four formerly productive horseradish cultivars were freed of pathogens via meristem culture in vitro. To make and maintain pathogen-free (PF) plants in vitro for the development of a certification program, a sensitive pathogen screening method was required. To test for the presence or absence of TuMV, leaf samples were harvested from putative PF plantlets growing in vitro. Half of each leaf sample from an individual plant was subjected to the enzyme-linked immunosorbent assay (ELISA). Total RNA, including viral RNA, was extracted from the other half of each leaf and was evaluated via the reverse transcriptase and polymerase chain reaction (RT-PCR). The degenerate primers used were designed to amplify DNA fragments specific to highly conserved areas from potyvirus coat protein genes. To test for the presence or absence of *Verticillium* spp. fungi *in planta*, a streamlined PCR-based testing system capable of species differentiation was developed. Root samples were collected from symptomatic plants, and the segments were placed inside a resealable plastic sandwich bag with a piece of moistened, sterile paper towel to encourage fungal growth. Bags were incubated at 22 °C, DNA was extracted at 0, 3, and 7 days, and subjected to PCR testing. For TuMV detection, RT-PCR was found to be 100–1000 times more sensitive than ELISA and should be used to screen certified propagation materials in vitro. For *Verticillium* detection, the streamlined testing protocol is superior to traditional plating techniques because it does not require the use of a laminar flow hood, surface disinfestation of roots (even from field samples), or a detailed knowledge of fungal morphology. In addition, PCR-based techniques can differentiate between infected, but symptomless, plants and non-infected plants. This information is critical for the development of a production protocol for rapid and cost effective propagation of PF horseradish sets.

Specified Source(s) of Funding: Illinois Council on Food and Agricultural Research (IL C-FAR); University of Illinois College of Agricultural, Consumer, and Environmental Sciences (U of I ACES); Horseradish Growers of Illinois (HGI).

2:15–2:30 pm

Using Vegetation and Polymers to Control Sediment, Nutrients, and Bacteria in Irrigation Run-off from Vegetable Fields

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Irrigation tail water from vegetable fields is a source of nutrients, sediments and bacteria in surface water on the central coast of California. Because of concerns for microbial food safety and quality of surface water, effective measures that control run-off are needed for the cool season vegetable industry. We conducted a 2-year study evaluating the effectiveness of vegetated ditches and polymers to reduce levels of sediment, nutrients, and *E. coli* bacteria in run-off from sprinkler-irrigated lettuce grown in the Salinas Valley. The trials were begun after the thinning stage of a head lettuce crop. Generic *E. coli* was introduced to the field by placing satchels of sand media containing

the bacteria in the furrows for the first irrigation with overhead sprinklers. The field trial followed a randomized latin square design with 4 replications over time. Four 0.36-ha plots were sprinkler irrigated with water treated with either a 5 ppm concentration of polyacrylamide or water that was untreated. Run-off from the plots was diverted through ditches of a 52-m length that were either bare or lined with grass vegetation. Composite water samples were collected above and below the ditches and analyzed for suspended sediments, nutrients, and *E. coli* and coliform bacteria. Applied water was measured using flow meters and total run-off from the plots was measured using trapezoidal flumes. Polyacrylamide in the irrigation water reduced suspended sediment concentration and turbidity by more than 90% in the run-off. Polyacrylamide also reduced the concentration of total P, and total N by as much as 70% in the run-off, and soluble P was also significantly reduced but by less than 50%. The vegetated ditches did not consistently reduce the concentration of suspended sediments and nutrients in the run-off. Neither vegetation nor polyacrylamide reduced the amount of run-off from the fields or reduced the concentration of coliform and *E. coli* bacteria in the run-off.

Specified Source(s) of Funding: California State Water Quality Control Board

2:30–2:45 pm

Assessing a Site-specific Yield Determination and Field-level Tracking System for Iceberg Lettuce Production in the Desert Southwest

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Field packing into cardboard cartons is the current method for the handling and later transport of all leafy vegetables, including Iceberg lettuce. Field packing generally provides greater marketable yields because of reduced mechanical damage. And, for Iceberg and other lettuces, field efficiency, postharvest quality, and enhanced productivity necessitate the boxing and identification of quality attributes early in the supply chain, either in the field or packinghouse. Consumer demand for ever-increasing amounts of minimally processed fresh produce can run the risk of being contaminated by pathogens which can heighten the decay process and, in some cases, make consumers seriously ill. And, should an unfortunate issue involving field-level food safety arise, the ability to trace a contaminant back to a specific field location is critical to the rapid and effective understanding, management and control of the event. Viewed broadly, U.S. food producers have developed an enormous capacity to track the flow of food along the supply chain, though individual systems vary. Some traceability systems are deep, tracking food from the retailer back to the farm, while others extend back only to a key point in the production process. In the fresh produce industry, the development of trace-back systems has been greatly influenced by the characteristics of the product, the harvesting infrastructure, and the current technology. Yet, the ability to georeference cut and packed lettuce back to a precise field location is still in its infancy. In this light, there is no current system which has the capability to trace carton-level packed Iceberg to an exact field location. Using RFID and integrated GPS technologies, we demonstrate the first field-level, georeferenced carton tracking system to the leafy green industry. The system is highlighted with the seamless traceability of produce from the retail shelf back to precise grower protocols, field locations, crop vigor status, field worker identification and weather conditions during growth and subsequent harvest. As the system will incorporate carton level GPS links, precise lettuce yield determinations can be made within a field and later integrated into other precision management strategies.

Specified Source(s) of Funding: Arizona Iceberg Lettuce Research Council

Oral Session 34:

Jefferson C

Marketing/Consumer/Extension Horticulture

Tuesday, 28 July 2009, 1:00–3:00 pm

Moderator: Kathleen Kelley, kmk17@psu.edu

1:00–1:15 pm

Use of a Sensory Evaluation to Assess Consumer Acceptance and Preferences of Lesser-known Cultivars of Apple Scab Resistant Fresh Apples

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One hundred and forty-nine consumers participated in a sensory evaluation, conducted on 14 Nov. 2008 at The Pennsylvania State University, University Park campus to determine consumer acceptance and perceptions of apple-scab resistant cultivars of apples. The study was conducted to provide Pennsylvania tree fruit growers with a better understanding of consumer demand for apples that could be produced at orchards in the Commonwealth and serve as substitutes for common cultivars which require frequent conventional pesticide applications. As growers in Pennsylvania consider “certified” organic production practices, it is necessary to determine what cultivars, suitable for organic production, end users desire. Participants were recruited from the university community and were screened in order to select those who consumed fresh apples. During the 10-minute sensory evaluation, participants rated six apple cultivars, ‘Crimson Crisp,’ ‘GoldRush,’ ‘NY 49,’ ‘Crimson Topaz,’ ‘Sundance,’ and ‘Jonagold,’ a commercial available cultivar, on appearance, aroma, texture, flavor, and overall appeal. ‘Crimson Topaz,’ ‘NY 49,’ and ‘Crimson Crisp,’ three of the four cultivars tested with a “red” colored peel, were rated significantly higher than the other samples based on appearance, receiving ratings that were between “like moderately” to “like very much.” In regards to texture, ‘Crimson Topaz,’ ‘GoldRush,’ ‘Sundance,’ and ‘Crimson Crisp’ received scores between ‘like slightly’ and ‘like moderately.’ For overall liking scores, ‘Crimson Crisp,’ which was rated between ‘like slightly’ and ‘like moderately,’ was not significantly different from ‘Crimson Topaz’ and ‘GoldRush;’ however, ‘Crimson Crisp’ was rated higher than ‘Jonagold,’ ‘NY 49’ and ‘Sundance.’ Participants also responded to questions regarding their food purchasing attitudes and behaviors. When asked how often they purchased “certified” organically grown fruits and/or vegetables in the past year, approximately one-third (34.9%) responded that they had not purchased these items, while an additional 30.2% indicated that they purchased these items “about once a month” or more frequently. Sixty-two percent of participants purchased fresh apples for themselves and/or other household members at least “two or three times a month” during an average year. Only 2.7% responded that they purchased fresh apples “more than once a week.” Assessments of potential markets, both within Pennsylvania and in bordering states, for organically-grown apples are necessary to determine which opportunities are truly feasible and which are not as practical. Learning directly from the consumer as to their wants and needs is absolutely crucial for any effort to be successful and economically sustainable.

1:15–1:30 pm

Consumer Flower Color Preference on Calendar and Non-calendar Occasions

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Flower color is a dominant product attribute of fresh flowers, likely playing a key role in purchase preference. Previous studies showed flower color preference differed by gender. Data for this study was collected by the Ipsos-National Panel Diary Group (NPD) for the American Floral Endowment (AFE) which maintained an extensive consumer panel with 24,640 floral transactions from 1992 to 2005. Multinomial logit analysis of single stem cut flower purchases showed that men and women differed in their flower color preferences, but that color preference also varied with other demographic characteristics and by occasion. The highest percentage of flowers purchased were bronze/rust, orange, or red/crimson (34%) while the lowest percentage of flowers were (10.01%) yellow, and other flower colors accounted for < 5% of purchases. Both men and women were more likely to buy red/bronze flowers for an anniversary and buy peach/pink flowers for Mother's Day. Over time, women were less likely to purchase peach/pink flowers and men were less likely to purchase red/crimson, bronze/rust and orange flowers. Both male and female consumers' demand for blue/purple and yellow flower colors increased over time.

