ABSTRACTS

Colloquia
Workshops
Contributed Papers (Oral and Poster)

88th Annual Meeting of the
American Society for Horticultural Science

University Park, Pa.
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The Abstracts that follow are arranged in *numerical* sequence by the abstract number. For Poster Sessions, session numbers (in parentheses) follow the abstract numbers. Example: 003 (PS 1) represents abstract 003 in Poster Session 2; 304 (PS 14) represents abstract 304 in Poster Session 14.

Abstracts for Oral Sessions, Colloquia, an Workshops are grouped by sessions, which are arranged more or less in numerical order by session number. To determine when a paper is to be presented, check the session number in the Program Schedule or the Conference at a Glance charts. The author presenting the paper is indicated by an asterisk.

POSTER SESSIONS 1-16 (Abstr. 001-407)

001 (PS 1.)

EFFECT OF ETHEPHON AND GA_3 ON SEX EXPRESSION OF GYNOECIOUS CUCUMBERS (CUCUMIS SATIVUS L.).

Hurriah H. AL-Juboory, University of Baghdad, College of Agriculture. Department of Horticulture, Baghdad, IRAQ.

Gibberellic acid (GA_3) promoted maleness and 2-Chloroethyl phosphonic acid (ethephon) promoted femaleness in cucumber (Cucumis sativus L.) cv Regal 446 seedlings when treated with water, ethephon (250 or 350 ppm) or GA_3 (1000 or 2000 ppm) at the l-, 2-, or 3-leaf stage. Seedlings treated with ethephon at all stages produced more female flowers than those with water or GA3 treatments. GA_3-treated seedlings produced significantly more male flowers than water treatments, at all developmental stages. The differential response of cucumber seedlings treated at different stages indicated the importance of timing growth regulator applications.

002 (PS 2)

FRUIT DEVELOPMENT PATTERNS IN CRANBERRY

Carolyn J. DeMoranville* and Karl H. Deubert, University of Massachusetts Cranberry Experiment Station, P. 0. Box 569, E. Wareham, MA 02538.

Interaction of fertilizer use, cultivar and/or soil temperature with development of cranberry (Vaccinium macrocarpon Ait) fruit size and mass has been studied. Underfertilization impacts on fruit size after an initial lag of at least one season. The shape of fruit growth curves were similar for 6 cultivars: varying in growth rate for small vs large fruited cultivars. Frequencies for size classes (5.6-8 mm, 8-11.2 mm, 11.2-13.2 mm, 13.2-16 mm, > 16mm) shifted predictably during fruit development. The timing for the shifts may be related to soil temperature (3 year comparison) at critical stages. This information may have implications for forecasting fruit size and estimating crops in commercial production.

EFFECT OF THIDIAZURON (TDZ) AND FORCHLORFENURON (CPPU) ON SHOOT ORGANOGENESIS FROM NODAL TISSUE CULTURES OF COMMON AND FABA BEANS

Mohamed F. Mohamed*, Paul E. Read and Dermot P. Coyne, Department of Hort., Univ. of Nebraska, Lincoln, NE 68583-0724

Few cytokinins have been found effective for shoot regeneration in tissue culture of grain legumes. Dry seeds of 2 genotypes of common bean (Phaseolus vulgaris L.) and one cultivar of faba bean (Vicia faba L.) were germinated in darkness on MS_5 medium (Murashige and Skoog (MS) nutrient elements and Gamborg's B_5 vitamins) containing either 5µM Benzyladenine (BA), thidiazuron (TDZ) or Forchlorfenuron (CPPU). After 2 weeks, cotyledonary nodes (CN) from faba bean or stem primary nodes (PN) and CN from common bean were excised. All axillary shoots (0.5-l cm) on CN or PN explants were removed and cultured on half strength medium without growth regulators (½ OMS_5). Explants of CN and PN tissues from seedlings grown on 5µM BA were placed on the same medium (5µM BA) or MS_2 medium without growth regulator (OMS_5). CN and PN tissues from seedlings grown on 5µM TDZ or 5µM CPPU media were placed on media with the same cytokinins at 0, 1.25, 2.5 or 5µM. All cultures were maintained at 22°C under continuous light (40 µMol $s^{-1}m^{-2}$ from cool-white fluorescent tubes. Media containing TDZ and CPPU promoted multiple shoot bud organogenesis at a lower concentration than media containing BA at 5µM.

004 (PS 2)

THE EFFECT OF TIME AND SEVERITY OF PRUNING ON YIELD COMPONENTS OFCRANBERRY

Bernadine C. Strik* and Arthur Poole, Department of Horticulture, Oregon State University, Cordlev Hall 2042. Corvallis, OR 97331.

The effect of time and severity of pruning was studied in a 30-year-old 'McFarlin' cranberry *(Vaccinium macrocarpon* Ait.) bed. The treatments consisted of early or late pruning as main effects (Dec. 5 and March 9 1988/89 and 1989/90) and severity of pruning (control or no pruning; and light, moderate, or heavy pruning depths) as sub-plots in a split plot design with 3 replicates. A commercial reel-type pruner was used for the 6' × 20' plots. Treatments were repeated on each plot for two consecutive years. In fall 1989 and 1990, just before harvest, yield component data were collected from three 1/3 ft^2 samples in each plot. There was no significant effect of time of pruning on yield components. Thus, the data were pooled and analyzed as a RCBD. In 1989, the un-pruned and lightly pruned vines had a greater total sample fresh weight, number of berries, yield, average length of fruiting uprights (U,). and number of U_F, and a lower number of non-fruiting uprights (U_N) per ft_2 than the moderately or heavily pruned vines. There was no significant effect of pruning on average length of U_N or anthocyanin content of berries in 1989. In 1990, the effect of pruning severity was similar to 1989 with the control and lightly pruned vines having a greater total sample fresh weight, number of berries, yield, and average length of U_F and U_N per ft^2 than the moderately and heavily pruned vines. In 1990, the berries from un-pruned vines had a significantly lower anthocyanin content than those from pruned vines. Annual pruning may decrease yield.

005 (PS 1)

BA PROMOTES SHOOT EMERGENCE IN POTTED ASPARAGUS SEEDLINGS.

Sauveur Mahotiere. Clarence Johnson* and Philamenia Howard, Agricultural Research Station, Fort Valley State College, Fort Valley, GA 31030-3298

Four-month-old potted seedlings of 'UC 157 F_1', 'UC 157 F_2' and 'Mary Washington' asparagus cultivars (Asparagus officinalis L) grown under outdoor conditions were sprayed with BA solutions ranging from 0 to 400 mg. $liter^{-1}$ at 100 mg. $liter^{-1}$ increments. Beginning 10 days after the application of the treatments on 16 Nov., 1990, BA increased the number of new shoots under the fern canopy for all cultivars. The cumulative response lasted 3 weeks, after which time freezing temperatures killed the new shoots. The control plants virtually produced no shoots. In contrast, BA, particularly at 200 mg. $liter^{-1}$ produced a respective cumulative average of 13.6, 9.3 and 10.3 shoots/plant for 'Mary Washington', 'UC 157 F_1' and 'UC 157 F_2' on 12 Dec. 1990. Growth resumption after the intervening freezing temperatures killed the first shoots showed significant residual effects of the chemical regardless of concentrations.

006 (PS 2)

INTERSPECIFIC AND INTRASPECIFIC POLLINATION EFFECTS IN RABBITEYE AND SOUTHERN HIGHBUSH BLUEBERRY

Creighton L. Gupton* and James M. Spiers, USDA-ARS, Small Fruit Research Station. P. 0. Box 287. Poplarville, MS 39470

Increasing southern highbush (mostly Vaccinium corymbosum) will be planted in close proximity to rabbiteye (V. ashei) blueberry plants. A partial diallel set of crosses involving seven southern highbush and seven rabbiteye parents was made to estimate the effects of pollen source on berry weight (BW), seed number (SN), fruit set (FS) and time from pollination to ripe berry (TPRB). Compared to cross pollination, selfing increased TPRB and decreased BW and SN in southern highbush and rabbiteye blueberry. Fruit set was about equal for selfed and cross pollinated highbush but was less for selfed than cross pollinated rabbiteye. Highbush pollen on rabbiteye females increased TPRB and reduced BW, SN, and FS. Rabbiteye pollen on highbush females did not affect TPRB or FS but reduced BW and SN. Mixed southern highbush and rabbiteye pollen on highbush females did not affect TPRB or BW but reduced SN and FS. No significant effect of mixed pollen on rabbiteye females was found. Pollen source might affect earliness of ripening and yield in both species if natural pollination is similar to hand pollination.

007 (PS 1)

Effects of Ozone on Ethylene and Polyamine Biosynthesis and Rubisco Gene Expression in Potato Plants

F. B. Negm*, N. Reddy, Y-S. Ni, Y-R. Dai, R. N. Arteca, H. E. Flores and E. J. Pell, Environmental Resources Research Institute, The Pennsylvania State University, University Park, PA 16802

Potato plants (Solanum tuberosum L. cv. Norland) were grown in a charcoal filtered greenhouse and treated with 0.15 µl L^{-1} ozone in continuous stirred tank reactors for 4 h. After treatment, the tissue was analyzed for ethylene production, ethylene biosynthesis intermediates, polyamine levels and mRNA for the large and small subunit of rubisco. Immediately after exposure to ozone, leaves emitted higher levels of ethylene as compared to the control. Young leaves produced more ethylene than older leaves. Enzymes involved in ethylene biosynthesis as well as intermediates for ethylene biosynthesis, were higher in ozone treated plants than the control. Pools of polyamines and mRNA for the large and small subunits of rubisco were also higher in young leaves. The possible interactions between ethylene, polyamines and the genetic regulation of rubisco will be discussed. This work was supported by the Electric Power and Light Research Institute Contract #EPRI-RP8008-1.

008 (PS 2)

AMMONIUM AND NITRATE UPTAKE IN CONTAINERIZEDSOUTHERN HIGHBUSH BLUEBERRIES

Donald J. Merhaut* and Rebecca L. Darnell. Department of Fruit Crops, IFAS, University of FL, Gainesville, FL 32611.

Nitrogen uptake from different sources was evaluated in 'Sharpblue' southern highbush blueberries using 10% ^{15}N-enriched nitrogen. Plants were grown in 20/30 mesh, acid-washed silica sand and fertilized every other day with a modified Hoagland's solution, pH 5.0, supplemented with NH_4NO_3. Ammonium-nitrate was used in the fertilization schedule to maintain unbiased uptake of different nitrogen sources prior to labelling.

After three months of growth, plants were fertilized with 7.5 moles of ^{15}N-N as either $NaNO_3$ or $(NH_4)_2SO_4$. Shoots and roots were harvested at 0, 6, 12, 24, and 48 hours after labelling. Nitrogen content was analyzed by a mass spectrometer. Root uptake rates averaged 0.05 and 0.02 mg N/g root dw/hr in the first 12 hours for NH_4-N and NO_3-N, respectively, and declined thereafter. Translocation to shoots averaged 0.27 and 0.09 mg N/g dw/hr for NH_4-N and NO_3-N, respectively. Uptake rates vary with nitrogen source in 'Sharpblue' blueberry. Ammonium-N is taken up and translocated to shoots faster than NO_3-N.

009 (PS 1)

ETHYLENE BIOSYNTHESIS IN TOMATO PLANTS-EFFECTS OF ANAEROBIC STRESS IN THE ROOT ZONE

Tzann-Wei Wang* and Richard N. Arteca. Department of Horticulture, The. Pennsylvania State University, University Park, PA 16802

Anaerobic conditions were obtained by flowing N_2 through the solution in which the tomato plants *(Lycopersicon esculenfum* Mill cv Heinz 1350) were growing. l-Aminocyclopropane-1-carboxylic acid (ACC) synthase was induced in the roots first and ACC formed. Following this, ACC was then transported to leaves where it was converted to ethylene. After ACC was transported to leaves, malonyl-ACC was also formed in leaves but it was not detectable in the roots and stems. ACC synthase activity was also induced in the leaves by anaerobic treatment to the roots, but it is possible that some unknown factors are involved with this type stimulation. Although ethylene biosynthesis was inhibited by Co^{2+} and aminooxyacetic acid (AOA), ACC synthase induction was also enhanced by them; however, the mechanisms of enhancement could be different. Co^{2+} enhanced ACC synthase only under anaerobic conditions and only in the roots. Under normal aeration, AOA stimulated ACC synthase activity in both the roots and leaves; under anaerobic condition, AOA had no stimulatory effect on ACC synthase activity in the roots, but it caused a stimulation in the leaves.

010 (PS 2)

CONTRIBUTION OF CARBON AND NITROGEN RESERVES TO VEGETATIVE AND REPRODUCTIVE GROWTH OF RABBITEYE BLUEBERRY

Keith T. Birkhold and Rebecca L. Darnell* Department of Fruit Crops, IFAS, University of Florida, Gainesville, FL 32611.

Partitioning of carbon and nitrogen reserves were examined in two cultivars of rabbiteye blueberries *(Vaccinium ashei]* differing in their timing of vegetative budbreak relative to floral budbreak. Floral budbreak precedes vegetative budbreak in 'Climax', while floral and vegetative budbreak occur concomitantly in 'Bonita'. Twenty eight containerized plants from each cultivar were dual labeled in the fall with 105 µCi of $^{14}C0_2$ and 0.6 g of nitrogen enriched with 5% ^{15}N. Plants were grown outdoors throughout the winter and the following growing season. At five dates, beginning 27 days prior to full bloom and ending at fruit maturity, plants were harvested into old shoots, roots, fruit, and vegetative growth.

Fall leaf drop accounted for loss of 12% of applied N and 20% of applied ^{14}C. In the first harvest, approximately 73% of the recovered ^{15}N and 50% of the recovered ^{14}C was in the roots for both cultivars. By fruit maturity, approximately 8% of the recovered ^{15}N was in the fruits, 51% in new vegetative growth, and 41% in old shoots and roots. Approximately 1.2% of the recovered ^{14}C was in fruit, 1.5% in vegetative growth, and 97% in old shoots and roots. Data suggest that differences in the timing of vegetative budbreak between these two cultivars do not influence overall partitioning patterns of reserve carbon and nitrogen.

011 (PS 1)
USE OF LYSOPHOSPHATIDYLETHANOLAMINE, A NATURAL LIPID, TO DELAY TOMATO FRUIT AND LEAF SENESCENCE.
Karim M. Farag and Jiwan P. Palta.
Dept. of Horticulture, University of WI, Madison, WI 53706.

