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

(032) Seedling Rootstock Recommendations for Nursery Container Production and Improved Field Establishment of Pawpaw Cultivars

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The pawpaw [*Asimina triloba* (L.) Dunal] is native to the southeastern United States and is in the early stages of commercial production as a tree fruit crop. Clonal rootstocks are not currently available for pawpaw cultivars; therefore, nurseries graft cultivars onto rootstock derived from locally available seed. Great variation in scion growth is observed with this rootstock and grafted trees can be delayed in producing fruit. Pawpaw rootstocks that are vigorous, which have a high survival rate, but promote precocity would be desirable to growers. A series of greenhouse and field studies were conducted using seed from 'PA-Golden', 'Sunflower', 'Susquehanna', 'K8-2', and commercially available seed to determine if: 1) genotype and seed size influenced vigor of greenhouse grown container seedlings; 2) graft compatibility and growth rate of scions would vary by rootstock; and 3) field establishment and scion precocity was influenced by various seedling rootstocks. Larger seeds were found to produce larger diameter seedlings grown in containers that can be grafted earlier than rootstock produced from small seeds. Genetic background of rootstock did not affect bud take of cultivars. In May 2004, a trial was planted that consisted of the cultivars Sunflower and Susquehanna budded onto the rootstocks. Genetic background of rootstock did not influence precocity of scions or vigor once field-planted. Most seedling rootstocks showed a high survival rate during establishment (81%); however, rootstock derived from seeds of 'Susquehanna' had a low survival rate (52%) and therefore should not be used to produce pawpaw rootstock.

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(033) Characteristics of Hardy Kiwifruits Native to Japan

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Sarunashi [*Actinidia arguta* (Sieb. et Zucc) Planch ex Miq.], an indigenous *Actinidia* species grown in Japan, has an edible fruit skin, high vitamin °C content, good flavor, and high protease (actinidin) content. *Actinidia arguta* shows wide variations in ploidy, with 2x, 4x, 6x, 7x, and 8x found in Japan. Fruit composition (var. *hypolecula* 'Nagao' (2x), 'Nagano' (4x), 'Gassan' (6x), 'Issai' (7x), 'M6' (8x)), fruit ripening characteristics and storability ('Gassan', 6x) of *A. arguta* were examined. Major sugars were glucose, fructose, and sucrose. Citrate was a predominant organic acid followed by quinic and malic acids. The amount of ascorbic acid ranged from 26.4 to 144.4 mg per 100 g FW between selections. Protease activity in the fruit was 6.1-92.6 nmol pNA released per minute. Ripening behavior and storability of *A. arguta* 'Gassan' were determined by storage of fruit at 15 °C with or without propylene treatment. Control fruit reached edible quality after 11 days of storage when determined through firmness (1.1 N). The levels of acidity and soluble solids were 0.3 % and 13.6 % after storage. Propylene treatment at 100 and 1000 ppm (15 °C 24 hours) accelerated the physiological changes associated with fruit quality (an increase of soluble solids and decrease of acidity), irrespectively of the propylene concentration. Fruit of 'Gassan' were packed with plastic film and ethylene absorbent and stored at 2 °C up to 14 weeks. The firmness of fruit was maintained at a quite high level for 10 weeks (40% of their initial firmness). After storage, the fruit ripened normally with ethylene treatment.

Specified Source(s) of Funding: Department, College, State and/or HATCH Onion Breeding Program, NMSU

Thursday, 24 July

12:00–12:45 pm **Grand Ballroom A/B/C**

Environmental Stress

(263) Cold Acclimation Can Benefit Only the Clones with Poor Needle Retention Duration (NAD) in Balsam Fir