1:30–1:45 pm

Understanding Grower Perceptions of Sustainability

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Sustainable floriculture production is an emerging issue for floriculture producers in the United States, yet most do not have a clear understanding of this topic and varying opinions exist about its importance. The objective of this study is to identify barriers to entry into sustainable practices among floriculture producers. A national convenience sample was conducted via a paper questionnaire and the internet of floriculture producers between June and October, 2008. Approximately 96% of respondents had heard of sustainable floriculture and the majority (65.2%) viewed sustainable practices as "very important" to the environment. More than half (63%) of the respondents already use some type of sustainable practice in their operation. Recycling plastic pots and/or greenhouse glazing materials was the most common sustainable practice producers currently had in place (73%) followed by water recycling and/or water conservation (62%). The top five practices that the growers felt were important to implement included: recycling plastic pots and/or greenhouse glazing, biological controls, conservation of energy, water recycling and/or conservation, and alternative energy sources. Respondents agreed that implementing sustainable practices would be a worthy investment (67.5%) as it was a viable marketing trend in the floriculture industry (63%). However, respondents were uncertain on whether becoming sustainable would generate more profits for their operation (54.9%). Less than half (47.7%) of growers were uncertain whether customers would value sustainable floriculture production practices. Producers either disagreed or were undecided with the statement that the conversion to sustainable production was risky (71.1%).

Specified Source(s) of Funding: Purdue Mission Oriented Grant, Ball

Horticultural Company

1:45–2:00 pm

Consumer Perception of Sustainably Grown Bedding Plants

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Consumer perception and value can influence the adoption of sustainable production for greenhouse growers. The objective of this study was to identify consumer knowledge and willingness to purchase sustainably produced bedding plants at a premium price. Sustainably and conventionally grown geranium, marigold, vinca, petunia, and New Guinea impatiens were delivered to five garden centers in Indiana. At three of the garden centers, the sustainably grown plants were priced 20% higher than the conventionally grown plants. The average price of the sustainable 4-inch New Guinea impatiens and geranium pots ranged from \$4.79 to \$7.19, and conventional petunias, marigolds, and vinca ranged from \$3.59 to \$5.15. We determined that 71% of the higher-priced sustainably grown plants sold at retail while 78% of the conventionally grown plants sold at the 20% lower price. At the two other garden centers, sustainably grown plants were priced the same as conventionally grown plants. Prices ranged from \$3.99 to \$4.49, and we found that 85% of sustainable plants sold versus 87% of conventional plants. Approximately 80% of respondents who purchased the plants had not heard of sustainability. The 10% that had heard of this term stated they thought it meant "chemical free," "earth friendly," and "harmless to the environment." From the survey responses, approximately 64% of plant sales were for environmentally friendly plants. Fifty percent of the plants sold were influenced by the point of purchase display with another 23% of plants purchased that day were based on "what they were coming for that day". These results indicate that consumers are willing to purchase sustainable plants at similar rates as conventionally grown plants. However, the maximum amount consumers are willing to pay for sustainable plants needs to be further analyzed.

Specified Source(s) of Funding: Purdue Mission Grant and Ball Horticulture Company

2:00–2:15 pm

Support of CEA Applications with Telepresence

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To establish successful CEA operations, education, training, and experience for the system operators are required. Decision support from off-site consultants or other support groups can be beneficial to help the operation, but to provide an effective response, they require environmental information and plant status, as well as, easy access to sufficient data. Telepresence procedures can improve remote deci-

sion support of CEA facilities through environmental monitoring, controlling, decision-support of operations, crop diagnostics, system diagnostics, and distance education, by using web cameras, climate control computers, and email. These practices have provided effective support within several applications which will be reported.

Specified Source(s) of Funding: Sadler Machine Co; NSF/Raytheon Polar Services; NASA; UA-CEAC

2:15–2:30 pm

Simple Irrigation Plan—Turning Evapotranspiration Science Into Irrigation Decisions

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The Simple Irrigation Plan (SIP) Web site was created to provide a turfgrass irrigation decision support tool simple enough for consumers to use. The site uses the American Society of Civil Engineers standardized reference short crop evapotranspiration multiplied by individual coefficients for bermudagrass, zoysiagrass, and tall fescue. Turf coefficients are adjusted based on average daily temperature, rather than by calendar dates to make the turfgrass evapotranspiration rates more responsive to the highly variable Oklahoma weather. The Web site has three options for entering and receiving a watering time recommendation: “Simple Watering,” “Advanced Watering,” and “Advanced Watering Plus.” The primary goal of the “Simple Watering” option is to create a Web based decision support product consumers would use. Informal evaluation of existing Oklahoma Mesonet evapotranspiration models indicated there was a high interest by consumers for an online irrigation decision support tool, but that they would not use models that required: them to learn scientific terms and methods, them to record or add up data, them to interpret data from tables. The SIP Web site design and choices for “Simple Watering” were purposely pared down to provide the user an answer as fast as possible with as few inputs as possible. Sprinkler run times are reported in a range of minutes to account for variation in sprinkler watering rate. The “Advanced Watering” option provides a more precise sprinkler run time, but requires the user to enter more data about their irrigation and turfgrass situation. The third option, “Advanced Watering Plus,” offers users a way to save their inputs in “Advanced Watering” by getting a free account name and password. Evapotranspiration rates are based on weather data from Oklahoma Mesonet sites. This network has 120 sites, approximately 32 kilometers apart, across Oklahoma. All options include a water cost calculator with water costs for over 200 Oklahoma communities. Turfgrass and sprinkler choices are made by selecting from pictures to speed selection and avoid confusion in sprinkler selection.

Specified Source(s) of Funding: State funds

2:30–2:45 pm

A Tool to Help Producers Calculate Their Costs

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How do producers make money with shrinking margins, rising costs, and demanding customers? Which crops are making money, and which ones are losing money? A simple cost accounting program distributed by Rutgers University Cooperative Extension enables producers to determine the profitability of greenhouse crops. The newest version calculates costs of crops produced outdoors as well as greenhouse crops. New features of the Rutgers Cost Accounting Program include calculating the percentages of each overhead cost, inputting data from the balance sheet and calculating key financial ratios. In addition to analyzing actual costs, the program can be used as a planning tool to analyze the impact of increased energy costs and prices as well as changes in marketing mixes, or other changes producers are considering. The Rutgers Cost Accounting program begins by collecting information typically contained in income statements (or Schedule F) and balance sheets that is readily available to managers. The user then enters information on direct costs of each crop. From this input, the program allocates as many costs as possible to individual crops. The program assigns the remaining unallocated costs from the income statement to each crop on a per square-foot-week basis. The program then calculates information on costs and returns per crop, per unit (pot or flat), and per square foot for each crop, as well as an income statement showing total costs, allocated costs, and unallocated costs. In addition to analyzing their actual costs, managers can use the program as a planning tool to analyze the impact of increased energy costs and prices as well as changes in marketing mixes, or other changes they are considering in their business. Managers can use the software to analyze various strategies to improve the overall profitability of their businesses. This can be done by entering either hypothetical crops into the program or hypothetical changes in the current production system and comparing the results to that system. The program also can be used for student instruction in production and management classes or for extension workshops.

2:45–3:00 pm

A Consumer Survey on Purchasing Waterwise Plant Material

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Research indicates a trend in the western United States where 40% to 60% of all water use by single family residences occurs in the home landscape and that landscapes are overwatered by approximately 40%. The demand for conserving and managing water usage is critical to support, protect and preserve valuable water supplies. Oregon State University Extension Service has launched a statewide waterwise program that invests in teaching Oregonians about water conservation for home and commercial landscapes. The Oregon waterwise program includes several projects with goals to increase awareness of waterwise landscaping and change behavior with landscape practices related to plant selection, landscape design, and irrigation technology. One of the projects included development of a waterwise logo that was used on several promotional pieces including two postcards with a list of waterwise plants (for both the wet and dry sides of the state),

tree tags, and stickers to place on pots in retail nurseries. In addition, a short postcard survey was also developed to be filled out by consumers. The objectives of this project were to determine if waterwise plant tags/stickers 1) influenced consumer purchases and 2) increased awareness or interest in waterwise plants/gardening. Several nurseries participated in this statewide project. Postcards were displayed and plant material was labeled with tags/stickers at each participating nursery. At the point of purchase, consumers were asked to fill out a five question survey regarding their waterwise plant purchase; 103 surveys were returned. Results from the survey indicated that 80% of consumers saw a waterwise plant tag/sticker near or on the plant(s) being purchased. Of those that saw the tag/sticker, 71% reported that it was influential in their choice to buy a waterwise plant(s). Sixty-six percent of consumers were unaware of the plant(s) being waterwise prior to seeing a tag/sticker. The survey also indicated that 79% of consumers were interested in more information on waterwise gardening, and of those 36% preferred the website as their source for waterwise information, followed by publications (21%), displays at nurseries (21%), and plant lists (19%). Suggestions for other sources of information included books, demonstrations, and classes. Some consumer survey comments included "it helped in making my decision" and "great idea – very helpful." Results suggest that this waterwise project was successful in introducing waterwise plants to consumers, influencing their decisions in purchasing plants, and that there is a high level of interest to learn more about waterwise gardening.