About l0-15 week old plants were sprayed with Lysophosphatidylethanolamine (LPE, 100 mg. $Liter^{-1}$) and leaves were sampled over 12 days after the spray. Leaves that had been senescing on the plant showed a climacteric-like rise in ethylene production but not in respiration rate which decreased continuously with time. LPE treated leaves maintained lower rates of respiration and ethylene production than the control over the experimental period. Detached treated leaves had a climacteric-like pattern in respiration. Dark incubated leaves showed enhanced senescence with a rapid rise in ethylene production. LPE treated leaves had consistently lower rates of ethylene and CO_2 production, higher chlorophyll content. lower loss of fresh weight and lower electrolyte leakage. A continuous supply of LPE to excised (firm ripe) fruits through the pedicles delayed fruit senescence and lowered the rates of ethylene and CO_2 production. We conclude: 1. LPE has the potential to delay senescence of leaf and fruit tissues. 2. LPE has the potential to enhance fruit ripening while delaying fruit senescence (manifested fruit softening).

012 (PS 1)
ENHANCING RIPENING AND KEEPING QUALITY OF APPLE AND CRANBERRY FRUITS USING LYSOPHOSPHATIDYLETHANOLAMINE, A NATURAL LIPID.
Karim M. Farag* and Jiwan P. Palta.
Dept. of Horticulture, University of WI, Madison, WI 53706.

We have demonstrated that Lysophosphatidylethanolamine (LPE) is able to stimulate ethylene production in fruit tissue while keeping the respiration low. Spray application of LPE (50-100 mg. $Liter^{-1}$) was made on Searles cranberries (nonclimacteric) and McIntosh apples (climacteric) two weeks before harvest. The fruit anthocyanin content was markedly increased and color uniformity was improved. Treated apples had very little or no green area around the stem ends. During the postharvest air storage the LPE treated fruits had higher firmness than the control. Postharvest treatment of apples with LPE by vacuum infiltration or dipping stimulated ethylene production while keeping the respiration rate similar to control. Postharvest treated fruits had higher firmness. Postharvest LPE treatment of cranberry fruits reduced the percentage of soft fruits after 8 days by 39 to 55% compared to control. These results show that there is a potential for the use of LPE as an aid to enhance ripening and keeping quality of apple and cranberry fruits.

013 (PS 1)
INFLUENCE OF $CuSO_4$ SPECTRAL FILTERS AND EXOGENOUS GIBBERELLIC ACID ON CHRYSANTHEMUM GROWTH
Nihal C. Rajapakse* and John W. Kelly, Department of Horticulture, Clemson University, Clemson, SC 29634

The response of chrysanthemum plants to exogenous gibberellic acid (GA_3) and daminozide grown under $CuSO_4$ and water spectral filters was evaluated to determine the involvement of GA_3 biosynthesis or action in regulation of plant height under $CuSO_4$ filters. GA_3 treatment increased plant height in both control and $CuSO_4$ chambers but the height increase by GA_3 treatment in $CuSO_4$ chamber was about 20% greater than that in control chamber. Daminozide treatment reduced plant height in control and $CuSO_4$ chambers but the height reduction in control plants was slightly greater than in $CuSO_4$ chambers. The height reduction caused by daminozide was prevented by simultaneous GA_3 application in control plants while plants in $CuSO_4$ chamber responded more to simultaneous GA_3 application. The results suggest that GA_3 may be partially involved in height reduction under $CuSO_4$ filters.

014 (PS 2)
NO SOMACLONAL VARIATION FOR RESISTANCE TO POWDERY MILDEW, FREEZING, OR 2,4-D FOUND IN VITIS
Elizabeth S. Zimmerman*, John V. Carter, and James Luby, Department of Horticultural Science. University of Minnesota, 1970 Folwell Ave., St. Paul, MN 55108

Somatic embryos of three grape cultivars were produced in vitro on callus derived from immature flower plants. Plants from individual embryos were divided to form subclones, and 4 replicates/subclone were tested for powdery mildew, 4/subclone for 2,4-D and 6/subclone for freezing tolerance. In all, 477 'Merechal Foch', 505 'Lacrosse', and 214 'Seyval Blanc' subclones were tested for one or more hardiness traits. Cultivars differed in susceptibility and some initial differences among subclones were found. However, repeated duplicate testing of random subclones found low correlations between scores of subclones on first and second tests (r=-.08 powdery mildew, r=.30 freezing, r-.24 2,4-D). Also, when subclones selected for particular hardiness or susceptibility in initial tests were compared again in retests, using different sets of replicates, no significant differences in hardiness were observed.

015 (PS 1)
CHRYSANTHEMUM RESPONSE TO PRE-PLANT PACLOBUTRAZOL OR UNICONAZOLE SHOOT DIPS
David A. Gilbertz, University of Georgia, Department of Horticulture, Georgia Station, Griffin, GA 30223

Rooted cuttings of *Dendranthema grandiflora* (Tzvelev.) 'Bright Golden Anne' were dipped above the root zone into solutions of 20, 40, 60, 80 or 100 mg liter-' paclobutrazol (PB) or 10, 20, 30, 40 or 50 mg $liter^{-1}$ uniconazole (UC). Treatments averaged 3.3 ml PB or 2.6 ml UC solution per cutting. Cuttings planted 4 per 15 cm pot were pinched and maintained at 3 branches per cutting. Minimum and maximum temperatures averaged 18 ± 2 and 26 ± 2C, respectively, and daily PPF averaged 9.5 ± 4.5 moles $m^{-2}day^{-1}$.

Branch stem elongation was effectively controlled by PB or UC however, variability in plant height within pots was high with PB and highest UC rates. Regression equations for plant height (Y) as a function of rate in mg $liter^{-1}$(X) were: $Y = 26.1 - 0.59X + 0.008X^2$ (R^2=0.66) for UC and $Y=26.7 - 0.20X + 0.001X^2$ (R^2=051) for PB.

Compared to controls, dips caused a 33-51% reduction in leaf dry weight and production of 5-7 fewer leaves per cutting. Flowering was not delayed compared to controls and flower diameter was reduced only by the 2 higher rates of each chemical.

016 (PS 2)
ROOT EXUDATION RATES IN ELEVEN GRAPEVINE ROOTSTOCK GENOTYPES
Nancy K. Nord* and Robert J. Joly, Horticulture Department, Purdue University, West Lafayette, IN 47907

The effect of rootstock genotype on root exudation rates under greenhouse conditions of non-limiting soil moisture was determined for eleven American grapevine rootstock hybrids. Three-month-old rooted cuttings were detopped and exudate was collected hourly for eight h from tygon tubing affixed to the stumps. Exudate volume was weighed and flux was expressed on both a xylem cross sectional area and shoot dry weight basis. Significant differences were observed among genotypes when exudation was expressed as flux per xylem cross sectional area, with the greatest difference occurring two h after the shoot was severed. At hour two, rootstocks 101-14 Mgt and 110R exhibited exudation rates of 7.1 gcm^{-2} and 5.1 gcm^{-2}, respectively whereas 039-16 and St. George exuded at 2.4 gcm^{-2} and 2.1 gcm^{-2}, respectively. These rates decreased as the experiment progressed, and differences among genotypes in the exudation rate changed over the eight hour time course. The observed genotypic differences in grapevine root exudation rate suggest differences in radial and/or axial resistance to water transport, differential rates of active transport of ions into and/or out of the stele, and/or genotypic differences in the amount of substrate necessary to provide the energy to drive active transport.

017 (PS 1)
GROWTH REGULATORS INFLUENCE ROOTING AND SHOOT GROWTH OF MYRTLE MYRTUS COMMUNIS VAR. 'COMPACTA
Pantelis j. Michalas*. E. Jay Holcomb, Department of Horticulture, The Pennsylvania State University, University Park, PA 16802

Myrtus Communis Var. Compacta, "Dwarf Myrtle" is an ornamental evergreen shrub recently attracting attention in the European Community as a potential pot plant.

Due to low rooting percentages, a study was conducted using different humidifiers, various rates of IBA potassium formulation, and selected media to improve this percentage. Best rooting was obtained when the plants were propagated under a fog versus a mist system. A 1:3 peat/perlite media was compared to a 1:1 peat/perlite and the drier media proved to be better. From the several stem dip treatments IBA at 5000 ppm proved to be best.

We also looked at producing Myrtus as a flowering potted plant. Various growth regulators tested showed that uniconazole at 35 ppm and ancymidol at 100 ppm reduced height and improved the overall plant form better than chloromequat and daminozide.

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We also looked at producing Myrtus as a flowering potted plant. Various growth regulators tested showed that uniconazole at 35 ppm and ancymidol at 100 ppm reduced height and improved the overall plant form better than chloromequat and daminozide.

025 (PS 1)
GROWTH REGULATOR EFFECTS IN SEED-PROPAGATED *BEGONIA X TUBERHYBRIDA*

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The influence on growth and development by foliar applications of chlormequat, daminozide, paclobutrazol and triadimefon (Bayleton 25WP) was studied in *Begonia* × *tuberhybrida* 'Musical Orange'. The plants were grown at 20 ± 2C day and 18 ± 2C night temperature, and a day length of 16 hours at 100 µmol· $m^{-2}s^{-1}$ (5.8 mol· $m^{-2}day^{-1}$). Seedlings were transplanted into 750-ml pots filled with a peat-lite medium, six weeks after seeding. Plants were treated two weeks after transplanting at application rates of 500 or 1,000 mg· $liter^{-1}$ chlormequat, 2,000 or 3,000 mg· $liter^{-1}$ daminozide, 5 or 10 mg· $liter^{-1}$ paclobutrazol, and 375 or 750 mg· $liter^{-1}$ triadimefon. Seven weeks from time of application, plants treated with any rate of the tested growth regulators were shorter than the control plants. Begonias treated with paclobutrazol were on average ca. 70% shorter, chlormequat and triadimefon treated plants ca. 50% shorter and daminozide treated plants ca. 20% shorter compared to the height of the control plants.

026 (PS 2)
THE EFFECTS OF TRELLIS AND GROUNDCOVER MANAGEMENT ON RED RASPBERRY YIELD IN CONNECTICUT

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A trial was established in 1987 to test the effects of Linear, Narrow, Wide, and Narrow V trellises end presence end absence of groundcover on productivity in Canby and Titan red raspberries. The 2 × 4 × 2 factorial experiment was in a split-split plot design with groundcover as the main plot, trellis es the subplot, and cultivars as the sub-sub plot. Plots were harvested in 1989 and 1990. Trellis configuration had a significant effect on yield in both years. Yields were lower in the Linear trellis than in the Narrow, Wide, end Narrow V trellises. Yield in the latter did not differ significantly. In 1989 groundcover increased marketable yield; however, yields were not significantly different in the presence or absence of groundcover in 1990. Interactions between cultivar and groundcover had significant effects on yield in 1989 and 1990.

027 (PS 1)
GROWTH SUPPRESSION OF EUSTOMA GRANDIFLORUM

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Plugs of E. grandiflorum 'Yodel Blue' were potted on 14 March 1990 into 1.5-liter containers and grown in a greenhouse with a minimum temperature of 16C. Plants were pinched to 3 nodes 3 weeks later. On 14 April when new shoots were 3-5 cm long, 10 single-plant replicates were treated with a foliar application of 5, 10, 15, 20, or 25 ppm uniconazole, or 2500 or 5000 ppm daminozide, or a drench of 0.5 or 1.0 mg a.i. ancymidol pot . All treated plants were shorter than the control 5 weeks after treatment; the highest rates of uniconazole and ancymidol produced the shortest plants. All treatments delayed flowering; the 3 highest rates of uniconazole and the highest rate of ancymidol delayed flowering by 10 days es compared to the control. Flower diameter and flower bud number were not significantly affected by any of the treatments. Application of uniconazole or ancymidol can be en effective method of reducing excessive vegetative growth of E. grandiflorum.

028 (PS 2)
CARBOHYDRATE PARTITIONING IN PRIMOCANE-FRUITING RED RASPBERRIES

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Leaf removal with and without girdling and ^{14}C experiments were conducted on 'Heritage', 'Autumn Bliss', and 'Redwing' primocane-fruiting red raspberries to determine which leaves contribute the most assimilates to yield. Although there were differences between cultivars, cultivar by leaf removal interaction wee not significant. Yield from ungirdled canes was not influenced by leaf removal treatments due to translocation from the other leaves within the cane. When canes were girdled and the leaves from the upper portion of the cane removed, the reproductive components were severely reduced. With the same girdling treatment but with the leaves left intact, yields were similar to controls. Using ^{14}C, translocation patterns within the reproductive portion of the cane demonstrated that the leaf closest to the fruiting lateral was the major source of carbohydrate for that sink; ^{14}C was also translocated to other nodes according to leaf phyllotaxy.

029 (PS 1)
THE EFFECT OF UNICONAZOLE FOLIAR SPRAYS ON PINCHED VS. UNPINCHED ORNAMENTAL PEPPER

Terri Woods Starman, Department of Plant and Soil Science, Southern Illinois University, Carbondale, IL 62901

Ornamental peppers are regaining popularity as potted plants because the seed is easy to germinate, cropping time is short, and they have good keeping quality. Conventionally, ornamental pepper plants have been pinched two times to encourage branching and treated with daminozide to control height during pot plant production. The objective of this research was to determine the effect of uniconazole concentration on pinched vs. unpinched Capsicum annuum L. cv. Holiday Cheer and to compare uniconazole efficacy with daminozide treatment. Results of the studies show that one application of uniconazole es a foliar spray at 5.0, 10.0 and 15.0 mg·$liter^{-1}$ gave more effective height control than one foliar spray application of daminozide at 2500 mg·$liter^{-1}$ when plants were grown in 0.4-liter containers. Also, it was found that a second pinch was not necessary to produce a well-rounded plant when uniconazole was the growth retardant used. Elimination of the second pinch treatment shortened crop time by 2-3 weeks and reduced labor.

030 (PS 2)
THE INFLUENCE OF LEAF POSITION, AGE, AND ENVIRONMENTAL FACTORS ON NET PHOTOSYNTHESIS OF RED RASPBERRY.

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Tissue cultured 'Titan' red raspberry plants *(Rubus ideaus* L.) were grown outside in 19 liter plastic pots. Net photosynthetic rates (Pn) were measured for terminal and side leaflets of primocanes as the leaflets matured. Pn was determined on the terminal leaflet at every fourth node during the growing season. The diurnal pattern of Pn was determined outside under natural light and the Pn response to Photosynthetic Active Radiation (PAR) was determined inside using metal-halide lamps.