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Needle loss is the most significant challenge facing Christmas tree producers in Atlantic Canada. While the exact reason for needle drop is yet to be uncovered, it is commonly believed that warm winter temperatures could promote needle drop since Christmas trees are harvested early to meet the U.S. Thanksgiving market. Cold hardening is believed to predispose trees, promoting better needle retention. The objective of this study was to determine if natural cold acclimation would increase needle retention duration (NRD). A paired comparison was constructed for 85 samples obtained from a clonal orchard in Debert, NS on 12 Oct. 2007 (prior to natural cold acclimation) and then again on 12 Jan. 2008 (after natural cold acclimation). The samples were set in a laboratory maintained at 24 °C and 27% humidity and monitored daily until complete needle loss. There was an average increase of 6 days in needle retention after cold acclimation that was significant ($P < 0.05$). Regression analysis was completed for pre-cold acclimation needle retention time against change in needle retention time. There was a strong negative relationship ($r = 0.922$), suggesting that clones with poor NRD significantly benefited due to cold acclimation and maintained needles better, while those trees with initial high NRD did not benefit from it. There appears that needle retention or abscission is differentially regulated depending on the genotype.

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(264) Deacclimation Significantly Reduced Cold Hardiness of 'Densa' and 'Shamrock' Inkberry

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Deacclimation is one of the most important factors that affects woody plant cold hardiness. Fully cold acclimated potted plants of inkberry [*Ilex glabra* (L.) A. Gray] 'Densa' and 'Shamrock' were moved into a greenhouse (20.8 1.93 °C for deacclimation every other day from 18 to 27 Jan. 2008. Ten leaf discs (30.67 mm^2 each) were sampled to be frozen from –4 to –48 °C with intervals of 4 °C in a programmable freezer. Electronic leakage conductance (ELC) was measured after leaf samples were completely thawed in a cooler and stored at room temperature for 24 hours with 10 mL of dd water. LT_{50} (lethal temperature

for 50% cold damaged) was calculated by using the Boatman's model. The results showed that ELC fit well for this model ($\chi^2 < 0.016$; SSR < 0.01 and $R^2 > 0.89$). Cold hardiness of 'Densa' significantly reduced by 3.9 °C from 1 to 3 days of deacclimation (DOD), then gradually dropped only by 1.1 °C till 7 DOD, and followed by another dramatically decreasing of 5.5 °C at 9 DOD; while that of 'Shamrock' gradually decreased only by 5.4 °C from 1 to 9 DOD. Their cold hardiness had a strong, negative linear correlation as DOD increased ($r^2 = 0.88$ for 'Densa' and 0.78 for 'Shamrock'). 'Densa' lost its cold hardiness faster than 'Shamrock' did. A total of 33.5% and 17.2% of cold hardiness reduction were observed for 'Densa' and 'Shamrock', respectively. Deacclimation significantly reduced cold hardiness of inkberry and its effect varied with cultivars. Further research should focus on the physiological mechanism of deacclimation, which leads to the loss of cold hardiness. Donglin Zhang is also a guest professor at Central South University of Forestry and Technology.

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(265) Response of Two Pecan Cultivars to Spring Freeze Injury

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This study was established to assess the effects of a severe late spring freeze on flowering, shoot growth, leaf nutrient status, and the retention of fruit developing from secondary buds of pecan [*Carya illinoinensis* (Wangenh.) K.Koch]. Four trees of each cultivar ('Desirable' and 'Kiowa') were assigned one of two damage levels, none (0%) or severe (80% to 100%) injury, following a late spring freeze occurring on 8 Apr. 2007. Ten exterior terminal branches per tree were flagged on 15 Apr. 2007 at approximately 9 ft aboveground, and the following data were collected at 32, 47, 91, and 147 days after the freeze (DAF): shoot length, number of terminals bearing pistillate flowers or fruit, and cluster size (number of pistillate flowers or fruit per fruiting terminal). A leaf chlorophyll index was measured at each of the above dates using a SPAD chlorophyll meter. Leaf samples, consisting of 30 middle leaflet pairs of the middle leaf of sun-exposed terminals, were collected on 12 July 2007. All data were analyzed by *t* test to compare differences between measured parameters of damaged and non-damaged trees within each cultivar. 'Desirable' produced a crop of pistillate flowers from secondary buds following the freeze; however, many of these flowers were abnormal in appearance. Freeze-damaged 'Desirable' trees exhibited shorter shoots, reduced flower and fruit retention, a lower chlorophyll index, and decreased leaf nitrogen (N) concentration compared to non-damaged trees. Leaf zinc (Zn) concentration was higher in freeze injured 'Desirable' trees than in non-damaged trees. Freeze-damaged 'Kiowa' trees had longer shoots and failed to produce a crop of pistillate flowers from secondary buds on most shoots. Freeze damage led to the appearance of mouse-ear leaf symptoms and reduced leaf chlorophyll index, leaf N, and leaf magnesium (Mg) concentrations in 'Kiowa' . Leaf phosphorous (P) and leaf potassium (K) concentrations were higher in freeze-injured 'Kiowa' trees than in non-damaged trees. These observations provide insight into the potential response of bearing orchard trees injured by a late spring freeze.