Specified Source(s) of Funding: Department, College, State and/or Hatch

Oral Session 35: Lewis
Crop Physiology/Physiology:
Floriculture Crops
Tuesday, 28 July 2009, 2:30–3:45 pm

Moderator: Michelle Jones, jones.1968@osu.edu

2:30–2:45 pm

Phosphorus Remobilization During Developmental and Nutrient Stress-induced Senescence in Petunias

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The programmed degradation of macromolecules during senescence allows the plant to remobilize nutrients from dying to developing tissues. Senescence is the last stage of leaf and petal development and this process can be accelerated by a number of biotic and abiotic stresses. The plant hormone ethylene is the primary regulator of senescence in many plant species. These studies investigated ethylene's role in nutrient remobilization during developmental and nutrient stress-induced senescence in petunia. Only nitrogen and phosphorus levels were found to change significantly from petal opening to the advanced stages of senescence in both pollinated and unpollinated *Petunia × hybrida* 'Mitchell Diploid' (MD) flowers. The largest senescence-related changes in the nutrient content of petals were consistently observed with phosphorus. To further investigate the mechanisms of P remobilization during petal senescence the expression of five high-affinity phosphate transporters was investigated. Only one phosphate transporter (*PhPT1*) was found to be induced during petal senescence. Relative abundance of *PhPT1* in petals increased following treatment with 0.1 $\mu\text{L}\cdot\text{L}^{-1}$ ethylene for 2

hours. The P and N content of petals was determined in ethylene-sensitive MD petunias and transgenic petunias with reduced sensitivity to ethylene (35S::*etr1-1*). When compared to the total P content of corollas on the day of flower opening, P in MD corollas had decreased 74% by the late stage of senescence. In contrast, P levels were only reduced by an average of 32% during *etr1-1* corolla senescence. The N content decreased by 60% in MD and 45% in *etr1-1* corollas. *PhPT1* transcript abundance increased in senescing MD corollas and much smaller increases were detected in *etr1-1* corollas. *PhPT1* transcripts were also detected in petunia roots and leaves and mRNA abundance increased in both organs following P deprivation. Phosphorus deprivation resulted in the induction of *PhPT1* gene expression in the leaves of MD but not *etr1-1* petunias. These experiments indicate that expression of the high-affinity phosphate transporter *PhPT1* is regulated by ethylene in both petals and leaves and *PhPT1* appears to be involved in Pi reallocation during senescence.

Specified Source(s) of Funding: College, State and/or HATCH, Federal competitive, USDA Floriculture and Nursery Research Initiative

2:45–3:00 pm

The Uptake and Partitioning of Nitrogen in *Phalaenopsis Sogo Yukidian*

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The low growth rate and slow response to fertilizer application of *Phalaenopsis* make it difficult to understand its nutrient requirement. In this study, we used stable nitrogen isotope, ^{15}N , to trace nitrogen absorption and partitioning in *Phalaenopsis*. Mature *Phalaenopsis* Sogo Yukidian 'V3' plants were potted in sphagnum moss and fertigated with modified Johnson's solution. The KNO_3 in the solution was partially substituted by K^{15}NO_3 . Both roots and leaves were capable of taking up nitrogen; the uptake efficiency was highest in new roots, lower in old roots, and lowest in leaves. There was no difference on nitrogen uptake efficiency between upper and lower leaf surfaces. After one single ^{15}N application, tissue ^{15}N content reached a plateau about 8 weeks after treatment. These results indicated that sphagnum moss is a substrate good for retaining fertilizer and *Phalaenopsis* has a high efficiency for nutrient utilization. Growing young leaf is the major sink during vegetative growth stage and stalk during reproductive phase. The sink strength of leaves decreased as the leaf age increased. Data revealed that mature leaves and roots act as storage organs and are able to translocate nitrogen to stalks during reproductive phase; this explains why well-grown *Phalaenopsis* can still flower after months of fertilizer cessation.

3:00–3:15 pm

Nutrient Leaching from Garden Mums Fertilized Using Water Soluble Fertilizer, Controlled Release Fertilizer or a Combination Program

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Field grown garden mums (*Chrysanthemum ×morifolium*) are often produced using drip irrigation with water soluble fertilizer (WSF). This

practice can yield high quality plants but may result in nutrient leaching to the soil. Controlled release fertilizers (CRF) have the potential to greatly reduce nutrient leaching. The objective of this experiment was to quantify nutrient leaching and plant growth in response to WSF, or CRF amended with 0, 2, 4, or 6 weeks of WSF (denoted as CRF+0, CRF+2, CRF+4, CRF+6). Rooted cuttings of *Chrysanthemum* 'Helen' were transplanted outdoors into 9.5 inch pan pots containing a commercial peat-based substrate. Plants were irrigated daily (or as needed) using drip irrigation with a 20% leaching fraction. WSF plants were fertigated using a commercially available fertilizer at a rate of 200 to 400 ppm N depending on growth stage. CRF plants were fertilized using substrate incorporated Osmocote Plus 15-9-12 with an 8-9 month release. There were 4 replicates per treatment. During the 10 week production period leachate samples were collected twice weekly and pooled into one weekly sample per plant. Leachate was analyzed for phosphorus, ammonium-nitrogen, and total-nitrogen concentration. Leachate nutrient concentration was significantly affected by fertility treatment and production week. When averaged across the entire sampling interval, WSF plants had more than five times the P and N leachate concentration compared to CRF+0 plants. For example, average P leachate concentration was 22, 55, 75, 91, and 112 ppm, respectively, for CRF+0, CRF+2, CRF+4, CRF+6, and WSF. For CRF treatments that contained added liquid fertilizer (CRF+2, CRF+4, and CRF+6) leachate concentrations were similar to WSF for the weeks that they had added liquid fertilizer. For these treatments, once liquid feed was ended, leachate concentration declined to CRF+0 levels within 1–2 weeks. Plant dry weight was significantly reduced for plants not receiving any liquid feed; and plant diameter was reduced for treatments receiving less than 6 weeks of liquid feed. We conclude that when CRF is used as the primary fertilizer source nutrient leaching can be substantially reduced in garden mum production. However, more work is required to determine a CRF rate that provides optimal plant growth while still reducing nutrient leaching.

Specified Source(s) of Funding: Hatch funds, private donations

3:15–3:30 pm

Use of Compact Fluorescent Lamps to Provide a Long-day Photoperiod to Petunia and Pansy

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An experiment was conducted to assess the efficacy of compact fluorescent (FL) lamps alone or in combination with incandescent (INC) (INC+FL) lamps for providing low intensity long-day (LD) lighting to promote flowering of herbaceous LD plants. The LD plants *Petunia xhybrida* Vilm.-Andr. (petunia) 'Single Dreams Red' and 'Purple Wave' and *Viola xwittrockiana* Gams. (pansy) 'Colossus Yellow' and 'Delta Blue Blotch' were grown in a greenhouse at 20 °C. Plants were grown under a truncated 9-h photoperiod with or without a 6-h day extension (DE; to create a 15-h photoperiod) or a 2- or 4-h night interruption (NI). The DE and NI treatments were provided by INC and FL lamps, alone or combined, at a photosynthetic photon flux of 1.4 to 3.5 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$. *Petunia* 'Wave Purple' did not flower under the SD photoperiod whereas 60% to 100% flowered under the LD treatments at 10 weeks after transplant. Time to flower was most rapid under the INC or INC+FL lighting treatments. In addition, plants under DE and 4-h NI generally flowered earlier than under the 2-h NI. All petunia 'Single Dreams Red' plants flowered within 65 days after transplant, although flowering occurred earliest under the DE and 4h-NI when provided by the INC or

INC+FL lamps. In addition, INC lighting promoted stem elongation of both petunia cultivars. In pansy, all LD treatments promoted flowering of 'Colossus Yellow' compared to plants under short days; 'Delta Blue Blotch' was less responsive to photoperiod. Collectively, our results indicate that flowering of some LD plants is delayed when FL lamps are used alone to create an artificial LD.

3:30–3:45 pm

Bedding Plants Responded Differently to Salinity Stress

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Bedding plants are extensively used in landscapes in the United States. As high quality water supply becomes limited in many parts of the world, recycled water is being encouraged to irrigate landscapes. Therefore, information on salt tolerance of bedding plants is of increasing importance. Seedlings of ten species were transplanted to 2.6 L or 10 L pots containing potting mix according to their mature sizes. Plants were grown in a shadehouse with a shade cloth of 25% light exclusion and irrigated with solution at 1.5, 2.5, 3.5, 5.0, or 7.0 dS/m created by adding salts to tap water to simulate the composition of local reclaimed water. After three months of treatments, shoot dry weight and growth index were reduced by elevated salinity. The magnitude of reduction varied with species. The salinity thresholds in which growth reduction occurred were 3.5 dS/m for angelonia cultivars and ornamental pepper 'Calico', 3.5 to 5.0 dS/m for helenium, helichrysum and plumbago. Shoot dry weight and growth index of ornamental pepper 'Black Pearl' and vinca 'Titan' decreased linearly as salinity level increased. All plants survived, regardless of treatment, except for ornamental pepper 'Purple Flash'. The mortality rate of 'Purple Flash' was 17%, 17%, 33%, 50%, and 100%, respectively, when plants were irrigated with solutions of 1.5, 2.5, 3.5, 5.0, and 7.0 dS/m. Since mortality occurred at the beginning of the study, elevated salinity may not be the sole cause. Physiological responses such as ion uptake, osmotic potential, and cell membrane stability to salinity treatment varied with species. Further studies are needed to confirm the relative salinity tolerance of these species obtained from this experiment.