The maximum Pn of terminal or side leaflets was reached when they were 75 to 85% fully expanded. The maximum Pn of side and terminal leaflets was similar and Pn of both declined slowly with aging. The diurnal Pn rate peaked at approximately 10:00 AM and gradually declined to 50% of the maximum at 6:00 PM EDT. The Pn rates of terminal leaflets increased with increased PAR with maximum Pn rates occurring at approximately 1000 to 1200 $uEm^{-2}s^{-1}$.

031 (PS 1)
EFFICACY AND POSTHARVEST LONGEVITY OF UNICONAZOLE TREATMENT ON POLKA-DOT PLANT

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The objective of the research was to determine the effectiveness of uniconazole on Hypoestes phyllostachya Bak. cv. Pink Splash and to compare the effect and persistence of uniconazole with chlormequat and daminozide for limiting stem elongation during post-greenhouse, low light conditions. Uniconazole at 5.0 mg·$liter^{-1}$ reduced all measured plant dimensions to the same degree as chlormequat at 2500 mg· liter-l when both chemicals were applied twice as foliar sprays at a two week interval. These treatments resulted in the most compact and aesthetically pleasing 0.4-liter potted plants. However, this uniconazole treatment was not as persistent in postproduction low light conditions as chlormequat. By the fifth week under low light conditions, only the highest drench concentration of uniconazole tested (0.10 mg a.i. per pot) remained the same height as chlormequat treated plants.

032 (PS 2)
INCREASED EARLY YIELD OF 'HERITAGE' RED RASPBERRY WITH ROW COVERS

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'Heritage' is the most extensively grown primocane fruiting red raspberry in the northeast United States, but typically a percentage of the fall crop is lost to early frosts. This study was conducted to determine if floating row covers (FRC) could be utilized to induce earlier fruiting. Poly-propylene (0.6) FRC were installed on 4/l/89 (41FRC), 3/l/90 (32FRC), and 4/l/90 (42FRC), after primocanes were mowed in February. FRC were removed when primocane growth was first restricted (May). Maximum air temperatures ranged from 8-14C higher, minimum air

temperatures ranged from 3-6C higher, and soil temperatures averaged 2-6C higher, under FRC. Plots of 41FRC were harvested 12 days earlier than the uncovered control; 42% of the fruit was harvested from 41FRC in August versus 20% for the control. In year two, .32FRC and 42FRC were first harvested 21 days earlier than control; 35% of the total yield of 32FRC and 42FRC was harvested in August, in contrast to 3% for the control plots. October harvest was 10-15% of total for 32FRC and 42FRC, but 40% for control. There were no significant differences in berry weight and %Brix for the treatments. Treatments can be used to induce earlier harvest and/or stagger production peaks.

033 (PS 1)
AUXIN TRANSPORT AND ABSCISSION IN *COLEUS*

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Leaf abscission in a developing plant usually occurs first on the more lower positioned leaves. While this has been frequently associated with reduced light levels or other stresses, the mechanism responsible has not been delineated. An evaluation of leaf loss on explants (4th through 7th node, top to bottom) of Coleus blumi Benth. cv. Ball 2179 Red plants indicated abscission occurs first at the most proximal node. Inhibition of auxin transport with 2,3,5-triiodobenzoic acid between the 5th and 6th nodes increased abscission at nodes 4 and 5. Abscission of bladeless petioles is independent of nodal position when the nodes are separated from each other. Addition of auxin to the stem top hastens the abscission process at nodes 6 and 7, while auxin application to petioles inhibits abscission at all nodes. The evidence suggests leaf abscission at any nodal position is governed by an auxin gradient induced by IAA transport from the leaf and through the stem.

034 (PS 2)
TRICKLE IRRIGATION OF DAY-NEUTRAL STRAWBERRIES USING EVAPOTRANSPIRATION.

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The purpose of this project was to investigate the use of evapotranspiration (ET) as a guideline for trickle irrigation timing in field-grown day-neutral 'Tristar' strawberry. Proper management of trickle irrigation would allow optimum yields and quality with minimum water inputs. A randomized complete block field design with four replications was used at the ISU Horticulture Station in central Iowa. Irrigation treatments were based on % of ET and number of applications per week. The four treatments included: 30, 60, and 90 % of ET applied once per week (1X) and 30% of ET applied 3 times per week (3X). Total yield data (kg of fruit per season) indicated the 30% of ET (3X) treated plants yielded 15% more fruit than the 30% of ET (1X) plants. Berry number was 14% greater from plants receiving the 30% of ET (3X) treatment than from those receiving the 30% of ET (1X) treatment. Average berry weights for the entire growing season were similar among all treatments.

035 (PS 1)
CHANGES IN NON-STRUCTURAL CARBOHYDRATES OF SEVERAL APPLE ROOTSTOCKS AS INFLUENCED BY UNICONAZOLE

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In addition to the inhibition of gibberellin biosynthesis, uniconazole (UCZ) also modifies cytokinins, ABA, ethylene, and sterols in plant tissue. Besides effective growth suppression, our studies show UCZ increased chlorophyll content in treated leaves, modified stomata1 conductance and net CO_2 assimilation. In this study, changes in non-structural carbohydrates in apple rootstocks were evaluated in the greenhouse and in the field. UCZ was foliar sprayed two or three times at 0, 65, or 130 mg·liter^{-1} to dwarf (MARK, EMLA 27), semi-dwarf (EMLA 7), and semi-standard (MM 111) rootstocks. Effects of GA_{4+7} were also evaluated in the field study. Excluding sorbitol, soluble carbohydrate levels were reduced by two applications of 130 mg·liter^{-1} UCZ only in EMLA 7 rootstocks. Sorbitol content in dwarf and semi-dwarf rootstocks was significantly higher in shoots than roots; and starch in roots was higher than in shoots during dormancy. Root starch content in EMLA 7 was double that of MARK. Dwarf rootstocks had higher root sucrose, glucose, and fructose content during dormancy than semi-dwarf stocks under greenhouse conditions. In field experiments no treatment differences in non-structural carbohydrate content were found.

036 (PS 2)
COMPARATIVE STUDIES OF STRAWBERRY CULTIVARS DIFFERING IN RESISTANCE TO TWO-SPOTTED SPIDER MITE

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Seventy-eight strawberry cultivars of *Fragaria* X *ananassa* Duch. and one cultivar of *F. moschata* Duch. were preliminarily screened for resistance to Two-spotted spider mite (TSSM) using a leaf-disc bioassay based upon oviposition [eggs/ mite/day (e/m/d)] and damage [leaf scars/mite/day (1s/m/d)] The *F. moschata* cultivar, 'Profumata di Tortona' (1.7 e/m/d, 0.8 Is/m/d) was significantly more resistant than all cultivars of *F.* X *ananassa*, whereas 'Floridabelle' (3.0 e/m/d, 6.7 1s/m/d) and 'Pajaro' (2.7 e/m/d, 8.1 1s/m/d) demonstrated the highest levels of resistance within the latter group. Susceptible cultivars were 'Canoga' (10.2 e/m/d, 13.8 1s/m/d) 'Scott' (8.8 e/m/d, 15.9 1s/m/d) and 'Selva' (7.6 e/m/d, 14.2 1s/m/d). TSSM population dynamics were monitored in a greenhouse study designed to compare host plant-pest interactions among cultivars representing the range of reaction to the pest. The number of adult females was monitored weekly as well as the plant's response to infestation over a period of 8 weeks. Population curves for each cultivar were analyzed.

037 (PS 1)
CPPU THINS AND INFLUENCES FRUIT QUALITY OF MCINTOSH APPLES

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Mature McIntosh apple trees/M.7 were treated with either 7.5 or 15 mg·liter^{-1} CPPU at petal fall or 19 days later when fruit size was 8 to 9 mm in diameter. CPPU thinned and increased fruit size comparably, regardless of time of application. Flesh firmness was increased linearly with increasing concentration when CPPU was applied 19 days after petal fall, but it had no influence when applied at petal fall. Fruit L/D ratio was increased when applied at petal fall but was reduced when applied 19 days later. No treatment influenced soluble solids, red color, or fruit classified as U. S. Extra Fancy. Treatments caused irregularly-shaped fruit. CPPU applied at petal fall elongated fruit and the irregularity at this time was due primarily to an unequal length of the calyx lobes. Misshapen fruit at the later timing was due primarily to lopsided fruit, not necessarily at the calyx end.

038 (PS 2)
REDUCED CELL TURGOR DECREASES ^{14}C-SUCROSE UPTAKE IN STRAWBERRY FRUIT CORTEX TISSUE

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Reducing cell turgor of plant storage organs increases sucrose uptake and may represent a point of regulation in sucrose translocation to sink tissues. The effect on ^{14}C-sucrose uptake by strawberry fruit tissue was studied. Disks (1.3 × 7.0 mm) were cut from primary fruit of 'Brighton' and pooled in a control incubation solution of 10 mM sucrose, 50 mM $CaC1_2$ and 20 mM citric acid (pH 5.0). Disks were transferred into incubation solutions containing C-sucrose (10 mM) and increasing concentrations of mannitol, a slowly permeating osmoticum, to reduce cell turgor. A 35% decline in sucrose uptake was correlated (r = .79) with a reduction in cell turgor from 105 to 64 kPa. Mannitol neither influenced cell mortality nor membrane integrity. Substitution of mannitol with ethylene glycol, a rapidly permeating osmoticum, did not lower cell turgor or reduce C-sucrose uptake. Apparently, the decline in cell turgor, not increased solution osmolarity, was responsible for reduced C-sucrose uptake.

039 (PS 1)
EFFECT OF RAINFASTING ON FOLIAR ADSORPTION AND PENETRATION OF BENZYLADENINE AND NAPHTHALENEACETIC ACID IN APPLE LEAF DISKS

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Benzyladeneine (BA) or naphthaleneacetic acid (NAA) were applied to leaf disks. Disks were then exposed to differing amounts of simulated rain (rainfasting) at specified times after

application. The amount of 14C-BA or 14C-NAA determined immediately after rainfasting or 24 hours after application. Rainfasting reduced the amount of BA and NAA entering the leaf. More BA and NAA was removed from the upper surface than the lower surface. Less chemical was removed from the lower surface by rainfasting, presumably because of the presence of trichome on the lower surface. Extensive rinsing of the leaf surface did not completely remove the chemicals from the leaf surface. An acetone rinse was required to remove chemicals adsorbed on the leaf surface or in the surface waxes. Tween 20 removed some of the surface-bound chemicals.

040 (PS 1)
INFLUENCE OF TIME DURING THE DAY BENZYLADENINE IS APPLIED ON PENETRATION INTO APPLE LEAVES
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Penetration of foliar-applied chemicals can be influenced by a number of environmental conditions including: light, temperature, and humidity. These change during the day. 14C-benzyladenine (BA) was applied to the upper or lower surface of McIntosh apple leaves from 6:00 to 21:OO hours at 3 hour intervals. The amount of BA entering a leaf over a 24-hour period was not influenced by the time of application. Temperature was correlated with BA retention in the wax layer (correlation coefficients, r=0.064 and r=0.70 for the upper and lower surfaces, respectively) and with penetration through the upper surface (r=0.58). BA penetration into the leaf was not correlated with light intensity, relative humidity, or time of droplet drying.

041 (PS 1)
PUTRESCINE EXTENDS THE EFFECTIVE POLLINATION PERIOD IN 'COMICE' PEAR *(PYRUS CUMMUNIS* L.) DUE TO INCREASED NITROGEN CONTENT.
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Putrescine (PUT) 10^{-3} M, a polyamine applied at bloom, prolonged the effective pollination period by delayed ovule senescence and induced an earlier pollen tube penetration of 'Cornice' pear ovules without affecting flower ethylene levels. Evolved flower ethylene peaked at pollination and again at petal senescence ("in vivo") while evolved ethylene peaked only during fertilization on gynoecium cultures ("in vitro"). Endogenous polyamine levels in treated flowers were not related to ethylene levels during the post-bloom period and exhibited lower levels of evolved ethylene than untreated flowers. Putrescine-treated flowers had lower endogenous polyamine levels and higher nitrogen content than untreated flowers. Earlier pollen tube penetration and the extended 'Cornice' ovule longevity from a PUT application could be due to an increase in nitrogen content and not from a reduced level of ethylene.

042 (PS 2)
SUPERCOOLING IN FLORAL BUDS OF RIBES SPP.
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Differential thermal analysis (DTA) experiments and viability tests were conducted on floral buds of 'Danka' black current and 'Red Lake' red currant sampled from Nov. 1989 through Mar. 1990 to determine the mechanism by which these tissues survive low temperatures. Scanning electron microscopy (SEM) was also performed on the floral buds to determine the relationship between floral morphology and the freezing characteristics of the buds. Floral buds had multiple abrupt low temperature exotherms (LTEs) and one or two broad LTEs in DTA tests. Abrupt LTEs appeared to be associated with injury to the inflorescence in viability tests. The number of abrupt LTEs did not correspond to the number of racemes or flowers per bud, indicating that several flowers froze simultaneously. DTA experiments conducted in Jan. 1991 revealed that the broad exotherm detected in 'Danka' samples at -14 to -20 C resulted from the supercooling of water in the outer non-living region of the periderm of cane tissue attached to the bud sample.

043 (PS 1)
EFFECT OF CUTTING DATE, SHOOT POSITION, IBA, AND PACLOBUTRAZOL ON ROOTING OF APRICOT SEMIHARDWOOD CUTTINGS
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Apricots are typically propagated by T-budding or chip budding onto apricot, peach, or myrobalan plum seedling rootstocks. In the eastern US and Canada, propagation on apricot seedling rootstocks is preferred because of incompatibility on peach. Although growing apricots on their own roots is potentially an inexpensive alternative to T-budding, the propagation of apricot by cuttings is difficult. This study investigated the effect of cutting date, shoot position, and hormone treatment on the rooting of two NJ apricot selections, 'Jerseycot' and NJA82. Three hormone treatments were used: a) control, b) 10 sec dip in 2500 ppm IBA, and c) 30 min dip in 500 ppm paclobutrazol followed by 10 sec dip in 2500 ppm IBA. No cuttings rooted without IBA. Paclobutrazol promoted rooting of NJA82 July 25 cuttings, but it was ineffective in rooting 'Jerseycot'. Generally, terminal shoots rooted better than sub-apical water shoots and the cultivar 'Jerseycot' was more difficult to root than NJA82. The highest level of rooting (78%) was observed with July 25 cuttings of NJA82 treated with paclobutrazol and IBA.