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(266) Species Variation in Freeze-induced Leaf Movements (Thermonasty) and Winter Photoprotection in *Rhododendron* Section *Pontica*

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In temperate zone evergreens, downregulation of photosynthesis during winter can result in damage to photoreaction centers from excessive light energy. Leaf drooping and curling at freezing temperatures (thermonasty) in some evergreen *Rhododendron* species were hypothesized to function as light avoidance, photoprotective mechanisms. The relationships between leaf movements, photoinhibition (Fv/Fm), and cold hardiness were analyzed from field measurements taken on six related species from fall to mid-winter. All species showed a seasonal increase in photoinhibition, but differed up to 1.7-fold in their cumulative responses, measured as the area under the Fv/Fm plots over time. Species with the most leaf drooping (near vertical) and curling (70% or more) at subfreezing temperatures were also the hardiest and most photoinhibited. Species with less photoinhibition over this period were characterized by more upright leaves (40 or more from vertical) and less curling. A leaf manipulation experiment was also conducted during the same period, using two species (one thermonastic) and an F1 hybrid between them. Leaves held vertically down with weights over the time course were less photoinhibited than leaves held in slightly upright positions (~115 from vertical). For all three genotypes, leaves allowed to move naturally were as photoinhibited as leaves forced in upright positions. These data indicate that thermonasty is most pronounced in photosensitive species, and that a sustained vertical leaf position confers some photoprotection. Under natural conditions, however, this effect does not appear to offset cumulative photoinhibition at cold, supra-freezing temperatures (non-thermonastic), which accounts for most (64%) of the daylight conditions in this time course. Since less photosensitive species in our study had limited leaf movements, they presumably rely on other avoidance or tolerance mechanisms for maintaining PSII photochemical efficiency under cold conditions.

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(267) Structural Adaptations in Over-wintering Leaves of Thermonastic and Non-thermonastic *Rhododendron* Species

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Evergreen rhododendrons are important woody landscape plants in many temperate zones. During winters, leaves of these plants are frequently exposed to a combination of cold temperatures, high light, and reduced photosynthetic activity, conditions that render them vulnerable to photooxidative damage. In addition, these plants are shallow-rooted and thus susceptible to leaf desiccation under windy and/or freezing conditions. In this study, the potential adaptive significance of leaf morphology and anatomy in two contrasting *Rhododendron* species was investigated. *Rhododendron catawbiense* (native to eastern U.S.) exhibits thermonasty (leaf drooping and curling at freezing temperatures) and is more winter hardy (leaf freezing tolerance, $LT_{50} = -35$ °C), while *R. ponticum* (native to central Asia) is less hardy ($LT_{50} = -16$ °C), and non-thermonastic. Thermonasty may function as a light and/or desiccation avoidance strategy in rhododendrons. Microscopy revealed that *R. ponticum* has a significantly thicker leaf blade but thinner cuticle than *R. catawbiense*. There is one layer of upper epidermis and three layers of palisade mesophyll in *R. catawbiense*, compared to two distinct layers of upper epidermis and two layers of palisade mesophyll in *R. ponticum*. We suggest that the additional layer of upper epidermis in *R. ponticum* and thicker cuticle and extra palisade layer in *R. catawbiense* represent structural adaptations for reducing light injury in leaves and could serve a photoprotective function in winters when leaf photochemistry is generally sluggish. Results also indicated that whereas stomatal density of *R. ponticum* was higher than that of