Specified Source(s) of Funding: RGBI of CSREES-USDA

Oral Session 36:

Chouteau

Crop Physiology/Physiology: Fruit Crops Tuesday, 28 July 2009, 2:45–4:30 pm

Moderator: Lynnell E. Teichman Sage

2:45–3:00 pm

Organic Acid Metabolism and Nitrogen Metabolism in the Leaves of Transgenic Apple Trees with Decreased Sorbitol Synthesis

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Sorbitol is a main photosynthetic end-product and a primary translocated

form of carbon in apple and many other tree fruits of the Rosaceae family. Sorbitol synthesis shares the same hexose-phosphate pool with sucrose synthesis in the cytosol of source leaves and the reaction catalyzed by aldose-6-phosphate (A6PR) is the limiting step. When 'Greensleeves' apple was transformed with the cDNA of A6PR in the antisense orientation, A6PR activity in mature leaves was decreased to approximately 15% to 30% of the untransformed control, and consequently sorbitol synthesis was significantly decreased. As a result, both glucose 6-phosphate and fructose 6-phosphate accumulated in the cytosol at the expense of inorganic phosphate, leading to up-regulation of starch synthesis without altering CO₂ assimilation. The objective of this study was to determine how the metabolism of organic acids and amino acids responds to decreased sorbitol synthesis in the leaves of the transgenic trees. The leaves of the transgenic plants were found to have higher concentrations of phosphoenolpyruvate, pyruvate, citrate, 2-oxoglutarate, succinate and oxaloacetate, higher activities of key enzymes in glycolysis and TCA cycle such as ATP-phosphofructokinase, PPI-phosphofructokinase, phosphoenolpyruvate carboxylase, pyruvate kinase, aconitase, isocitrate dehydrogenase and NAD-malic enzyme and higher concentrations of 12 amino acids (e.g. Asp, Asn, Glu, Gln, Ser, etc.) out of the 20 free amino acids measured. Additionally, when the detached leaves of the untransformed control were fed with 10 mM mannose to lower the inorganic phosphate pool, some key enzymes in organic acid metabolism such as phosphoenolpyruvate carboxylase, ATP-phosphofructokinase, PPI-phosphofructokinase, isocitrate dehydrogenase, NAD-malic enzyme showed a similar trend as found in the transgenic plants. These results support our hypothesis that both organic acid metabolism and amino acid metabolism are up-regulated in the transgenic plants with decreased sorbitol synthesis.

Specified Source(s) of Funding: Cornell Agricultural Experiment Station and Department of Horticulture

3:00–3:15 pm

Inhibition of Sorbitol Synthesis in Leaves Altered the Primary Metabolism in Transgenic 'Greensleeves' Apple Fruit

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Antisense suppression of aldose-6-phosphate reductase decreased the concentration of sorbitol but increased the concentration of sucrose in leaves of the transgenic 'Greensleeves' apple trees. Since most of the carbon used by fruit is supplied from leaves, we investigated the metabolism of sugars, organic acids, and amino acids in the fruit of the transgenic trees. The concentration of sorbitol was lower whereas that of sucrose, glucose, galactose, and raffinose was higher in the transgenic fruit than in the untransformed control, and these differences became larger as fruit developed. The concentration of fructose and starch was similar in the transgenic and non-transgenic fruits. Sorbitol dehydrogenase activity was lower; the activity of acid invertase was slightly higher, whereas the activity of neutral invertase and sucrose synthase remained the same in the transgenic fruit. The concentration of organic acids such as malic acid, fumaric acid, 2-oxoglutaric acid, and oxaloacetic acid was lower but citric acid concentration was higher in the transgenic fruit. Respiration rate and the activity of citrate synthase, cis-conitase and NADP-malic enzyme were higher in the transgenic fruit. The concentration of amino acids such as aspartic acid, alanine, serine, proline, threonine, and methionine was higher in the transgenic fruit. The activity of NADH-dependent glutamate synthase, glutamate dehydrogenase, and asparaginase was higher in the transgenic fruit at the early developmental stages. These results indicate that inhibition of

sorbitol synthesis in leaves altered not only carbohydrate metabolism but also the metabolism of organic acids and amino acids in fruit.

Specified Source(s) of Funding: Cornell Agricultural Experiment Station

3:15–3:30 pm

Regulation of Return Bloom in Honeycrisp Apple: Fruit Position and Seed Number

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The apple variety 'Honeycrisp' tends to be strongly biennial. More than seven fruit per cm² trunk cross sectional area, TCA, results in few flowers the next spring. While adjustment to four to seven fruit per TCA appears optimum, it is not sufficient to assure adequate return bloom for all trees. We hypothesize the king fruit (from the center flower of a fruit bud) has greater influence on return bloom than lateral fruit (from an outer flower) manifested either through growth rate or seed production of GA (gibberellic acid), which inhibits flower bud initiation (FBI) in that spur for the next season. Experiments were initiated in the spring of 2008 on two Michigan sites of 'Honeycrisp' on M-9 rootstock: a grower orchard in the southwest (SW) at 1 m × 4 m, and the west central Clarksville Horticultural Experiment Station (CHES) at 1.5 m × 4.5 m (1998). At full bloom, every flowering spur on entire trees were hand thinned to a single king flower or a single lateral flower. At fruit set (2–3 weeks later), crop load was adjusted to range between four to six fruit per TCA. From fruit set, 100 fruit per treatment were measured monthly (SW) and bi-weekly (CHES) to determine fruit growth rate. At harvest, fruit size, size and weight distributions, seed number and bitter pit data were collected. Lateral fruit had more seeds per fruit than king fruit at both locations. Seed number ranged from 1–14, and averaged 7.1 for laterals and 6.4 for king fruit at SW, and 9.0 and 7.7, respectively, at CHES. Lateral fruit were larger than king fruit. There was no significant difference in crop load. Season-end fruit weight was not greatly affected by seed number. Bitter pit was inversely related to seed number and positively related to fruit size. The results were surprising in that king fruit are usually larger and have more seeds than lateral fruit in most varieties. In addition, the number of locules (3–7) and number of viable seeds (1–14) were more variable than found in other varieties. The number of seeds is important in relationship to return bloom because they produce GA, which is known to inhibit flower bud formation in apple. Flowering data in Spring 2009 will relate return bloom to previous crop size, fruit growth rate and seed number.

Specified Source(s) of Funding: Michigan State Horticultural Society and G.R.E.E.E.N

3:30–3:45 pm

Native Variation of Flowering and Fruiting in Spur-type 'Delicious' Apple

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Native variation is a common physiological trait in polycarpic woody

species. This condition in apple often limits the value of some otherwise desirable cultivars, including 'Delicious'. Irregular cropping in 'Delicious' usually develops slowly as the trees mature, but may be dramatically induced by severe stresses, e.g. frost, drought, biotic and over-cropping. We followed temporal and within year variation of flower density, yield and fruit size on a highly uniform population ($n = 95$) of Redchief 'Delicious'/M.106 growing on a virgin site over a period of 8 years. Crop load was adjusted by hand in the first year to establish a tree population with a normally distributed fruit load. Thereafter, all trees received identical cultural practices (no further crop load adjustment) for the duration of the study. We rated bloom (1 to 10, highest) and measured yield and fruit size on a per tree basis annually. The temporal profiles for bloom and yield show four periods of bloom and yield above and below the population mean. There were two, two-year periods of insignificant biennial alternation for both measurements. The annual range in bloom density varied from 3.0 to 8.1 and in yield from 54 to 168 kg/tree, a 2.7-fold difference in bloom and 3.1-fold difference in yield. Irregular cropping was more pronounced when expressed as a percentage deviation from the population mean or percentage change from the previous season. The intensity of alternation (Hoblyn's Intensity Index) ranged from 0.01 to 0.37 for bloom and from 0.04 to 0.37 for yield. There was no significant relationship between yield and incremental diameter growth of the trunk in the same or following year. Annual mean fruit weight was inversely related to annual yield, but percentage of small (51 mm to 63 mm) or large (70 mm to 82 mm) fruit were not consistently related to yield. The within year variation (synchrony) varied widely with the coefficient of variation (CV) ranging from ~11 % to ~66 % for bloom and ~11 % to ~42 % for yield. The highest degree of synchrony in bloom (~11 %) occurred in the tree population which had the highest CV in yield the previous season. The relationship of performance of individual trees relative to the population and significance in selection of trees for experimental studies on flowering and fruiting will be discussed.

Specified Source(s) of Funding: Michigan Apple Research Committee

3:45–4:00 pm

Abscisic Acid, Ethylene, and Polygalacturonase Are Involved in Young Fruit Abscission Induced by NAA and Shading in 'Golden Delicious' Apples

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Expression of genes for abscisic acid (ABA) biosynthesis, ethylene biosynthesis, ethylene perception and cell wall degradation in fruit and fruit abscission zones was studied in relation to young fruit abscission after treatment with Naphthaleneacetic acid (NAA) at $15 \text{ mg} \cdot \text{L}^{-1}$ and shading in 'Golden Delicious' apples (*Malus × domestica*). Both NAA and shading enhanced fruit ethylene production and young fruit abscission. NAA enhanced the expression of 1-aminocyclopropane-1-carboxylate (ACC) synthase genes (*MdACS5A* and *MdACS5B*), whereas shading increased *MdACS5A* and *MdACS5B* expression in fruit abscission zones but not in fruit cortex. Both NAA and shading increased the expression of ACC oxidase gene (*MdACO1*) in fruit cortex and fruit abscission zones. Ethylene receptor genes (*MdETR1a*, *MdETR1b*, and *MdERS1*) were up-regulated by shading in fruit cortex and fruit abscission zones. NAA increased the expression of *MdETR1a*, *MdETR1b*, and *MdERS1* in fruit cortex but had a little or no effect on their expression in fruit abscission zones. The expression of genes related to cell wall degradation (*MdPG2*) and ABA biosynthesis (*MdNECD1*) in fruit abscission

zones was increased by NAA and shading. Our results suggested that ABA and ethylene biosynthesis is involved in young fruit abscission caused by NAA and shading in 'Golden Delicious' apples.