044 (PS 2)
NITROGEN PARTITIONING IN THORNLESS BLACKBERRY
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Partitioning patterns of ^{15}N in container-grown 'Chester Thornless' blackberry [Rubus spp.) plants were determined over two growing seasons following application of $^{15}NH,^{15}NO_3$. The roots and primocane tissues, leaves plus canes, comprised the majority of the plant biomass each year. The N concentration of both primocane and floricane leaves was lower in 1988 than 1989 but was highest overall, followed by values for fruit, roots, and canes. As determined by isotope partitioning ratios, fruit and primocane cane and leaf ^{15}N enrichment from newly-acquired N were higher in 1988 than in other tissues. In 1989, when only stored ^{15}N was available, the floricane was the most enriched, followed by the fruit and roots. Thus, newly-acquired N was preferentially allocated to primocane tissues, fruit, and roots. Stored ^{15}N was allocated to all tissues from the roots and floricanes, but a significant amount remained in the floricanes. After two seasons, the roots retained only 15% of the total ^{15}N acquired.

045 (PS 1)
EFFECT OF GIBBERELLIC ACID ON ABSORPTION AND DISTRIBUTION OF ZINC-65 BY PECAN SEEDLINGS
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William A. Young, Department of Horticulture, Louisiana State University, Baton Rouge, LA 70803

Zinc is one of the essential minor nutrient elements for pecan crop. Its deficiency causes rosetting of the shoot and reduces yield. A completely randomized design with one-year old pecan seedlings grown in modified Hoagland's nutrient solution was conducted to evaluate the effect of foliar spray application of gibberellic acid on absorption and distribution of Zinc-65. Four GA concentrations (0, 1,000, 3,000 and 5,000 ppm) were used. GA treatments reduced the absorption of Zinc-65 during the study period. The distribution of Zinc-65 at older stem tissues was reduced by GA treatments. Significant increase in Zinc-65 accumulation at the apical stem portion with immature and unexpanded leaves was observed.

046 (PS 2)
GAS EXCHANGE CHARACTERISTICS OF FIELD-GROWN 'SHAWNEE' BLACKBERRY
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Gas exchange (assimilation, transpiration, water use efficiency, and conductance) of 'Shawnee' blackberry were measured under field conditions with a portable system (ADC-IRGA with Parkinson Leaf Chamber). Gas exchange primocane pentifoliate leaflets were similar. Gas exchange rates of leaves along a cane exhibited a quadratic function of leaf position with leaves in lower-mid sections (relative position 0.3 - 0.5) having higher A, TR, WUE, gs than either basal or apical leaves. Leaves subtending fruiting laterals on fruiticanes had higher assimilation than similar age leaves on primocanes but did not

differ in Tr, WUE, or g. Primocanes had estimated dark respiration rates of 0.33mg·dm^{-1}.hr^{-1}, estimated light compensation at 14-20 mol.m^{-2}.s^{-1}, estimated light saturation at 1000-1100 mol.m^{-2}.s^{-1} with maximum A rates ranging from 24-30 mg CO_2.dm^{-1}.hr-^{1}. Measurements were made at field temperatures ranging from 24-35 C. Although temperature response was not measured, correlation indicated that Tr, WUE, and gs were more closely related to temperature than A. Similarly, Tr and WUE were more closely related to gs than A (r = 0.6 to 0.8).

047 (PS 1)

THE INFLUENCE OF CONCENTRATION, SPRAY INTERVAL AND NUMBER OF APPLICATIONS OF GA_{4+7} (PROVIDE) ON SUPPRESSION OF 'STAYMAN' FRUIT CRACKING.

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Airblast applications of GA_{4+7} (Provide) were applied at 1250 1/Ha (150 gal/A), which represented 50% of the calculated tree row volume pesticide dilute water rate. Concentrations of 25 and 50 ppm were applied at two and three week intervals. Treatment trees received either four or five applications in all concentrates X interval plots. All treatments were compared to an unsprayed control. A 0.1% concentration surfactant (Tritan B-1956) was added to all applications. When all eight treatment combinations were compared to the control, the use of 25 ppm @ 2 week intervals for four applications reduced cracking by 26% from control but was not as effective as the other treatment combinations which reduced cracking by 69% to 82% and were not significantly different. Main effect comparisons showed that: 50 ppm concentration at three week intervals and the use of five applications were superior.

048 (PS 2)

GENETICS OF SHIKIMATE DEHYDROGENASE (SKDH) IN DIPLOID FRAGARIA

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A diverse collection of diploid Fragaria was examined for variation in shikimate dehydrogenase (SKDH) **isozymes.** Fragaria vesca cultivars 'Baron Solemacher' (red fruit) and 'Yellow Wonder' (yellow fruit), produced single bands of differing mobilities, which in F_1 and F_2 populations appeared to be monomeric and controlled by a single locus. Several additional polymorphisms for SKDH were identified among wild accessions.

In F_2 progenies of crosses between 'Yellow Wonder' and a 'Baron Solemacher' plant (M502D) heterozygous **for a** chlorophyll deficiency mutation, the SKDH variant and the chlorophyll marker segregated independently. Preliminary data suggest a linkage between SKDH banding pattern and fruit color.

049 (PS 1)

GROWTH INHIBITION AND ENHANCED FLOWERING OF CAMELLIA HIEMALIS 'SHISHI-GASHIRA' WITH UNICONAZOLE

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John A. McGuire, Department of Research Data Analysis, Auburn University, AL 36849

Container grown 'Shishi-Gashira' camellias received a single foliar spray of 0, 5, 10, 15, 20, 40, or 60 mg a.i. liter uniconazole on 26 May 1989. Growth indices were determined about every 4 weeks during the 1989 growing season and following the spring 1990 growth flush. Flowering was also monitored. Growth was suppressed linearly or quadratically over the duration of the test, with growth inhibition 12 months after treatment ranging-l from 3.7% (5 mg a.i. liter^{-1}) to 20.6% (60 mg a.i. liter^{-1}) relative to the control Flower number increased from 52.6% (5 mg a.i. liter^{-1}) to 100% (60 mg a.i. liter^{-1}) compared to the control.Time to flower was not affected by 5 to 20 mg a.i. liter^{-1} uniconazol but increased 4 to 7 days with the 40 and 60 mg a.i. liter^{-1} rates. Uniconazole rate did not affect flower diameter.

050 (PS 4)

RESPONSE TO AIR AND SOIL TEMPERATURE OF TOMATO GROWN IN UNHEATED HIGH TUNNELS IN CONNECTICUT

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What factors limit earliness and yield of tomato (Lycopersicon esculentum Mill) grown in unheated polyethylene-film-covered high tunnels in early spring in Connecticut? In 1990, growth and nutrient content within 2 weeks of planting, and yield of ripe fruit within 16 weeks of planting, were compared for 3 planting dates; 3 and 17 April and 1 *May,* in tunnels ventilated at 4 different temperatures; 14, 22, 30 and 38 C. The earliest ripe fruit came from 3 April transplants grown in a tunnel ventilated when air temperature exceeded 30 C. Each P-week delay in transplant delayed ripening by 2 weeks. The 3 April transplant date resulted in lower yield and smaller fruit than later plantings, perhaps due to nutrient deficiencies that developed in seedlings within 2 weeks of transplant. Dry matter accumulation rates were related to daytime air temperature, and a warmer ventilation temperature accelerated growth and development. However, nutrient uptake also depended on night time soil temperature, which was affected more by planting date than by ventilation temperature. Because of this, the best compromise for both earliness and high yield and fruit size was a mid April transplant date.

051 (PS 1)

EFFECT OF BENZYLADENINE AND MYO-INOSITOL SPRAYS ON COLD HARDINESS AND OVERWINTER SURVIVAL OF *STEWARTIA MONADELPHA* CUTTINGS

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Cuttings of *Stewartia monadelpha* root *well,* but do not survive the titer in high percentages. Bark splitting near the base. of the cuttings during overwintering indicates the tissue is not cold hardy. Benzyladenine (N-(phenylmethyl)-1H-purin-6-amine)(BA) and myo-inositol (1,2,3,4,5,6-cyclohexanehexolphosphoric acid)(MI) sprays during rooting have increased the overwinter survival rates of some cuttings. The purpose of this study is to determine the effect of exogenous sprays of BA (100 mg/liter), MI (10 g/liter), or a combination BA (100 mg/liter) and MI (l0g/liter) on cold hardiness, overwinter survival, and bark splitting. For five weeks, the sprays were applied weekly in the evenings on the adaxial leaf surfaces beginning the day (June 27) the cuttings were inserted into the propagation media. The relative cold hardiness of the cuttings was assessed by visually examining damage as stem tissue was cooled in a laboratory freezing test from 0 to -24" C. On October 24, the lowest temperatures that the cutting stem tissue survived were: stock plant (-12), control (-6), and other treatments (-9). On December 12, the lowest surviving temperatures were: stock plant (-24) and other treatments (-21). Cold hardiness will be assessed again on January 12, and overwinter survival and bark splitting results will be determined in May.

052 (PS 4)

EFFECT OF ROOT CELL SIZE AND TRANSPLANT AGE ON COLE CROP YIELDS

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Kentucky growers produce cole crops for both spring and fall markets. This study was undertaken to determine if transplant age or root cell size had an effect upon yielding ability of cabbage, broccoli and cauliflower. Transplants were grown in a glasshouse in TODD flats of various root cell sizes (18.8 to 81.4 cm") or to various ages (20 to 49 d). Seedlings were transplanted in randomized complete block designs. Normal cultural practices were utilized including overhead irrigation.

Transplant age did not significantly influence spring cabbage early or total yields in 1988 or 1989. In 1988, larger cabbage cell sizes (39.5, 81.4 cm") produced greater total yields than did smaller sizes. This difference was not significant in 1989. In 1988. older fall broccoli and cauliflower transplants (³35 d) produced significantly higher early yields. Greater total yields were obtained only with older cauliflower seedlings. Broccoli age did not influence spring early or total yields, whereas older cauliflower transplants produced higher early spring yields. In all trials, significantly higher broccoli and cauliflower early yields were obtained with larger cell sizes. Total yields were generally not improved with use of larger cell sizes. Weather conditions may have influenced transplant response over years and seasons. Larger cell sizes and older transplants should be favored for late fall plantings or when poor weather conditions are anticipated in the spring.

053 (PS 1)

USING PLANT GROWTH REGULATORS TO ENCOURAGE BUD-BREAK IN NEWLY ROOTED SOFTWOOD CUTTINGS

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Rooted cuttings of many woody species cease growth for a period after propagation. This sort of dormancy slows production, and cutting survival the first winter may be low unless new shoot growth is produced before overwintering. Studies were conducted to characterize the effects of post-propagation $GA_{4/7}$, BAP and STS foliar sprays on the growth of newly rooted softwood stem cuttings of Carpinus betulus 'fastigiata', Corylus colurna, Malus 'Spring Snow' and Syringa reticulata 'Ivory Silk'. $GA_{4/7}$ stimulated bud break in rooted cuttings of Carpinus, Corylus and Malus, but not Syringa, which broke bud 100% following natural defoliation during propagation. The addition of 10 mg-liter-^{1} BAP reduced the bud break of $GA_{4/7}$ treated Carpinus and Corylus, but not Malus 'Spring Snow' shoots. Shoots lengths also increased with $GA_{4/7}$ treatment though, again, this effect was reduced for all species, except

Malus, by the addition of 10 mg·liter^{-1} BAP. STS at 1 and 5 mM promoted bud break and shoot growth on Carpinus, and at 5 mM yielded greater shoot lengths in Syringa. It is hoped these methods of promoting the aftergrowth of rooted tree and shrub stem cuttings will contribute to greater success in the production of those woody plant species which exhibit post-propagation dormancy.

054 (PS 4)

EFFECT OF ROOT CELL SIZE AND TRANSPLANT AGE ON YIELD OF TRANSPLANTED EGGPLANT

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Kentucky growers are interested in evaluating alternative vegetable crops for successful production, This study was undertaken to determine if transplant root cell size or age had an effect upon early or total yields of 'Black Beauty' eggplant. Transplants were grown in a glasshouse in Todd planter flats in various root cell sizes (5.6, 15.4, 18.8, 30.7, 39.5, and 81.5 cm^3) and ages (28, 35, 42 and 49 days). Seedlings were transplanted in 1988 and 1989 at Lexington and Quicksand, Kentucky, respectively, in a randomized complete block design. Normal cultural practices were maintained each year, including overhead irrigation. Significant differences were observed in the early yields of eggplants as a result of transplant age or root cell size treatments. Optimal transplant age was between 35 and 49 days, with transplants of less than 35 days producing minimal early yields. In addition, significantly increased early yields were obtained with larger root cell sizes (30.7, 39.5, and 81.5 cm", in comparison to smaller cells. Growers interested in obtaining highest quality transplants and higher early market prices should consider utilizing older transplants (49 days) produced in larger cell sizes (greater than 30.7 cm^3).

055 (PS 1)

CGA-163935: A NEW GROWTH REGULATOR FOR USE IN WARM- AND COOL-SEASON TURF.

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CGA-163935 is a growth regulator being developed by CIBA-GEIGY Corp. for vegetative inhibition of warm-and cool-season turfgrass. CGA-163935 reduces cell elongation by inhibiting giberellin biosynthesis. Major turfgrass species such as St. Augustinegrass (Stenotaphrum secundatum [Walt.] Kuntz), bahiagrass (Paspalum notatum Fluegge, Bermudagrass Cynodon dactylon L. Pers.), tall fescue (Festuca arundinacea Schreb.), perennial ryegrass (Lolium perenne L.) red fescue (Festuca rubra L.) and Kentucky bluegrass (Poa pratensis L.) have shown activity from applications of CGA-163935. Effective use rates vary from 200 to 1000 g ai ha^{-1} with excellent crop safety. Factors which influence optimum use rates include turf species, application timing, environmental conditions and duration of desired inhibition. Following application, reduced foliar growth has led to reduced number of mowings, clipping weights per mowing, stolon growth and seedhead production. For example, a single application at 800 g ai ha^{-1} reduced the number of mowings of St. Augustinegrass, bahiagrass, and bermudagrass 66%, 57% and 33%. respectively, for a period of six weeks and tall fescue mowings were reduced 50% for seven. weeks.

056 (PS 4)

INFLUENCE OF CELL SIZE, HYDROGEL, AND DROUGHT STRESS ON BELL PEPER TRANSPIRATION, WATER USAGE, AND GROWTH

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'Giant Keystone Resistant' pepper seedlings *(Capsicum annuum* L.) were grown in Speedling cell sizes: 200 (73 cm^3), 150 (31 cm^3), or 100A (19 cm^3). The roots of six-to seven-week-old seedlings were dipped in Hydrosource gel (3.5 g polymer liter^{-1} of water), transplanted in either plastic or peat pots and repeatedly drought stressed. Seedlings grown in the 200 cell size had greater fresh plant and root dry weights, and leaf numbers than smaller cell sizes. Transpiration and irrigation frequency were unaffected by cell size. but total water applied was higher for the largest cell size. Plant growth, transpiration rate, water usage, and irrigation frequency were unaffected by root dips. Interactions between cell size, root dips, and/or drought stress were very small and negligible. The use of root dips and larger cell sizes to ameliorate drought stress was not justified.

057 (PS 1)

EFFECT OF DIKEGULAC ON FLOWERING AND GROWTH OF BOUGAINVILLEA 'RAINBOW GOLD'

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Profitability and production of hanging baskets of bougainvillea, a short day species, could increase if vegetative growth and flowering were more easily controlled. Rooted liners of Bougainvillea 'Rainbow Gold' in 11.4-cm pots (3 liners/pot) were transplanted into 25.4-cm baskets on 1 Aug. 1990 and pruned on 3 Aug. The plants were then treated with dikegulac (ATRIMMEC; PBI/Gordon) as follows: 0 ppm, 1200 ppm at 0 or 4 weeks after pruning (WAP), or 600 ppm at 0 and 2 WAP or 4 and 6 WAP. There were 6 replications per treatment in a CRD. Plants were grown under full sun. Plants not sprayed with dikegulac at 4 or 6 weeks were pruned again at 4 weeks. Marketable hanging baskets of 'Rainbow Gold' bougainvillea were produced from rooted liners in 9 weeks when treated with 1200 ppm dikegulac 4 WAP. Application of 600 ppm dikegulac at 4 and 6 WAP similarly enhanced flowering but the overall quality of these plants was less. While dikegulac improved flowering, it did not affect bract size, branching, height, width, or the clippings dry weight.

058 (PS 4)

GAS EXCHANGE, CHLOROPHYLL CONTENT AND LEAF AREA INDEX OF OKRA AT SIX IN-ROW PLANT DENSITIES

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The effect of in-row plant densities on gas exchange, chlorophyll content and leaf area index of okra *(Abelmoschus esculentus* (L.) Moench) was studied. The six in-row plant densities ranged from 8 cm to 48 cm (D1 - D6). On 11 and 27 July 1990, the photosynthetically active radiation (PAR), transpiration (E), net photosynthesis (P_n) and chlorophyll content (Chl) at top- and mid-canopy levels and leaf area index (LAI) were measured. Mid-canopy PAR was 86 ± 6% less than that of the top-canopy and E, P_n and Chl at mid-canopy were respectively 55, 90 and 10% lower than those of the top-canopy. The interaction of plant density with canopy position was significant for E and P_n. The highest E and P_n, (12.28 mmol $m^{-2} s^{-1}$ and 22.01 µmol $CO_2 m^{-2} s^{-1}$, respectively) were recorded at the D5 top-canopy. In-contrast, the lowest E and P_n, (4.17 mmol $m^{-2} s^{-1}$ and 1.23 µmol $CO_2 m^{-2} s^{-1}$, respectively) at the D6 mid-canopy were recorded. The LAI also exhibited significant variation among plant densities with a range of 4.65 to 4.97 for D5 and D3, respectively. These results indicate that 40 cm in-row density was the most suited for gas exchange of okra.

059 (PS 3)

POST-PLANTING MANAGEMENT EFFECTS ON TRANSPLANTED CONTAINER-GROWN, FIELD-GROWN, AND FABRIC CONTAINER-GROWN TREES

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Municipalities and others purchasing trees can select from container-grown, field-grown or fabric container-grown trees. However, there is no scientific data on the merits of choosing among these tree production methods. Three-liter sized laurel oak, American holly and slash pine were planted into 56-liter containers, planted in the field or grown in fabric containers in the ground. All trees were grown under standard production practices for 2 years. The 180 trees in the study ranged from 5-8 cm caliper and 3-4 m tall at transplanting. More than 90% of total root weight was harvested within the root ball of field-grown and fabric container-grown trees. However, only 13 and 10% of the weight of roots less than 2mm in diameter was within the bail of field and fabric-container-grown trees, respectively. There were no differences in photosynthesis, stomatal behavior and water stress among tree production methods if trees were irrigated daily following transplanting. In contrast, when irrigation was withheld for cyclic lo-day periods, field-grown and fabric container-grown trees were severely water stressed: whereas, container-grown trees exibited minimal stress. Photosynthesis in trees transplanted from the two in-ground production methods was less than in trees produced in containers. Root regeneration on trees recieving daily irrigation after transplanting was greater than on those subjected to drought stress. There was no differece in root regeneration among production methods.

060 (PS 4)

IN VITRO CONTROL OF *PHOMOPSIS* SHOOT BLIGHT FUNGI WITH FAERIEFUNGIN, A NOVEL ANTIBIOTIC PRODUCED BY *STEPTOMYCES GRISEUS.*

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Several species of *Phomopsis* cause stem cankers and shoot blights of horticultural crops, including spruce, juniper, blueberry, and grape. Fungicide sprays currently used against *Phomopsis* species provide only limited control. Alternate strategies *are* needed to provide improved disease suppression, particularly considering the potential for these organisms to acquire resistance to fungicides.

Streptomyces griseus var. autotrophicus (ATCC 53668), an actinomycete isolated from soil obtained from a fairy ring, produces strong antifungal antibiotic, faeriefungin. In vitro assays of faeriefungin activity on two *Phomopsis* species were conducted. Conidia harvested from cultures of *Phomopsis occulta* and *P.vaccinii* were used to prepare lawns on plates of potato dextrose agar. Aliquots (25µl) of DMSO containing 1, 10, 2.5, 50, and 100 ppm faeriefungin were placed in the center of the lawns and incubated at 30°C for four days. Faeriefungin was found to have inhibitory activity at 1 part per million against both *P. occulta* and *P.vaccinii.* The results of assays against several other species of *Phomopsis* will also be discussed.

061 (PS 3)
POTENTIAL OF THREE CALCIUM SOURCES FOR INCREASING CALCIUM CONTENT AND MAINTAINING FIRMNESS OF APPLES DURING COLD STORAGE

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Five cultivars of apple fruit *(Malus domestica* Borkh.) were pressure infiltrated at 103.4 kPa for 6 minutes with 0, 0.73, 1.46, 2.91 or 5.82 % (w/v) solutions of calcium as either $CaCl_2$, calcium EDTA chelate, or Stopit™. The fruit were stored at 1°C for 3 months, then evaluated for firmness, injury, and calcium content.

The calcium chelate treatment resulted in the least increase in fruit calcium levels, and was highly injurious at all treatment levels across cultivars. There were no significant differences between the effects of $CaCl_2$ and Stopit™ treatments across cultivars. As the calcium concentration in solution was increased, tissue calcium levels (2-4 mm depth) increased up to 800%, and firmness increased up to 41%. Firmness and fruit calcium levels were positively correlated for $CaCl_2$ and Stopit™ treatments. Both compounds caused injury that would affect marketability at solution calcium concentrations above 2.91%.

062 (PS 4)
THE EFFECT OF SOLARIZATION ON SEEDLING DISEASES OF SPINACH IN ARKANSAS.

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Thirty (S30) and 60 (S60) day solarization treatments were evaluated for their effect on seedling diseases of spinach. Additional treatments included methyl bromide (MB), a metalaxyl drench (R), and a non-solarized control (C). Solarized plots were covered with 4 mill clear polyethylene plastic. S60 and S30 treatments were established in July-August or August, respectively immediately prior to planting. Cultivars Grandstand and Fall Green were planted (250 untreated seed/7m row) on 9/25 or 10/24. Data were collected on stand counts and plant vigor and isolations were made from all dead or dying seedlings. Mean stand counts for the C and S60 treatments were significantly different (P=.05) for both planting dates. For planting date one, counts averaged 12-26 or 97-106 plants/7m for the C and S60 treatments, respectively for the two cultivars tested; planting date 2, counts averaged 61-89 (C) and 149-157 plants/7m (S60). The **highest to** lowest stand counts were observed in the S60, S30, MB, R, and C treatments. Rhizoctonia solani was recovered from over 95% of dead or dying seedlings. Fusarium oxysporum and Pythium spp. were also recovered, but at a much lower frequency.

063 (PS 3)
SURFACE COVER PROVIDED BY SELECTED VEGETABLE CROPS

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Crop Surface Cover is widely recognized as a major factor affecting soil erosion. The effectiveness of ten crops grown over a period of twelve months was measured for surface cover, canopy height and width and days to reach maximum cover. During the twelve month period, squash achieved maximum cover before other crops. However, sweet potatoes produced a denser cover than other crops. Relationships for estimating vegetable surface cover from vegetative mass is presented. In a cropping system, vegetable crops could serve as an important component in reducing soil erosion.

064 (PS 4)
EFFECT OF TARNISHED PLANT BUG ON YIELD OF DRY BEANS

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In 1989, a study was undertaken to determine the effect of tarnished plant bugs (TPB) (Lygus sp.) on dry bean yield in response to growers concerns. TPB are known to cause economic injury in lima beans in NY.

Treatments consisted of insecticide sprays at bud, blossom and pinpod stages respectively, at bud, blossom and pinpod stages; systemic insecticide application at planting and no insecticide check. TPB populations were monitored from bud through pinpod stages. Highest populations were found in the untreated check, averaging one TPB per sweep. No significant differences were found among treatments in yield or in number of pods per ten feet of row.

In 1990, 35 dry bean fields were monitored to determine if populations of TPB were consistent with levels found in the 1989 trials. Maximum population levels were found to average one TPB per sweep. At this population level, no decrease in dry bean yield is expected.

065 (PS 3)
EFFECT OF MULCH ON THE GROWTH AND DEVELOPMENT OF LATE FALLTOMATOES

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The objective of this study was to determine if different mulches would affect days to flowering or prolong the fall growth for tomatoes *Lycopersicon esculentum.* The mulches used were: black plastic, white plastic and straw. The tomatoes were transplanted to the field on 20 September 1990. Diurnal atmospheric and soil (just under the mulch) temperatures were taken at 12:00 noon. Average daily soil temperatures in September were 24°C, 22.5°C, 22°C and 21.5°C for black plastic, white plastic, the control, and straw respectively. Average soil temperatures ranged from 28.5°C for black plastic to 24.5°C for the straw treatments. Temperatures in October and November were 3 to 4 degrees lower for soils and between 4 to 7 degrees lower for the atmosphere. Average days to flowering were 68, 70, 68.5, and 75 for black plastic, white plastic, control, and straw treatments respectively. The average growth per plant were 20.5, 22.5, 25.9, and 12.5 centimeters for black plastic, white plastic. control. and straw respectively.

066 (PS 4)
HOPS VARIETY TRIALS FOR NEW ENGLAND

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With the increased interest in small scale and home brewing in New England, the potential exists for limited production of high quality hops (Humulus lupulus).This study was begun to compare potential growth, yields, quality and problems of common varieties in New England. Three replicate plants of each of 14 varieties were planted late fall 1933 in Burlington, with first data taken in 1990. Mean vine length, fresh weight of cones per vine, and alpha acid content, respectively, were: Aquila 3.9m, 415g, 4.00%; Backa 4.7m, 133g, 0.38%; Chinook 4.0m, 377g, 8.08%; Elsasser 3.6m, 44g, 0.52% Fuggle 2.4m, 19g, 1.89%; Calena 4.3m, 369g, 8.44%; Hallertauer 3.6m, 37g, 1.95%; Hersbrucker 3.7m, 66g, 0.76%; Mt. Hood 2.9m, 52g, 1.24%; Nugget 3.2m, 92g, 5.73%: Perle 1.7m, 12g, 2.60%; Saaz 2.9m, 10g, 1.00%; Willamette 3.5m, 153g, 4.83%. Illustrations, further descriptions of varieties and data wi11 be presented.

067 (PS 3)
PREEMERGENT REPRODUCTIVE SUCCESS IN CACAO (THEOBROMA CACAO L.)

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Seasonal cacao bean distribution, pollen availability and their relationship to pod set were examined in a cacao field. Five blocks of 16 trees each were selected for the experiment, which continued for one year. Pollen availability was monitored from one of the five blocks on a single day. Ovules/ovary count was done at the same time. The number of pods and beans/pod, were evaluated monthly and bimonthly, respectively, for a year on each of the selected trees. Pollen rarity index, calculated by Pareto's distribution, could not predict the fruiting capacity of the cacao tree. Only 0.72% of the flowers examined had 35 or more pollen grains on their stigmas, the number considered necessary for the pod setting. Ovules/ovary were normally distributed, but beans/pod were not.

068 (PS 3)
ELITE TREE SELECTION IN CACAO (THEOBROMA CACAO L.)

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A field selection of cacao trees producing 60 or more pods was started in 1985. Further selection criteria were pod index and fat content. A selection index of four was used as a final criterion for further

propagation of a selected tree. Total yield, bean size and fat content were used to calculate the selection index. Initially, 150 trees were selected and further selection pressure yielded 50 trees. Fifty trees were followed for pod index and fat content for two years. The leaf, fruit and beans of the selected trees were described. In a field trial two of the selections yielded significantly higher than the eight elections and one of the selections had a significantly lower pod index than the remaining nine selections. Fat content of the selections varied from 48 to 55%.

069 (PS 3)

CHUPON BUDDING IN CACAO (THEOBROMA CACAO L.)

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Mature tree budding has been used in the past in Malaysia to improve the yield of the low producing trees. The main trunk of the cacao tree is budded with the scion of an elite tree. A mature tree budding project was initiated wherein chupon budding was adopted because it is easier and similar to the budding technique used in the nursery. Ninety low producing trees were pruned to initiate chupons. Two chupons per tree were retained for budding. Regular patch budding was used. All of the chupons were budded on the same day. The buds were released in two weeks. After the successful growth of the scion, the branches above the bud patch, were pruned from from the mother tree, to accelerate the scion growth. Presently 150 chupons or 75 trees can be budded per man day. An average success rate of bud take was 74%. Presently scion growth is being monitored on a monthly basis. Some of the scions are about a year old, but none have set pods.