4:00–4:15 pm

Regulated Deficit Irrigation of Montmorency Tart Cherry

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Regulated deficit irrigation (RDI) has been used in some fruit crops to improve water use efficiency, to control vegetative growth, and to maintain or improve fruit quality. The effects of RDI on growth, yield and fruit quality of 'Montmorency' tart cherry (*Prunus cerasus*) were studied during the 2007 and 2008 seasons. Five irrigation treatments were imposed during stage III fruit development on replicated plots in a uniform mature commercial orchard. Irrigation treatments supplied approximately 30% to 115% of crop evapotranspiration (ET_c) from pit hardening to harvest. Midday stem water potential at harvest was closely correlated with irrigation levels and ranged from 0.8 to 1.2 MPa. Harvested yield did not differ significantly among irrigation levels. Fruit size differed among treatments and years, but only the lowest irrigation level had significantly more undersized (cull) fruit. Fruit soluble solids content was inversely proportional to irrigation level. The effects of RDI during stage III fruit development on tree health are not yet clear. However, RDI treatments in 2007 did not result in noticeable flower doubling, and the severity of visible bark splits resulting from mechanical harvest were inversely correlated with irrigation level. These results suggest that some level of RDI may improve fruit quality and reduce accumulated trunk injury in 'Montmorency' tart cherry.

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

4:15–4:30 pm

Transcriptional Regulation of Cell Cycle Genes During Fruit Development in Apple

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Fruit growth in apple is facilitated by the coordinated progression of cell production and cell expansion. Molecular mechanisms involved in the regulation of cell production during early fruit growth are not well understood. Core cell cycle genes control progression through the cell division cycle and may therefore regulate cell production during early fruit development. Fruit growth, cell production, cell expansion and cell cycle gene expression were characterized in 'Gala' apples from 11 days before bloom until harvest. The relative fruit growth rate was low before bloom, was rapidly induced after pollination and fertilization, and subsequently decreased at later stages. Analysis of cell production indicated a large increase in the relative cell production rate (RCPR) at 11 days after bloom (DAB) followed by a gradual decline until 32 DAB. Cell production continued during later stages of fruit development, but at a lower rate. Mining publicly available apple EST databases resulted in the identification of 77 core cell cycle genes including cyclins, cyclin-dependent-kinases (CDKs), CDK inhibitors (KRPs), CDK activating kinases, E2F-like transcription factors, retinoblastoma-related genes and a WEE kinase. Expression of 65 of these core cell cycle genes was studied during 15 stages of fruit development using quantitative RT-PCR. Majority of the core cell cycle genes exhibited greater than 3-fold change in expression during apple

fruit development. The 32 core cell cycle genes, including CDKBs, A2-, B-, and D3-type cyclins, were expressed at higher levels during early fruit development and at much lower levels during later stages. Among these, 14 genes exhibited expression patterns positively correlated with changes in RCPR. The above genes were induced by 2- to 4-fold at 8–11 DAB, concomitant with an increase in RCPR. These data suggest pollination and fertilization dependent activation of cell cycle gene expression and subsequently, an increase in cell production. Interestingly, these genes also exhibited a decline in expression between 11 days before bloom and 3 DAB indicating active suppression of cell cycle activity, cell production and fruit growth prior to pollination and fertilization. Additionally, 5 genes including a KRP exhibited negative correlation with RCPR. These data suggest dynamic regulation of cell production by the core cell cycle transcriptome during fruit growth. Core cell cycle genes with expression patterns correlated with changes in cell production may have potential roles in regulating early fruit growth and final fruit size.

Specified Source(s) of Funding: Hatch funds

Oral Session 37: Jefferson A
Horticultural Crops Culture and Management:
Vegetable Crops 2
Tuesday, 28 July 2009, 2:45–4:45 pm

Moderator: Harlene Hatterman-Valenti, h.hatterman.valenti@ndsu.edu

2:45–3:00 pm

Effect of Simulated Glyphosate Drift on Irrigated Potato Growth and Yield

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Field research was conducted to evaluate Russet Burbank growth the same year simulated glyphosate drift occurred to irrigated potatoes. Glyphosate was applied at rates one-third, one-sixth, and-twelfth, and one-twenty-fourth the standard use rate (0.25, 0.125, 0.0625, and 0.0313 lb ae/A) at the tuber hooking (TH) 0.25 lb ae/A only, tuber initiation (TI), early tuber bulking (EB), and late tuber bulking stage (LB). In 2007, total yield from potatoes treated with glyphosate at the TH stage was significantly lower than any other treatment (88 cwt/A). This was followed by potatoes treated with 0.25 lb/A glyphosate at the TI stage (187 cwt/A). Only plants treated with 0.25 lb/A glyphosate at the TH, TI, and LB stages or with 0.125 lb/A glyphosate at the TI stage yielded less marketable tubers than the untreated due to an increase in cull tubers. Fewer 4 to 6 oz tubers were produced when potatoes were treated with 0.25 lb/A glyphosate at the TH stage. Likewise, fewer 6 to 10 oz tubers were produced when potatoes were treated with 0.25 lb/A glyphosate at the TH and TI stages. Fewer >10 oz tubers were produced when plants were treated with 0.25 lb/A glyphosate at the TH, TI, or LB stages, or when treated with 0.125 lb/A glyphosate at the TI stage. In 2008, total yield from plants treated with 0.25 lb/A glyphosate at the TH, TI, and EB stages or with 0.125 lb/A glyphosate at the TI and EB stages were significantly lower than any other treatment, except 0.063 lb/A glyphosate at the TI stage. Results were similar for marketable tubers except that plants treated with 0.063 lb/A glyphosate at the TI stage also had significantly less marketable tubers due to an increase in cull tubers. Fewer 4 to 6 oz tubers were produced when potatoes were treated with 0.25 lb/A glyphosate at the TH, TI, and EB stages. Likewise, fewer 6 to 10 oz tubers were produced when potatoes were treated

with 0.25 lb/A glyphosate at the TH, TI, and EB stages, or with 0.125 lb/A glyphosate at the TI and EB stages, or with 0.063 lb/A glyphosate at the TI stage. Fewer >10 oz tubers were produced when plants were treated with 0.25 lb/A glyphosate at the TH, TI, or LB stages, or when treated with 0.125 lb/A glyphosate at the TI and EB stages, or when treated with 0.063 lb/A glyphosate at the TI stage.

3:00–3:15 pm

Hill Geometry Influence on Irrigated Russet Burbank Yield and Grade

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Field research was conducted the past four years at the Northern Plains Potato Grower's Association Irrigation Research site near Tappen, ND to evaluate hill shape influence on 'Russet Burbank' growth, yield and tuber quality. Treatments consisted of: 1) no hill, 2) standard "A" shaped hill, 3) furrow planting, 4) "M" shaped hill, and 5) flat top hill. No other cultivation occurred after hills were formed. Furrow planting consisted of seed pieces planted in furrow rows that had hills made between the planted rows with disk openers. Hill formation for the remaining treatments with the exception of the no hill treatment occurred through modifications to the disk hiller. Every 2 weeks, beginning shortly after tuber initiation, 5 plants (tubers, roots, and shoots) were dug per treatment in each rep and measured, counted, and weighed. Treatment effect on plant growth, tuber yield, and tuber quality varied between years. It was obvious that weather greatly influenced hill shape's effect on measured variables. For example, the standard "A" shaped hill had the greatest total yield during the cool growing conditions of 2004, but had the lowest total yield in 2007 when the weather was hot and it was difficult to maintain targeted soil water levels. In 2007, plants from the furrow planting, "M" shaped hill, and flat top hill treatments had greater yields than the total yield from plants in no hill or standard "A" shaped hill treatments. The furrow planting generally resulted in a lower tuber set and thus fewer tubers per plant at harvest, but a higher percentage of these tubers weighed 6 oz or greater. French fry sugar end percentage also varied amongst treatments depending upon the year. However, fries from the standard "A" shaped hill treatment tended to have more sugar ends.

3:15–3:30 pm

A Survey of High Tunnel Crop Producers in the Central Great Plains

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A multidiscipline and multiinstitutional high tunnel extension and research project was initiated in the Central Great Plains in 2002. High tunnel producers in the region were surveyed from 2002–2008 to evaluate production and marketing practices and to determine research and extension priorities. Rapid adoption of high tunnels as season extension tools was observed over the course of this project with growers producing a diversity of crops with high profit potential per land area. Most high tunnel crops were direct marketed locally through community

farmer's markets. Gross revenue exceeded \$2.00/ft.² of high tunnel area per year. Grower respondents indicated that knowledge was less of an impediment to expanded high tunnel production over the course of the project, yet labor and capital could often be limiting factors to high tunnel adoption. Temperature management within the high tunnel was cited as the most challenging production issue.