070 (PS 3)

A COMPARISON OF POST-BUDDING TREATMENTS OF CACAO IN THE NURSERY

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The percentage of bud burst, survival and growth was influenced by the budding site and post-budding treatment. Cacao (Theobroma cacao L.) seedlings budded at the cotyledonary node performed better than those budded at the eighth node above the cotyledon. Scions patch budded at the cotyledonary node performed best if four to eight leaves were left above the bud patch and the rest of the stem excised. Poor treatments were total leaf removal and decapitation two to three inches above the bud, bending the stock plant stem and removal of the apical bud.

071 (PS 3)

ESTIMATION OF GENETIC RELATIONSHIPS IN THEOBROMA CACAO

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Cacao is an important crop in the tropics, but its breeding has been hampered by a lack of understanding of its genetics. One result of this has been the introduction of "hybrid" trees which did not perform predictably under various environmental conditions. We are studying the inheritance of isoenzyme, RFLP, and Random Amplified Polymorphic DNA (RAPD™) markers in order to estimate the genetic relationships among and between populations. Our objectives include determining if any linkage exists between these molecular markers and witches' broom (Crinipellis perniciosa) resistance, a major disease of cacao.

072 (PS 4)

EFFECTS OF PRIMING ON BROCCOLI SEED GERMINATION AT HIGH TEMPERATURE

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In Southcentral Virginia, stands of summer direct-seeded broccoli are often poor because of high temperatures, soil crusting, and water stress. To assess the performance of primed seeds under these conditions. germination studies were conducted in the laboratory and the field. Seeds (cv. Packman) were primed in a 1.0:0.8:0.8 ratio of seed, vermiculite, and water, respectively, for 7 days at 20°C; in 0.31 grams PEG 8000 per gram water ($\psi = -1.2$ MPa) for 7 days at 20°C; or in water for 6 hours at 20°C. Prime seeds were redried prior to germination. Two replications of 25 seeds each were germinated in petri dishes on blotters saturated with water at constant 35°C and scored periodical1 for radicle emergence. Seeds primed in moist vermiculite had the lowest mean time to germination (MTG) (11.8 hours). The MTG of seeds primed in PEG was significantly greater than in vermiculite (13.4 hours but significantly less than seeds primed in water or unprimed seeds (27.1 and 26.7 hours, respectively). Germination percentages did not differ significantly, and were greater than 92%. High temperatures had little effect on radicle emergence, but may reduce root growth. Field emergence of 4 replicates of 100 seeds each of PEG primed and unprimed seeds (cv. Earl Dawn was compared in Halifax Co. VA. The mean daily temperature during the test was 25.3°C, and the plot was irrigated 24 hours before and after planting. There was no significant difference in the mean time to emergence (104 and 129 hours) or the total emergence (43 and 28%) of primed and unprimed seeds, respectively.

073 (PS 3)

CACAO SEED MATURITY AND ITS EFFECTS ON THE GROWTH OF THE NURSERY ROOTSTOCKS

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The object was to study the effect of cacao seed maturity on the rootstock in a nursery. Pollinations were done at 15 day intervals to obtain 156, 170 and 184 day old pods. Seeds from each of the maturity classes were planted individually in 30 15x25 cm plastic bags. Previous studies resulted in no significant effect of bag and seed size on the root stock growth in the nursery. Initially the height and the trunk diameter were measured when 50% of the seedlings shed their cotyledons, and a final reading was taken six month after planting. Leaf length and width of the first four hardened leaves were measured when 50% of the seedlings shed their cotyledons. Dry weight of the shoot was determined six month after planting. The least mature seeds were inferior to the other two classes in all the parameters measured. Hence, seeds from mature but unripe pods are suitable for rootstock production.

074 (PS 3)

HIGH-INTENSITY PLANTING SYSTEM IN CACAO (THEOBROMA CACAO L)

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In Central America cacao groves are usually established at densities of about 1100 trees/ha with seedlings from F1 hybrids families. High-intensity production with 2,000 to 4,000 budded trees/ha are being developed in Malaysia and the Philippines. A demonstration plot of a high-intensity cacao planting system was established. Five elite tree selections were budded onto rootstocks, obtained from the seeds of the Ceratocystis fimbriata resistant trees. Budlings from each of the five selections were grown in 21 single rows, making a total of 105 rows. The trees were planted at the vertices of equilateral triangle with 2.44x2.44x2.44m resulting in 1937 trees/ha. Each budling was planted under an Erythrina poeppiziana shade tree. Shade was thinned from 2.44x2.44x2.44 m to 9.7x9.7x9.7m during the first two years. The observations recorded were: semiannual height and girth of the trees and fortnightly total yield by row. The yield of the two selections was significantly higher than the remaining three selections.

075 (PS 3)

INTRODUCTION OF INDIGENOUS PLANTS TO FOOD GATHERERS IN AMAZONIAN ECUADOR

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As a consequence, of developmental activities in Tropical America, traditional cultures tend to disappear and so also the lore of plant utilization. Certain plants are already at the risk of extinction. Developmental activities in Ecuador are just being initiated currently, and many traditional societies in the East are still subsisting from plant gathering for food or medicine. Germ plasm of selected plants, highly valued by the indigneous population is collected and nurseries are established. Ultimately, plantlets are distributed among the indigenous people. In this way, introduction of novel agricultural practices will be stimulated to both ameliorate economy and help preserve highly important, yet unknown, plant species. Four nurseries have already been established along the Napo river. Methodology and relevant data of first-year work are discussed.

076 (PS 4)

CULTURAL PRACTICES IN WARM CLIMATES LEADING TO POTATO PRODUCTION FROM BOTANICAL SEED

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Experiments were conducted utilizing botanical or true potato, Solanum tuberosum, seed (TPS) of a white-skinned hybrid in southern Florida. Goals included producing virus-free seed tubers and tubers of marketable size within one season. Experiments included an evaluation of methods for pre-germinating seeds and sowing in various artificial media, application of growth regulators as seed priming treatments, and application of supplemental nitrogen fertilization during the growth of the plants. Plantings were evaluated at various temperatures to determine the effects of cooler temperatures on potato seedling growth and tuber formation. Pre-germinated seeds mixed in a moist peat-vermiculite mixture emerged readily at 20C within 4 days after planting. Growth regulator application lo seeds had no effect on germination or emergence.

077 (PS 3)

MECHANICAL HEDGING DOES NOT DECREASE YIELD OR ALTERNATE BEARING OF PISTACHIOS

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Pistachios bear on 1 year old wood; inflorescence buds for a crop are differentiated the previous growing season. Both thinning and heading pruning cuts typically remove buds. However, preliminary work has suggested that moderate mechanical pruning does not decrease yield.

Two moderate mechanical hedging treatments, heading 1 and 2 year-old wood, was done during the dormant season prior to both on- and off-year alternate bearing Pistacia vera, cv Kerman, pistachio trees. The treatments were a hand pruned control, a l-sided hedge, and hedging on both sides; applied prior to the on-year in 1988 and the off year in 1989.

Thus far, all three treatments, of both on- and off-year dormant mechanical hedging have produced no significant differences in nut yield quality, and tree growth. However, the data suggests that, prior to the on-year, the loss of buds sustained by moderate pruning is compensated for by the tree's ability to set more nuts per cluster. This effect did not appear to be operative during the off-year. Further data suggested that only dormant pruning produced this effect.

078 (PS 4)

EFFECT OF RELATIVE PLANTING DATE ON INTERCROPPING

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Intercropping is a management system that maximizes production per unit area of land. Intercropping has to be carried out with crops that are compatible in order to ensure increased productivity. An intercropping study was conducted to determine a suitable planting pattern for corn (Zea mays), an overstory crop, and sweetpotato (Ipomoea batatas), an understory crop. Five relative planting dates were established for each component crop (3 week; before, 3WB; 2 weeks before, 2WB; simultaneous, SIM; 2 weeks after, 2WA; and 3 weeks after, 3WA planting the other crop). Monocrop of each component was also planted. The marketable yields of sweetpotato were reduced by 48, 57, 75, 76 and 74% when sweetpotato was intercropped with corn and planted 3WB, 2WB, SIM, 2WA and 3WA corn, respectively. Corn grain yields were reduced 28, 28, 26, 57, and 66% when intercropped with sweetpotato beginning 3WB, 2WB, SIM, 2WA and 3WA sweetpotato, respectively. Although yields of individual component crop were reduced in intercrop, there was no significant difference in land utilization. Land equivalent ratio, area time equivalent ratio, and competition ratio were not significantly affected by planting date. Intercropping corn and sweetpotato was compatible when both crops were simultaneously planted.

079 (PS 3)

BIOLOGICAL CONTROL OF THE ORANGE SPINY WHITEFLY IN CAROLINE ISLANDS

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The orange spiny whitefly, Aleurocanthus spiniferus (Quaintance) (Homoptera: Aleyrodidae) was first reported on Yap in 1987 and on the island of Moen, Chuuk in 1989. When a heavy infestation of A. spineferus was observed on many citrus trees, introduction of Encarsia smithi (Silvestri) (Hymenoptera: Aphelinidae) was initiated to control A. spiniferus on Nov. 1, 1989 in Chuuk and Sept. 26, 1990 in Yap. In Chuuk, the establishment of the wasp was confirmed on Sept. 5 1990 with the great reduction on population of the whitefly on the island and the establishment and effectiveness of E. smithi on Yap is presently evaluated.

080 (PS 4)

EFFECTS OF TILLAGE AND MULCH ON THE EMERGENCE AND SURVIVAL OF WEEDS IN SWEET CORN

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The types of disturbance induced by management practices largely determine the characteristics of the weedy vegetation in agricultural systems. To increase production efficiency, agriculturalists would like to be able to predict the outcomes of management options on weed populations in the field. Such predictions require an understanding of the response of demographic parameters of weed populations to a range of management practices. This paper reports the effects of two tillage regimes (till and no-till) combined with two mulch regimes (no mulch and rye *(Secale cereale)* mulch) on the emergence and survival of weeds in sweet corn *(Zea mays)*. Most abundant weed species exhibited significantly lower emergence in till than no-till. Survival of *Amaranthus* was significantly greater in no-till. Presence of corn or corn and rye mulch significantly decreased emergence for all species at one or more censuses. Rye mulch slightly decreased emergence and had no effect on survival.

081 (PS 3)

OCCURRENCE OF CITRUS NEMATODE IN FLORIDA

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Ten mature citrus groves in each of 5 central and southern Florida counties were sampled to determine the incidence and population levels of citrus nematode (Tylenchulus semipenetrans). At each site 20 trees were randomly selected within an 8 ha block. Eight samples per tree, consisting of soil and roots taken within the dripline at a 15-30 cm depth, were subsampled to provide a 1-liter sample for analysis.

Eighty-eight percent of the 50 groves sampled were infested with citrus nematode, with nematode number per 100 cc soil in each of 20 samples per grove ranging from 0 to 1098. More groves were infested at higher levels in older interior and coastal flatwoods citrus areas with deeply drained sandy and poorly drained flatwoods soils, respectively, than in newly planted interior flatwoods soils. Incidence and population of citrus nematode in each grove was correlated with rootstock, soil type, organic matter, pH and soil nutrient levels.

082 (PS 4)

DIFFERENTIAL TOLERANCE OF SELECTED COLE CROPS TO CLOMAZONE

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Preliminary field and greenhouse studies indicated differential tolerance of various cole crops to the bleaching herbicide clomazone [2-(2-chlorophenyl) methyl-4,4-dimethyl-3-isoxazolidone]. Field observations also indicated red cabbage was more tolerant to clomazone (PPI) than green cabbage. A seedling bioassay was developed to examine the effect of clomazone on inhibition of total extracted chlorophyll and carotenoid content. I_{50} values for total chlorophyll were 16, 11, 3 and 11 µM clomazone for broccoli, cauliflower, green and red cabbage, respectively, while I_{50}) values for carotenoid content were 20, 10, 4 and 8 µM. Laboratory studies were conducted to investigate the influence of uptake, translocation and metabolism upon clomazone selectivity in these 4 crops over 96 h. Seedlings (2TL stage) were placed in a nutrient solution containing ^{14}C-clomazone to allow root uptake. Roots and shoots were separated and weighed and tissue was homogenized and extracted. There were no major differences in uptake or translocation between these crops. After 24 hours, 3 to 4 polar ^{14}C-metabolites were observed and their percentage did not vary over time. The percentage of ^{14}C-clomazone decreased over time as nonextractable ^{14}C levels increased, indicating a conversion of clomazone by cole crops to insoluble non-extractable forms. No major differences in conversion between species was noted. Observed tolerance differences to clomazone among cole crops may be due to differences in sensitivity at the site(s) of action rather that differential metabolism.

083 (PS 3)

TRANSFORMATION STUDIES ON CITRUS VIA AGROBACTERIUM TUMEFACIENS

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Citrus (Swingle) shoot tips (1 mm), stem cuttings and root cuttings (0.5 cm) were co-cultivated with *Agrobacterium tumefaciens* (LBA 4404) carrying the plasmid P GUS 3. This plasmid contained the reporter genes glucuronidase and NPT II.

Selection for transformed cultures was done on media containing 100 mg/l kanamycin, a concentration lethal to nontransformed citrus shoot tips.

The number of kanamycin tolerant regenerated shoots varied with the explant type. Fourteen (14) out of 111 shoot tips, 32 out of shoots from 256 stem cuttings and 89 out of shoots from 239 root cuttings survived repeated subcultures on kanamycin containing media.

Additional transformation studies will be done and the results will be discussed.

084 (PS 4)

USING POSTEMERGENT HERBICIDES TO MANAGE ALLELOPATHIC COVER CROPS FOR WEED CONTROL IN VEGETABLE CROPS

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Cropping systems that maintain plant residues on the soil surface are a very effective means of reducing weed problems, conserving soil moisture, and preventing soil erosion. Field studies have shown that management of the cover crop is critical for successful establishment of vegetable crops. One method to manage cover crops is to use a herbicide with foliar activity. Greenhouse experiments were established to determine the activity of postemergence herbicide on rye, hairy vetch, and Austrian winter pea. Ten days after treatment, injury was rated and the shoots were harvested. Regrowth observations were taken weekly after harvesting the shoots. Glyphosate and paraquat were the most effective herbicides for dessicating the cover crops. Regrowth of the cover crop was a problem with paraquat. Glyphosate was the most effective herbicide to prevent regrowth.