Specified Source(s) of Funding: USDA IFAFS

3:30–3:45 pm

Photoselective Shade Netting for Improving Vegetable Productivity, Pre- and Postharvest Quality and Pest Control

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Photoselective shade-netting is an emerging approach in protected cultivation. The photoselective net products are based on the introduction of various chromatic additives, as well as light dispersive and reflective elements into the netting materials during manufacturing. They are designed to selectively screen various spectral components of solar radiation (UV, visible, and beyond), and/or transform direct light into scattered light. The spectral manipulation is aimed to specifically promote desired physiological responses, while the scattering improves the penetration of the modified light into the inner plant canopy. The photoselective netting concept was studied in bell pepper (*Capsicum annuum* L.) cultivation in the Negev semi-arid area in Israel during the last four years. All nets were of a similar shading capacity (30% to 35%) in PAR. The Red, Pearl and Yellow shade nets (ChomatiNets[®]) were all found to increase pepper productivity, expressed by the number of fruits produced per plant as well as Ton/Ha, by 15% to 40%, compared with the traditional black shade net. Although the net holes allow free passage of small pests, the rates of pest infestations and vector-borne viral diseases were affected by the color and reflectivity of the nets. For example, the incidence of an aphid-borne cucumber mosaic virus disease was significantly lower under the Pearl (10 folds) and Yellow (3 folds) nets, compared to black net. Whiteflies penetration and establishment was 2 fold lower under the Yellow, compared to the black net. All tested pests did not distinguish between the Red and black nets. The reduction in viral infection under the Pearl and Yellow nets resulted in higher percentage of export-quality fruit produced under these nets, relative to either the Red or black nets. The photoselective reduction of pest infestation and viral diseases may lead to reduced pesticide application by growers. In addition, the pepper fruit seem to “remember” its growth shading conditions during post-harvest storage and shelf-life. Thus, fruit harvested from plants grown underneath the Pearl or Yellow nets, and then stored at 7 °C for 2 weeks plus 3 days at 20 °C (simulating sea transport and marketing to Europe), developed significantly less decay, compared with the fruit grown under the black shade net. The results might reflect a reduced occurrence of fungal spores under the Pearl and Yellow nets, and/or an enhanced natural resistance of the plants grown

under these nets to pathogens. The photosselective, light-dispersive shade nets provide a new, multi-benefit tool for crop protection.

3:45–4:00 pm

Production and Fruit Quality of Specialty Melons Grown in a Passively-ventilated Greenhouse

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As demand for higher quality fruit continues, increases in specialty melon (*Cucumis melo* L.) varieties with high soluble solids content (SSC) and longer shelf-life have also risen. In an effort to provide consumers with high-quality fruit, seed companies have focused on promoting specialty melons to both field and greenhouse producers. Due to lack of commercial greenhouse melon growers in the United States, seed companies in N. America lack information regarding production and quality of greenhouse-grown specialty melons. The objective of this study was to evaluate yield and fruit quality of specialty melons grown in a passively-ventilated greenhouse. During Spring 2008, 26 melon lines were evaluated at the University of Florida Protected Agriculture Greenhouse, located in Citra, FL. Of the 26 lines, 14 were ‘Charentais’-type cantaloupes (CT), four ‘Galia’-type muskmelons (GT), three Magenta-type melons (MT), three shipper-type cantaloupes (SC), one true ‘Galia’ muskmelon, and one Piel de Sapo melon. These lines were supplied by Western Seed, Nunhems, Zeraim Gedera and Hazera seed companies. The study was conducted in a randomized-complete-block design with three replications. Plant density was 2.5 plants/m². Seedlings were transplanted on 10 March 2008. Harvests occurred 11 May through 16 June 2008. Data were recorded for days to harvest (DTH), fruit yield and quality (weight, size, flesh thickness, SSC, and internal firmness). Differences were recorded for all variables measured except total kg/plant and total kg/m². Lines WS5019 (CT) and WS5020 (CT) averaged the lowest DTH at 38, while Piel de Sapo remained on the vine the longest with 58 DTH. Average fruit number per plant varied from 5.3 fruits [WS5031 (CT)] to 1.7 fruits [WS6062583 (SC)]. Average fruit weight ranged from 0.57 kg [WS5031 (CT)] to 2.3 kg [WS6062583 (SC)]. WS5021 (CT) produced fruit with the smallest length, width and flesh thickness while [WS6062583 (SC)] was among the largest fruits. Total fruit yield (kg/m²) was similar among all lines and ranged from 6.5 (‘Galia’) to 11 kg/m² [NUN8511 (SC)]. SSC was greater than 10 °Brix for all lines except ‘Elario’ (GT) and WS6062583 (SC) (mean 7.4 °Brix). ‘Galia’, WS5019 (CT) and WS6062583 (SC) had the least firm fruit (mean 12.8 N), while WS5026 (CT) produced the firmest fruit (54 N). Specialty melons may have a place for greenhouse growers, especially in Florida where high humidity and rainfall can reduced fruit quality, thus, U.S. seed industries must be prepared to supply the best types of melons and cultivars possible.

4:00–4:15 pm

Can Parboiled Rice Hulls Replace Perlite in Hydroponic Substrates?

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Hydroponic production systems utilizing substrate has traditionally used perlite, a non-renewable resource, as a major component of the substrate. Perlite is used to provide aeration and drainage and has the benefits of being sterile, a neutral pH, lightweight and disease free. The main disadvantage of perlite is it is non-renewable and does not decompose. Parboiled rice hulls (PBH), a renewable resource from rice production, are used in substrates in the ornamental and nursery industries. However, no research exists on PBH as a replacement for perlite in hydroponic production. Our question was if PBH could be used as a replacement for perlite in a hydroponic substrate. A vertical hydroponic system with two substrates consisting of approximately 85% perlite or PBH and 15% coir was used. Two towers with eight pots each were planted with parsley, basil, peppermint, nasturtiums and pansies for each substrate. Herbs were harvested weekly when the petiole or stem length exceeded 6–8 inches. Flowers were harvested when petals were open. Fresh weight and flower/stem number of the four plants in each pot per tower were weighed and counted at each harvest from mid-April to mid-July. No statistical differences were found between the two substrates for fresh weight or flower/stem number for any crop. Fresh weight per tower was 4.8 kg of basil, 3 kg of peppermint, 2.7 kg of parsley and 1.9 kg of pansies and nasturtiums over the 3 months. Thus, PBH can be used as a renewable substrate component for hydroponic production.

4:15–4:30 pm

Improvement of Vegetable Production Using Quartz Porphyry Treated Nutrient Solution: An Emerging Technology for Future Food Production

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As the world population continues to grow there is great pressure to find land that is fit for irrigation and agriculture, water, energy, and biological resources to provide an adequate supply of food. But because of use of unviable technology, population pressure and wasteful agricultural practices, efforts to increase food production have had an adverse impact on the environment. New production technology for high quality and high quantity agricultural products, quality irrigation water should be considered, and hydroponics can be used to improve water use efficiency. Quartz porphyry (QP) is a kind of natural rock that have additional negative charge (pH-dependent charge) used in the study in treating nutrient solution for improved cultivation of komatsuna (*Brassica rapa* L. nothovar) vegetable. During greenhouse cultivation in this experiment, pH of the nutrient solution decreased anomalously in higher rate at control in the initial days of experiment, while pH were not changed significantly in the same days at test, and then decreased linearly. ORP changed antagonistically in between test and control during the whole cultivation days. Electrical conductivity (EC) increased linearly in each experimental day at control and test. The

production of komatsuna vegetables improved in receiving QP treated nutrient solution (test) compare to the control. The treatment with QP in the nutrient solution reduced excessive concentrations of NO_3^- and SO_4^{2-} ions which caused the decrease of salinity and toxicity effects that might be some of the factors for improvement of plant production. Re-circulation of water with QP particles in hydroponics cultivation reduces irrigation amount and nutrient application improved efficient use of mineral nutrients and reduced the contamination of water.

Specified Source(s) of Funding: Not yet decided

4:30–4:45 pm

Protected Cultivation in Turkey

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Turkey is situated at the crossroads where three continents, Asia, Europe, and Africa, are closest to each other, and it is surrounded by sea on three sides. Thus, throughout history, it has been one of the important centers of civilization, agriculture, transport, and trade. Due to its climatic conditions and location, almost all temperate and sub-tropical horticultural crops can be grown in Anatolia. Vegetable growing is one of the most important activities in agriculture and horticulture. The total vegetable production is nearly 30 million tons and the production area is approximately 1.2 million ha. Under cover vegetable growing is a traditional production system in Turkey, especially in the Mediterranean coastal region. It is estimated that 3.7 million metric tons of vegetables are from the protected cultivation. Crop production under cover cultivation has increased significantly over the last two decades and the total area of protected cultivation is now over 53 thousand hectares. Majority of the greenhouses (80%) are covered with plastic films, and the remaining 20% with glass. Tomato comes the first line with 47% in total greenhouse production. Cucumber, pepper, and eggplant follow tomato with the percentages of 32, 9, and 7, respectively. The rest are green bean, lettuce, melon, squash, with the percentage of 5. Current production levels are satisfactory for domestic consumption, despite same disequilibrium between seasons, regions and crops. Increase and development in vegetable production should be considered in parallel to improvements in factors affecting export.