085 (PS 3)

USE OF GIBBERELLIN TO CONTROL ANTHESIS IN COFFEE FOR IMPROVED MECHANICAL HARVESTING

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The control of flowering and subsequent fruit ripening will improve the efficiency of coffee mechanical harvesting.

Two forms of gibberellins (GA3 and GA4&7) at 50 and 100 mg/l were sprayed to bearing 'Guatemalan' coffee trees when most of the first flush of flower buds were present at the "open white cluster" stage.

Gibberellin treatments increased the number of open flowers 12 days after application from 39% of the total buds to near 81% and reduced the harvest period by almost half.

The results suggest that gibberellin is a potentially important growth regulator to reduce the coffee harvesting period.

086 (PS 4)

ROTATING ROPE CURTAIN INCREASES PEACH THINNING RATE AT FULL BLOOM

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Studies were conducted on peach [Prunus persica (L.) Batsch] during 1988 and 1990 to test the performance of a tree-width rope curtain bloom thinner and a rotating rope curtain thinner. Six trips over the tree canopy were required with the tree-width rope curtain, and only one trip was *re*-quired with the rotating curtain to thin to an approximate spacing of **1** flower/9 cm of fruiting shoot length. Based on no. flowers/cm2 branch cross-sectional area (CSA) immediately following thinning and no. fruit/cm^2 CSA following June drop, rope curtain thinning was equal to hand thinning at full bloom (FB). Rope curtain thinning reduced hand thinning time by 40% and increased harvest fruit weight by 10 to 20%. Research on various modifications in tree training/pruning indicated that performance of the mechanical thinner was negatively correlated with shoot density. Thinning was maximum on open center trained trees in which detailed pruning had been conducted to eliminate overlapping shoots.

087 (PS 3)

EFFECT OF LEAF POSITION AND ANATOMY ON GAS EXCHANGE OF *COFFEA ARABICA* L. GROWING IN A HEDGEROW SYSTEM UNDER HAWAIIAN CONDITIONS

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We studied light penetration and utilization in relation to canopy structure of hedgerow-grown coffee trees (cv. Guatemalan) in Hawaii. Net CO, assimilation, photosynthetic capacity at saturating light, and leaf nutrient content were related to position within the canopy but not to direction of exposure. These differences were associated with distribution of light within the canopy and with leaf anatomical properties. Maximal carbon assimilation occurred earlier in the morning in upper and mid-canopy leaves than in lower leaves. Maximal assimilation rates were reduced by 50% in lower leaves. These results have implications for pruning decisions' during development of the intensive hedgerow system proposed for irrigated, leeward areas of Hawaii.

088 (PS 4)

SUBTERRANEAN CLOVER (TRIFOLIUM SUBTERRANEUM L.) GROUND COVER AFFECTS ON GROWTH AND FOLIAR NUTRIENT STATUS OF YOUNG PEACH [PRUNUS PERSICA (L.) BATSCH]

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Growth and foliar nutrient status response of young peach trees was evaluated in two-year studies comparing in-the-tree-row subterranean clover (SC) and conventional herbicide strip (HS) orchard floor management systems. Peach trees were planted into existing 2.6m subterranean clover strips. In another experiment, SC treatments were established four months after tree planting. In each experiment, growth of HS trees was greater in year 1. Differences were most pronounced in trees planted into existing clover. In year 2, increased shoot growth of SC trees, coupled with smaller trunk cross-sectional area differences, suggests a recovery from the growth effects of year 1. N, P, and K foliar levels were lower in established SC trees only in year 1. In both experiments, Ca and Mg levels in SC trees were equal to or slightly lower than HS trees. Although significant differences in nutrient levels existed between treatments, these levels were generally within the sufficiency range for peach.

089 (PS 3)

FLOODING AND NET GAS EXCHANGE OF APPROACH-GRAFTED AVOCADO TREES

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Pairs of avocado *(Persea americana* Mill. cv. Simmonds) trees were approach grafted at mid-stem to form experimental units with independent root and shoot systems on either side of the graft union. Soil on one side of the graft union (treated side) was either infested or not infested with *Phytophthora cinnamomi,* and phytophthora root rot was allowed to develop for 5 months. The treated side of each experimental unit was then flooded for 16 days; nontreated sides were not flooded. Net CO_2 assimilation (A) and stomatal conductance for CO_2 (g_c) were determined periodically during the flooding period for treated and nontreated sides of the graft union. Phytophthora root rot decreased A and g_c. However, reductions in A and g_c were greatest for flooded plants, regardless of whether or not plants were infected by *P. cinnamomi.* Flooding resulted in lower A for the treated side than for the nontreated side of the graft union. In contrast, flooding reduced g_c of both sides of the graft union. The data indicate that factor(s) responsible for reduced g_c in flooded avocado plants are apparently graft transmissible.

090 (PS 4)

EFFECT OF ORCHARD FLOOR MANAGEMENT AND ROOTSTOCK ON CARBOHYDRATE LEVELS OF 'REDHAVEN' PEACH

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Trees of 'Redhaven' peach *[Prunus persica (L.)* Batsch] budded to 'Lovell', 'Bailey', and 'Nemaguard' rootstocks were grown with either Bahiagrass or cultivated orchard middles. Terminal shoots were collected once a month through the **dormant season.** Trees with cultivated orchard middles had significantly greater levels of soluble sugars than those with sod middles. Levels of starch from each sampling date will be discussed.

091 (PS 3)
A NONDESTRUCTIVE METHOD TO MEASURE CHLOROPHYLL IN CITRUS LEAVES

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The Minolta chlorophyll meter SPAD-502 (Minolta Camera Company, 101 Williams Drive, NJ 07446, USA) was evaluated as an accurate, nondestructive means to measure chlorophyll content in citrus leaves. Meter readings from leaves of sweet orange and grapefruit citrus cultivars were used to develop a standard curve for citrus. A significant correlation value of 0.96 was calculated between the chlorophyll meter readings and actual chlorophyll extraction levels. The development of a standard curve using the SPAD-502 chlorophyll meter had not been established on citrus. The SPAD-502 chlorophyll meter proved to be a quick, accurate, simple, and nondestructive way to determine chlorophyll content in citrus leaves.

092 (PS 4)
RIPENING AND STORABILITY OF 'LIBERTY' AND 'EMPIRE' APPLES

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Ripening of 'Liberty' and 'Empire' apples was compared in 1988-90. The internal ethylene of 'Liberty' fruit reached 1 ppm approximately 7 to 10 days before 'Empire.' 'Liberty' and 'Empire' fruit both attained acceptable eating quality on approximately 30 Sept. each year. Generally, 'Liberty' fruit were firmer and had a higher soluble solids content than 'Empire' fruit. Storage properties were compared in 1988 and 1989. In 1988, fruit were harvested at weekly intervals from 20 Sept. to 12 Oct. and kept at 0C for 2.5 months. The firmest fruit of both cultivars were from the 27 Sept. harvest. Fruit of both cultivars harvested on 27 Sept. 1988 retained firmness better when kept at 3.3C, 3% O_2, 5% CO_2 than when kept at 0C, 3% O_2, 2% CO_2. Data from 1989 showed that 'Liberty' developed large amounts of browncore in controlled atmospheres at either 0C or 3.3C. The incidence of browncore in refrigerated storage declined with later harvests.

093 (PS 5)
POSTHARVEST DISEASES OF PACKAGED GREEN CHILE PEPPERS

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High postharvest water loss limits the shipping of fresh green chile peppers. Packaging green chile in semipermeable polyethylene bags reduces transpiration losses, but increases the incidence of postharvest diseases. New Mexico chile peppers were packaged and stored for 6 weeks at 8° C and 22° C. Postharvest disease developed within 2 weeks on peppers stored at 22° C and within 4 weeks at 8° C. Unpackaged controls had no disease, but were dehydrated after 1 week and considered unmarketable. Fungal pathogens isolated and identified from packaged chile included *Alternaria* species, *Fusarium* species and *Cladosporium* species.

094 (PS 4)
PERFORMANCE OF 27 STRAINS OF 'DELICIOUS APPLE IN IDAHO

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Yield, growth, fruit quality at harvest and after storage, and leaf mineral concentrations of 27 strains of 'Delicious' on M7 rootstock were studied in southwest Idaho. Apex, Improved Ryan Spur, Silver Spur, Starking and Red King Oregon Spur were among the high yielding strains (yields ranged from 91 kg/tree in Red King Oregon Spur to 99 kg/tree in Apex). Aomori, Redchief, Topred and Ace were among the low yielding strains (ranging from 23 kg/tree in Aomori to 48 kg/tree in Ace). Fruit were heavier in Rose Red, Classic, Starking, Redchief and Ace strains, ranging from 200 g/fruit in Ace to 239 g/fruit in Rose Red, while fruit were lighter in Aomori, Starkrimson, Hardispur and Redspur (171 g/fruit in Aomori to 175 g/fruit in Redspur). Fruits of Early Red One, Rose Red, August Red and Classic had more color (red) while fruits of Starking, Redspur and Hi Earl had poor skin color. Fruit from Aomori, Topred, August Red and Rose Red had high soluble solids at harvest ranging from 12.3% in Aomori to 12.0% in Rose Red, while fruit from Redspur, Redchief, Spured Royal and Wellspur had low soluble solids. Red King Oregon Spur trees had heavy fruit with moderate color and soluble solids in spite of their hi h yield. There were also significant differences in the storage quality factors and leaf mineral content among various strains.

095 (PS 5)
EFFECT OF UV-C ON THE RESISTANCE OF STORED CARROTS TO *BOTRYTIS CINEREA*

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UV-C, an elicitor of phytoalexins, was evaluated for its ability to induce disease resistance in stored carrots. Whole carrots (cv. CaroPak) were exposed to different doses of UV (2.2, 4.4. 8.8 and 17.6 × 10^6 erg/cm^2) and stored at 1°C for 25 days. The roots were subsequently inoculated with *Botrytis cinerea* and disease severity was assessed after 48 days. UV treatment at all doses caused a significant increase in disease resistance; the highest effect observed in the carrots treated with a dose of 17.6 x 10^6 erg/cm^2 Phytoalexin (6-methoxymellein) levels were also determined in carrot peels 25 days after treatment Levels varied little among UV doses except for 2.2 × 10^6 erg/cm^2, which induced lesser amounts. There was a relationship between disease resistance and phytoalexin content. The visual appearance of the roots was not affected by UV.

096 (PS 4)
PECAN PRODUCTION CYCLES

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The analysis of production from 1940 to 1988 indicated that production cycles of definite periods are poorly defined at the national, regional and state levels; hence production at these levels is best described as 'irregular'. Production by certain states was periodic. Even the alternate bearing cycles commonly exhibited at the individual tree and orchard levels was not reflected in the national pattern and was detectable only as a weak quasi-cycle having a period between 2 and 3 years. Production of 'cultivar-type' nuts was not predictable in any state; however, 'seedling-type' production was predictable for MS (r^2=.92) and TX (r^2=.63) with MS having a distinct 3 year cycle and TX a 2 and 4 year cycle. GA did not exhibit cycling in either nut class. Production of 'cultivar-type' nuts was most predictable in LA (r^2=.51) and TX (r^2=.43) with LA exhibiting a very weak 3 and 8 year cycle and TX a weak 3 year cycle. The degree of alternate bearing (I) appears to be highest for OK 'seedlings' (I=.53) and lowest for NM cultivars (I=.17).

097 (PS 5)
POSTHARVEST QUALITY IN SHORT-DAY ONIONS AFFECTED BY PURPLE BLOTCH AND THRIPS

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The effect of thrips (Thrips tabaci) and purple blotch (Alternaria porri) on postharvest quality in short-day (TG1015Y) onions were studied. Approximately 1.6 MT of onions grown in South Texas were placed in storage at 13C, 60% RH for 4 weeks followed by 2 weeks at 20C. 30% RH. Scales 3 through 6, relative to the outside skin, were used for analysis. Tissue discs were monitored for electrolyte leakage and remaining tissue was homogenized to determine pyruvate content, soluble solids and titratable acidity (TA). No change occurred in electrolyte leakage during storage. No relationship between pyruvate content and preharvest treatment was found, although a general increase in pyruvate was noted as the duration of storage increased Soluble solids decreased and TA increased during storage regardless of treatment. Respiration of intact bulbs showed no differences among treatments. Aspergillus niger populations increased during storage for all treatments, but no differences were found among treatments. In the present study, preharvest thrips and/or purple blotch did not have a significant impact on postharvest diseases.

098 (PS 4)

THE EFFECT OF FUNGICIDAL SPRAYS DURING SHOOT DEVELOPMENT ON POLLEN GERMINATION AND SHOOT EXPANSION IN PECAN

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Fungicidal sprays in pecan *(Carya illinoensis)* have been found to inhibit pollen germination in vivo and to suppress germination in vitro when incorporated into germination media (Wetzstein, 1990). In order to ascertain the effects of spray applications on staminate flower development and subsequent pollen germination, inflorescences were sprayed 1 or 3 times weekly, from bud break until pollen dehiscence with the following commercial fungicides at recommended rates: Cyprex, Orbit, Topsin, Benlate, Du-Ter, sulfur or water. Pollen was collected and germinated on a medium with sucrose, boron and agar. Spray applications during staminate flower development caused a significant decrease in pollen germination with Cyprex, Orbit and sulphur treatments compared to water controls. Shoot and leaf expansion were inhibited with Orbit treatments. Differences in pollen and leaf morphology will be discussed.

099 (PS 5)

MALATE METABOLISM IN TOMATO FRUITS

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The organic acid content of tomatoes is an important aspect of fruit quality. It has been proposed that the decline of acid content during fruit ripening is catalyzed by a cytoplasmic NADP malic enzyme (ME) which accounts for a high proportion of climacteric CO_2 evolution. Analysis of fruit tissue at weekly intervals following flowering showed a continuous increase in specific activity of ME to a peak value of 0.9 µmol $min^{-1}mg^{-1}$protein at the mature green stage; activity declined during ripening. The major accumulation of malate and citrate occurred in the later stages of fruit growth; a sharp decline of malate during ripening was followed by a decline in citrate. Specific activity of ME, and organic acid concentrations were highest in the locular gel tissue. However ME activity was also detected in leaf, stem and root tissue. ME action in fruit could provide pyruvate to sustain the TCA cycle with inputs of malate and citrate, but other roles for this enzyme cannot be excluded.