Specified Source(s) of Funding: part of my expenses funding by my university

Oral Session 38:

Field

Crop Physiology/Physiology: Environmental Stress

Tuesday, 28 July 2009, 3:15–5:00 pm

Moderator: Gary W. Stutte, garyw.stutte@nasa.gov

3:15–3:30 pm

Evaluation of *Acer truncatum* Germplasm for Use in Urban Landscape Plantings

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Maples are an important tree in the nursery industry, and have been a cornerstone in the urban tree population. Species diversity is a key to successful landscape plantings; however, the stressful conditions of urban environments limit the number of species that can be utilized. Currently in many urban environments only a handful of species comprise the vast majority of planted trees. The goal of this project is to

select an *Acer truncatum* specimen suitable for use as an urban street tree and thus broaden the palate of trees available for urban plantings. *Acer truncatum* have excellent potential for use as street trees due to their: cold hardiness (in zone 4b); visual appeal and good fall color; limited maximum height which makes it ideal for under-wire planting; and successful use as a street tree in Beijing and other areas of China. *Acer truncatum* are currently available in the trade but with minimal selection, and little data beyond anecdotal evidence have been collected. Cornell University currently maintains a large genetic resource of *Acer truncatum* that were collected internationally from 24 seed and wild sources in 1997. The ecotypes in this study displayed considerable variability of traits. Substantial differences have been observed in leaf morphology, fall coloration, and rootability of the various ecotypes. 3-year old potted seedlings were subjected to repeated drought cycles in a greenhouse to look for differential physiological performance under drought stress conditions. Initial screening was carried out in using chlorophyll fluorescence measurements, with the two ecotypes with the lowest fluorescence values and two with the highest fluorescence values selected for subsequent drought studies to characterize the drought performance range of the germplasm at Cornell. Results from rootability, morphology and gas exchange investigations will be presented.

3:30–3:45 pm

Growth and Quality of Lettuce Cvs. Outredgeous and Flandria Under Hypobaric Conditions

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Future space missions will likely include plants to provide fresh foods and bioregenerative life support capabilities. Current space craft such as the International Space Station operate at 1 atm (101 kPa) pressure but future missions will likely use reduced pressures to minimize gas leakage and facilitate rapid egress (space walks). Plants for these missions must be able to tolerate and grow reliably at these reduced pressures. We grew two cultivars of lettuce, cv. Flandria (green bibb type), and cv. Outredgeous (red, loose-leaf type), under three pressures: 96 kPa (ambient control), 67 kPa (2/3 atm), and 33 kPa (1/3 atm) for 21 days in rockwool using recirculating NFT. Each treatment was repeated three times using a different hypobaric chamber each time. Lighting was provided with metal halide lamps at 300 $\mu\text{mol m}^{-2} \text{s}^{-1}$ PPF for a 16-h photoperiod at 22 °C. Oxygen was maintained at 21 kPa (equal to 21% at 1 atm) and CO₂ at 0.12 kPa (equal to 1200 ppm at 1 atm).

Leaf area for cv. Outredgeous was reduced 20% and 38% at 67 kPa and 33 kPa, while shoot fresh mass was reduced 22% and 41% at 67 kPa and 33 kPa when compared to control plants at 96 kPa. Leaf area for cv. Flandria showed no difference between 96 and 67 kPa but was reduced 31% at 33 kPa, while shoot fresh mass was reduced 6% and 27% at 66 kPa and 33 kPa compared to 96 kPa. Previous studies with other cultivars of lettuce showed little change in growth across this range of pressures, suggesting responses may vary among genotypes and / or ancillary environmental conditions. Collectively the findings suggest further testing is needed to understand atmospheric pressure effects on plant growth.

3:45–4:00 pm

Dose-response Studies Assessing the Impact of Atmospheric Ozone on Greenhouse Crops

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Worldwide the horticulture industry has become increasingly threatened by air pollutants, especially the pervasive and highly oxidizing gaseous pollutant ozone (O₃) which detrimentally impacts forest, agronomic and horticultural crops. Our prior work documented dangerously elevated levels of ozone exceeding 50 ppb within commercial greenhouses; indoor levels often were greater by up to 1.7-fold that of outdoor ambient air. Here we report biological-assessment results of dose-response studies evaluating the effects of ozone on the growth and development of economically important greenhouse crops. Also reported is the engineering design and implementation of the specialized plant-growth research facility required for these studies. It consists of ten sealed acrylic plant chambers (107 L each) which can be fumigated with ozone-laden air (42 L/min) at prescribed concentrations (0, 40, 80, 120, and 160 ppb O₃). Individual chambers are supplied with conditioned air proportionally blended with ozonated air drawn from a central plenum which is maintained at a fixed concentration ($\pm 5\%$) over week-long intervals by electronic feedback control of an ozone generator/monitor instrumentation system. The plant chambers, with automated subsurface irrigation, are installed within a 2.7 m \times 2.7 m phytotron room which controls lighting, temperature and relative humidity. Studies in the facility have documented the effects of ozone on the development of selected plants, viz., petunia, marigold, impatiens, tomato, and lettuce. Parameters evaluated were plant dry-matter accumulation, leaf area, shoot-to-root mass ratios, chlorophyll fluorescence, flowering, and appearance of foliar lesions. Studies assessed ozone effects during plug production (from sown seed to plug size), and for production of plants from plugs to 10-cm pots.

4:00–4:15 pm

Alternate and Fixed Partial Rootzone Drying Save Water in Citrus

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We evaluated effects of alternate and fixed partial root zone drying (PRD) on leaf photosynthesis and water use efficiency (WUE = photosynthesis per transpiration) of split-root 'Carrizo' citrange seedlings

growing in autoclaved fine sandy soil in a green house. There were three treatments: 1) a well watered control where both root zone halves were well watered (WW) with 50% ET_c (total = 100% ET_c), 2) one half of the root zone consistently irrigated with 100% ET_c while the other received no water (fixed PRD = FPRD), or 3) one half of the root zone irrigated with 100% ET_c while the other was allowed to dry but the wet and dry halves were regularly switched (alternated PRD = APRD). Shoot growth did not differ among treatments. APRD and WW plants maintained similar patterns of root growth whereas the FPRD wet side resulted in the highest root growth and length. There were no treatment effects on specific root length (m g⁻¹). Root length remained at the same levels in WW and FPRD dry side. Transient drought stress tended to increase net assimilation of CO₂ (A_{CO₂}) and leaf transpiration as midday gas exchange rates were higher before irrigation than after irrigation. In addition, leaves above the dry side of the FPRD and above the temporarily dry side of the APRD had higher net gas exchange than WW plants. Leaf WUE did not differ among treatments but APRD and FPRD seedlings used 1.8% to 8.5% less water than the WW seedlings.

4:15–4:30 pm

Effect of Soil Moisture Level on Root and Shoot Growth of *Ligustrum japonicum* and Their Relationship to Free Amino Acid to Nonstructural Carbohydrate Ratios

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Ligustrum japonicum grown in 11.0 L containers were transplanted into elevated cross-shaped rhizotrons using a commercial container substrate. After a short acclimatization phase, plants were subjected to two constant moisture levels, 30 and 70% of drained saturated capacity. Substrate moisture levels were maintained using capacitance probes for four months after transplanting. Capacitance probes were relocated approximately every three weeks to the edge of the actively growing root tips. Both root and shoot tips were sampled periodically for free amino acids and total nonstructural carbohydrates. The effect of soil moisture levels on root and shoot growth will be reported. Changes in the free amino acid to nonstructural carbohydrate ratios will be discussed in relationship to episodes of root and shoot growth.

4:30–4:45 pm

Defining Post-flood Survival of Planted Oak Seedlings Using Odds Ratios

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For many planting scenarios, it is desirable to estimate the number of seedlings that need to be planted on flood prone sites to achieve management goals, based upon species flood tolerance ratings and desired stocking levels. However, previous assessments of flood tolerance for a range of oak species used in such plantings in Missouri have been inconsistent. Therefore, the objective of this study was to assess the flood tolerance of seven different oak species by examining the survival rates of newly planted seedlings in response to four flood treatments over two sampling dates. A total of 2713 one-year-old seedlings of

seven native oak species were planted in an outdoor, multi-channel flood tolerance laboratory located at the University of Missouri Horticulture and Agroforestry Research Center in New Franklin, MO in March 2005. End of season survival was determined in September 2005 (15 weeks post-flood) and in June 2006 (45 weeks post-flood). Survival data were analyzed using SAS PROC GENMOD, which provided for an analysis of species and flood treatment differences in survival rates based upon calculated odds ratios over two sampling dates. In this study, an odds ratio compared the probabilities of seedling survival rates between two species by calculating the antilog (e^x) of an estimate (= Logit P_i) value that represented the difference between two species least square means. These values were interpreted as the likelihood of one species to survive 15 weeks, or 45 weeks, post-flood versus the alternate species. Conversely, such odds ratios indicated the number of seedlings that would need to be planted of the less flood tolerant species for every seedling representing the more flood tolerant species to obtain the same survival at either 15 or 45 weeks post-flood. Survival rates based on odds ratios differed for non-flooded and flooded seedlings in both a flood tolerant (swamp white oak) and flood intolerant species (northern red oak) at 45 weeks post-flood, which clearly demonstrated the longer term impact of flooding on survival rates in response to flooding. It is recommended that an odds ratio approach be used as a management tool when making decisions on deploying specific species in adequate numbers across flood prone sites.

Specified Source(s) of Funding: University of Missouri Center for Agroforestry

4:45–5:00 pm

Soil Respiration and Soil Analysis Under American Sweetgum (*Liquidambar styraciflua*) as Affected by Pavement Type

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Placing impermeable pavement around existing trees can cause declines in tree growth and health due to reduced water infiltration and soil surface gas exchange. Using pervious concrete, with greater water infiltration and gas permeability, could be a good alternative. The purpose of this study was to test soil respiration, root growth and soil extract chemistry in root zones of American sweetgum (*Liquidambar styraciflua*) as affected by pavement. The experimental setup consisted of twenty-five sweetgum trees, with root zones covered by standard concrete (5 plots), pervious concrete (10 plots) or left uncovered (control, 10 plots). Each plot was outfitted with access points for soil respiration measurements. Soil respiration was measured monthly on two access holes per plot, with three sub-measurements per access hole. Data collected from February 2008 to January 2009 indicated that soil respiration correlated with seasonal soil temperatures. We observed tremendous variability in soil CO₂ efflux rates within treatments. Maximum rates of CO₂ efflux per plot were extremely high in both concrete treatments (up to 350 μmol·m⁻²·s⁻¹ of CO₂), while maximum rates in the control treatment reached up to 45 μmol·m⁻²·s⁻¹ of CO₂ per plot. This was likely an experimental artifact as collar depth (15 cm) may have exceeded the capacity of the equipment. Rates were generally higher for standard concrete than pervious and considerably higher for both concrete treatments than the control. It is likely that pavement

caused a build up of CO₂ in the root zone, resulting in high soil CO₂ efflux rates at the vents. Soil oxygen concentrations in control and pervious plots decreased with increasing volumetric water content (VWC). At field capacity (35% VWC), impervious plots had a lower soil oxygen concentration (7% O₂) than pervious plots (15% O₂) and the control (17% O₂). Soil samples were taken at 0–10 and 10–20 cm in the exposed soil by the tree trunk. Dissolved organic carbon (DOC) and nitrogen (DON) in soil extracts were significantly higher under the pervious concrete than the control at both depths. Soil extract chemistry under impervious concrete plots was not significantly different from that under control plots or pervious concrete plots. Neither treatment affected extractable nitrate, ammonium, or pH at either depths. Thus impervious concrete reduced oxygen infiltration under high soil moisture conditions and likely increased CO₂ concentrations in the soil, which could potentially lead to a more stressful environment for tree roots compared to pervious concrete and control plots.

Oral Session 39:
Horticultural Crops Culture and Management: Organic 2
Tuesday, 28 July 2009, 4:00–5:00 pm

Lewis

Moderator: Michelle Leinfelder, mml32@cornell.edu

4:00–4:15 pm

Orchard Soil Health Indicators and Yield Efficiency Show Similar Trends in Apple Replant Disease, Groundcover Management Systems, and Integrated Versus Organic Fruit Production Studies

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We are developing a protocol for evaluating soil health in apple (*Malus x domestica* Borkh.) orchards of New York State. Soil health may be described as soil functionality, in terms of agricultural productivity, environmental prudence and resource conservation, but soil health research has focused mostly on annual crop systems. Our objective is to determine the optimal set of chemical, physical, and biological soil indicators for testing soil health in orchards, and then to relate soil management practices to soil health and orchard productivity. We have used three research sites with different long-term management histories, including pre-plant compost or fumigation in an Apple Replant Disease (ARD) site; in-row pre-emergence herbicide, post-emergence herbicide, sod, or mulch in a Groundcover Management Systems (GMS) study; and a comparative study of integrated and organic fruit production (I/OFP) systems. Based on ANOVA and means separation procedures ($P < 0.05$), soil microbial respiration (MR), percent organic matter (%OM), percent nitrogen (%N), and percent carbon (%C) were significantly higher in the compost plots than in fumigated plots at the ARD site. These aforementioned indicators plus Potentially Mineralizable Nitrogen (PMN) were higher in GMS mulch plots than in sod and herbicide plots, and MR and %OM were higher in IFP plots than in OFP plots. Previous reports suggest that higher MR, %OM, %N, %C, and PMN are indicative of healthier soils. Trends in yield efficiency (kg fruit/cm² trunk cross-sectional area, TCSA) followed those of soil health indicators. Trees in the ARD compost plots had significantly higher yield efficiency than those in fumigated plots, and trees under IFP had higher yield efficiency than those under OFP. In the GMS

experiment, yield efficiency was statistically similar across treatments. However, TCSA was higher for trees in mulch than those in sod and herbicide plots, which were statistically similar in size. While large apple trees are often inefficient fruit producers, this was not true in the GMS experiment. The similar yield efficiency for trees of substantially different TCSAs suggests that large tree size and high yield efficiency are not mutually exclusive.

Specified Source(s) of Funding: Funding in part by the Toward Sustainability Foundation

4:15–4:30 pm

Soil Microbial Community Composition Under Integrated and Organic Apple Systems in a New York Orchard

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Terminal-Restriction Fragment Length Polymorphism (T-RFLP), a Polymerase Chain Reaction based method, was used to determine bacterial and fungal soil community composition in an orchard of disease-resistant ‘Liberty’/‘M.9’ apple (*Malus x domestica* Borkh.) trees during and after the transition from conventional to either integrated (IFP) or organic fruit production (OFP) systems. Sampling occurred in May and August over three years at both the 0–6 and 6–12 cm soil depths. Additional biological, chemical, and physical soil properties were also measured. Composted bark mulch with infrequent herbicide application was used for IFP, and provided effective weed control, while increasing soil organic matter, pH, soil nutrient availability, microbial biomass carbon, and microbial respiration. Mechanical cultivation along with chicken manure compost was used for OFP, and increased soil porosity, decreased aggregate stability, and increased potentially mineralizable nitrogen and total inorganic N. Neither system increased levels of leaf nutrients. The OFP system appeared to be leaching inorganic N through the soil profile. Using the T-RFLP analyses we found that sampling time influenced the soil bacterial communities more than the treatments. However, soil fungal communities in the 0–6 cm depth segregated by treatment, possibly because of increased detritivore presence under the bark mulch. For most measurements, the 6–12 cm depth only showed minimal treatment differences. Soil quality did not improve as much in the OFP system as in the IFP soil during four years at this orchard.

Specified Source(s) of Funding: USDA Integrated Research, Education, and Extension Competitive Grants Program—Methyl Bromide Transitions, Hatch Act funds, The Toward Sustainability Foundation, and the Cornell University Department of Horticulture

4:30–4:45 pm

Early Performance of an Organic Apple Orchard as Affected by Ground Cover Management and Nutrient Sources

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Major limitations to successful establishment in an organic orchard are weed vegetation competing with the tree and sufficient nutrients required for growth. Both affect growth, development and early cropping. Trees of 'Enterprise'/M26 planted at 600 trees/acre (1480 trees/ha) in 2006 and trained to a modified vertical axis were planted. Trees were treated with an interaction of ground cover management systems and nutrient sources. The ground cover management treatments were 1) urban green compost (GC), 2) wood chips (WC), 3) shredded paper (SP), or 4) a managed fescue and clover vegetation providing mulch through mowing (MB). Nutrients were provided by 1) a control (NF), 2) composted poultry litter (PL), or 3) an organic approved poultry-product based commercial fertilizer (CF). In the NF treatment, nutrients were to be derived solely from the ground cover management treatments. The orchard was managed as certified organic. The results of growth and production in the first three years are presented. Trees with GC or WC were tallest after two seasons and achieved growth target of 3.1 m while those with SP or MB did not. Likewise, tree width GC and WC had the largest TCSA in each of the first three seasons. Trees with SP suffered significant freeze injury during a spring freeze event in 2007 while trees with other treatments did not. After two seasons, trees with GC or WC were determined to be horticulturally large enough to crop while those with SP and MB did not fill their allotted space. Trees with SP exhibited less foliar chlorophyll and lower assimilation rates during mid-summer. In the third growing season, trees with GC and WC had 2 to 4 times more flower clusters per tree, and significantly higher fruit set. Trees treated with SP and MB did not crop in the third year while those with GC and WC did with similar yields and cropping efficiencies. Tree height was not significantly affected by nutrient source treatments although the NF trees were the shortest and had significantly less TCSA. The NF treated trees had fewer flowers per tree and less fruit set per tree. However, yield per tree was similar among all nutrient source treatments due to increased fruit size with reduced cropping in the NF treated trees.

Specified Source(s) of Funding: USDA-OREI

4:45–5:00 pm

Using “New” Alternatives to Enhance Adoption of Organic Apple Production

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Organic apple production in the eastern United States is significantly influenced by cultivar susceptibility to apple diseases because of the weather conditions during the growing season. In New England there has been a recent shift away from McIntosh, the historically predominant cultivar which is very susceptible to apple scab to newer cultivars. This shift is due to consumer preference and a shift in market focus from wholesale to more profitable retail and niche markets. A multi-disciplinary, multi-state long-term research project, *OrganicA Project*, was initiated in 2006 at the University of Vermont. One objective of this project is to incorporate and evaluate new apple cultivars and research-generated knowledge of apple ecosystem dynamics into organic production systems to determine their sustainability and profitability. We are examining two major production systems growers would use in changing cultivars: establishing a new orchard (Orchard 1) and top-grafting an existing orchard (Orchard 2) to the following cultivars: Zestar!, Ginger Gold, Honeycrisp, Liberty, and Macoun. During the establishment years of these orchards, we collected horticultural data on tree growth and survival, blossom density, and fruit yield. In Orchard 2, initial survival of new grafts was very good for most varieties (94% to 100%) except Zestar! which had only 84% of trees with at least one live scion in one year after grafting. By the end of 2008, many Zestar! trees, and to a lesser extent, Macoun trees were completely dead or of such low vigor they would not be profitable for commercial production. Growers who choose to top-graft an orchard rather than remove trees and plant a new orchard do so under the conventional wisdom that bypassing a two year fallow period followed by three establishment years for the new trees will give them a marketable crop sooner. Preliminary results indicate that poor survival of top-grafted trees may negate the benefit of earlier production for particular cultivars. Differences in precocity occurred in both orchard systems. In Orchard 1, Zestar! developed more flower clusters in 2007. In Orchard 2, Ginger Gold, Zestar!, and Liberty exhibited much higher flower density, indicating that these trees have the potential to bear commercial crops earlier and therefore may be more profitable to the grower.