100 (PS 4)

PHENOLOGICAL STAGES OF FRUIT DEVELOPMENT DURING FRUIT REMOVAL AFFECT RETURN BLOOM OF PECAN

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Fruit thinning has been shown to increase return bloom; however, the stage of fruit development at which to thin the fruit has not been determined. The objective of this study was to determine the effect of fruit removal at selected phenological stages of fruit development on return bloom. Fruit of 'Gormley' were. removed immediately after pollen shed, at ½ ovule expansion, full ovule expansion, dough stage, and 2 weeks after dough stage from ½ of the tree and retained on the other half. Each fruit removal date was replicated three times in a completely randomized design. Fruiting and vegetative shoots were tagged on defruited and fruiting sides of the tree to evaluate return bloom. Roots £ l3 mm in diameter and vegetative and fruiting shoots were collected from the defruited and fruiting sides of the tree during Dec. These samples were analyzed for reducing and non-reducing sugars and starch. Results of this study will indicate the critical stage of fruit development for fruit thinning to achieve adequate return bloom. Results will also relate non-structural carbohydrate concentrations in roots and shoots to return bloom in pecan.

101 (PS 5)

ACTIVITIES OF SOME GLYCOLYTIC ENZYMES IN 'BARTLETT' PEARS KEPT IN 0.25% O_2

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The ability of mature-green 'Bartlett' pear fruit *(Pyrus communis* L) to withstand low oxygen stress at 20°C was examined. Fruit were treated with 0.25% O_2 (balance N_2) for 4 days before transfer to air for ripening. Loss of green skin color was completely inhibited and CO_2 and C_2H_4 production rates were reduced under low O_2 but proceeded normally after transfer to air. Fruit exposed to 0.25% O_2 had lower pyruvate kinase (30%) and higher alcohol dehydrogenase (200%) activities compared to air treated fruit. Also, fruit treated with 0.25% 0, had slightly higher ATP-phosphofructokinase, PPi-phosphofructokinase and pyruvate decarboxylase activities compared to air treated fruit. These differences were not altered upon subsequent transfer to air.

102 (PS 4)

IN-ROW ROTARY TILLING FOR ORCHARD WEED CONTROL

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In-row rotary tilling was compared to conventional weed control methods using ten year old McIntosh/M.7 apple trees. The following treatments were assigned: 1) untreated control; 2) herbicide spray; 3) rotary tilling applied at tight cluster, mid-June. and late July; 4) rotary tilling plus herbicide; 5) rotary tilling plus living mulch (oats) sown in August. Treatments were replicated 8 times in a randomized complete block design. All weed control methods increased tree size over the untreated control. The herbicide treatments significantly increased yields and fruit size. The rotary till combinations produced growth, yield and fruit size similar to the herbicide treatment. except for the rotary till plus living mulch treatment. which had lower yield in 1989 and fewer large fruit in 1990. Rotary tilling alone provided less weed control than the herbicide treatment. Combining rotary tillage with living mulch or with a pre-emergent herbicide provided better weed control than rotary tilling alone. Preliminary results suggest that in-row tilling may be a viable alternative to chemical weed control.

103 (PS 5)

CELL WALL CHANGES IN PEACH FRUIT DURING SOFTENING

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Selected changes in cell wall polymers during peach fruit softening will be described. Mature peach fruit *(Prunus persica* cv Cresthaven) were harvested, mesocarp firmness measured using an Effegi penetrometer and fruit were grouped into three firmness classes. Enzymically inactive cell walls were prepared from mesocarp tissue for each firmness class using Tris buffered phenol. Sugar compositions for whole cell walls were similar between fruit from all firmness classes. Major sugars present in cell walls were arabinose, galactose, galacturonic acid and xylose. The degree of methyl esterification of pectins declined in samples from less firm fruit. Cell wall pectic polysaccharides were extracted using 0.5 M imidazole buffer, Ph 7.0 and a combination of anhydrous HF at -10 C and 0.5 M imidazole buffer, Ph 7.0. Progress towards characterization of these fractions will be presented. Supported by USDA grant 90-34150-5022 and the Oklahoma Agricultural Experiment Station.

105 (PS 4)

DIFFERENTIAL RESPONSE OF YOUNG MONTMORENCY CHERRY TREES ON MAZZARD AND MAHALEB ROOTSTOCKS TO ORCHARD FLOOR MANAGEMENT SYSTEMS.

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Montmorency sour cherry trees on mazzard and mahaleb rootstocks were planted April 11, 1986 in a Draper gravelly loam having a hard, firm restrictive layer at the 30-40 cm depth. A solid-set mini-sprinkler system was installed the following month and orchard floor management systems including clean cultivation, vegetation-free glyphosate-treated non-cultivation and permanent Elka perennial ryegrass and Ensylva creeping red fescue sod plots were established in June, 1986. Grass cover plots were subdivided into single-tree solid sod, 1 meter vegetation-free square around the tree trunk, and 1 meter vegetation-free strip down the tree row. Tree growth as measured by trunk diameter increase was proportional to the amount of vegetation-free area within the plot. Little difference in the competitive ability of the two grasses was evident after 5 years. Greatest growth of trees occurred in non-cultivated plots kept weed-free by repeat applications of glyphosate. Cherry trees on mahaleb rootstock were generally more vigorous than comparable trees on mazzard rootstock in all treatments except the herbicide treated plots.

105 (PS 5)
ANALYSIS OF VOLATILES AND FRUIT QUALITY OF 'DELICIOUS' APPLES FROM SEQUENTIAL CONTROLLED ATMOSPHERE STORAGE
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Low-oxygen controlled atmosphere (CA) storage of apple fruit delays senescence and preserves apple fruit quality attributes including firmness, soluble solids (SS) and titratable acidity (TA). CA environments have, however, been demonstrated to adversely impact fruit volatile synthesis resulting in less flavorful fruit after removal from storage. This effect increases with the duration of the storage period. Fruit responses to increased oxygen concentration after several months of storage were examined to determine if improvement in volatile synthesis could be achieved without excessive deterioration of other fruit quality attributes. 'Delicious' apples were stored under 1% O_2, 2% CO_2 at 1°. After 3, 4 or 5 months, oxygen concentration was increased to 2% and all fruit were removed from storage after 6 months. Significant differences in TA were observed after 1 day ripening and in firmness, SS and TA after 10 days ripening. After 10 days apples that had been held at 1% 0, for 6 months were slightly but significantly firmer than the other three treatments. Increasing 0, to 2% after 3 months resulted in the largest quantity of volatile esters after 1 and 10 days ripening out of storage. The amounts of volatile aldehydes and alcohols detected after 1 day ripening were influenced by the 0, treatments but differences were less pronounced following 10 days ripening.

106 (PS 4)
SPLIT APPLICATION OF HERBICIDES FOR WEED CONTROL IN WOODY NURSERY PLANTS
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Field research was conducted in 1989, 1990 and 1991 to evaluate the efficacy of standard and newly released herbicides for preemergence weed control in ten nursery crops. Herbicides were applied using a CO, pressured backpack sprayer and granular spreader in both the spring and fall of 1989, 1990 and 1991. Weed pressure and phytotoxicity were evaluated every four weeks from May through October. Weed control results obtained were similar in 1989 and 1990. Excellent broadleaf weed control was provided by Snapshot (DF and G) (isoxaben plus oryzalin or trifluralin), oxyfluorfen at 2.2 kg/ha, metolachlor at 6.6 kg/ha, metolachlor plus simazine (G) at 89.6 kg/ha, and isoxaben alone at 1.1 kg/ha. Excellent grass control was provided by dithiopyr (L or G), isoxaben plus oryzalin or trifluralin, oxyfluorfen and simazine plus oryzalin. Yellow nutsedge proved difficult to control. Overall, dithiopyr, formulations of isoxaben, formulations of metolachlor and oxyfluorfen appeared promising. Phytotoxicity was observed only sporadically in woody species in 1989. Long term growth reductions will be evaluated.

107 (PS 5)
EFFECTS OF STORAGE CONDITIONS ON ETHYLENE BIOSYNTHESIS IN APPLE FRUITS
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The effects of different storage temperatures and gas compositions on ethylene biosynthesis in apple fruits (Malus domestica cv. Golden Delicious) were studied over a period of 150 days. Four major storage treatments were made: 1) 0°C, 21% O_2 and 0% CO_2; 2) the temperature was decreased from 10 to 0°C over the first 90 days and held constant at 0°C, 21% O_2 and 0% CO_2; 3) 0°C 3% 0_2 and 3% CO_2; 4) the temperature was decreased from 10 to 0°C over the first 90 days (O_2 was constant at 3% O_2 and CO_2 levels were decreased from 12 to 6%) and for the last 60 days was held at 0ºC, 3% O_2 and 6% CO_2.

Apples stored under treatment 1 showed a reduction in C_2H_4 production and an accumulation of ACC and MACC while the EFE and ACC synthase were promoted later in storage. It was found that when apple were stored under the conditions outlined in treatment 2 EFE, ACC synthase, and C_2H_4 production increased rapidly during the first 1 to 2 months in storage with ACC and MACC accumulated in large quantities. Treatment 3 and 4 resulted in a reduction in ethylene production, ACC, MACC and related enzymes. The data suggests that high CO_2 was able to inhibit C_2H_4 biosynthesis without low temperatures and was the main reason why treatment 4 was as effective as treatment 3.

108 (PS 4)
PREEMERGENT WEED CONTROL IN CONTAINER-GROWN LANDSCAPE PLANTS
James E. Klett* and David Staats, Department of Horticulture, Colorado State University, Fort Collins, CO 80523.

Herbicides were applied to container grown landscape plants and evaluated on the basis of weed control, phytotoxicity, and effect on plant growth. Three preemergent herbicides were applied including: Oxadiazon (Ronstar) at 4.54 and 9.08 kg/ha, Oxyfluorfen + Oryzalin (Rout) at 3.41 and 6.81 kg/ha and Oryzalin (Surflan) at 2.27 and 4.54 kg/ha. There was also a weedy and non-weedy control. The plant species included: Syringa vulgaris (Common Lilac), Wisteria sinensis (Chinese Wisteria), Phlox paniculata (Garden Phlox) and Dahlia hybrid (Garden Dahlia). They were all grown in number one containers in a media of soil, spaghnum peat moss, and plaster sand (1:2:1 by volume). All herbicides tested controlled weeds effectively with no phytotoxicity except with Phlox paniculata. Oryzalin resulted in a phytotoxic effect on Phlox paniculata at both the 1x and 2x rates.

109 (PS 5)
CELL WALL CHANGES IN RIPENING 'KEITT' AND 'TOMMY ATKINS' MANGO (MANGIFERA INDICA) FRUIT
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'Keitt' and 'Tommy Atkins' mango fruit were evaluated at six ripening stages which were determined subjectively by firmness and skin color. In both cultivars, the inner mesocarp was less firm than the outer 5 mm of tissue at the mature green stage, indicating that softening began at the center of the fruit. The outer mesocarp of 'Keitt' remained firm longer than that of 'Tommy Atkins'; a fact which may have implications for postharvest shelf-life. However, the inner mesocarp softened at a similar rate in both cultivars. Mango pulp Hunter "L" values decreased and "a" and "b" values increased as ripening progressed. The cell wall composition and its modification during ripening were similar for the two cultivars. The dry weight of cell wall per gram fresh weight of mesocarp tissue decreased 50 to 55% during ripening. There was a loss of cell wall neutral sugars during ripening in both cultivars. The percentage of neutral sugars in the cell wall decreased from 36 to 20% in 'Keitt' and from 28 to 14% in 'Tommy Atkins'. Cell wall compositional analysis revealed a dramatic loss of cell wall arabinose (80 to 90%) along with decreases in galactose (50 to 60%) and rhamnose (65 to 75%).

110 (PS 4)
INSECT-INDUCED BIOCHEMICAL AND PHYSIOLOGICAL CHANGES OF SIAM WEED
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A host specific herbivorous insect Pareuchaetes pseudoinsulata was introduced to Guam to control a noxious weed, Chromolaena odorata (siam weed). Biochemical and physiological studies were conducted to reveal changes in C. odorata leaves when larvae of P. pseudoinsulata attack the plant. The rate of photosynthesis and the amount of chlorophyll were reduced in insect-infected plants. Protein analysis indicated a distinct change in the small subunit of ribulose-1,5-bisphosphate carboxylase of insect-induced yellow leaves.

111 (PS 5)
HOT WATER QUARANTINE TREATMENT EFFECT ON THE RIPENING AND SENESCENCE OF MANGO
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Hot water (46°C for 90 min) has been used in Mexico for the last 3 years as a postharvest insect quarantine treatment for mango. This study was conducted to investigate the effect of this treatment on the ripening and senescence of the fruit. Mango fruits *(Magnifera indica* L., cv Keitt) were treated with hot water (46°C) for 0, 60, and 90 min, and fruits were evaluated after 7, 14, and 21 days storage at 10°C. and subsequently after one week at 20°C. Hot water treatment increased the respiration rate and fruit water and firmness losses. In addition there was an increase in polygalacturonase and lipoxygenase activities. However, no fruit injury due to hot water was observed.

112 (PS 4)
THERMAL SANITATION WITH A MOBILE-FIELD BURNER FOR ERGOT CONTROL IN KENTUCKY BLUEGRASS SEED FIELDS
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A major constraint for bluegrass *(Poa pratensis)* seed production, and foreign marketing, is ergot caused by the fungus *Claviceps purpurea.* Currently, the only method of ergot control is open-field burning following harvest. This practice may be eliminated in the future. In 1990, following bluegrass harvest, machine, open-field, and no burn treatments were applied in the fall to determine their efficacy for controlling ergot. Ergot sclerotia harvested in July 1990 were put in stainless steel wire mesh packets and were placed at the soil surface, and at l-cm and 3-cm soil depths. Temperature data were collected and sclerotia were tested in the laboratory for viability. Peak temperatures for machine burn were 200 C greater than those for open-field burning. Germination of sclerotia placed at the soil surface was 1, 10, and 52% for machine, open-field and no burn treatments, respectively. There were no treatment effects on sclerotia placed at l-cm or 3-cm soil depths.

113 (PS 5)
CHANGES IN GALACTO- AND PHOSPHOLIPID CONTENT DURING STORAGE OF TOMATO FRUIT AT CHILLING AND NONCHILLING TEMPERATURES
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MG2 and MG4/BK stage tomato fruit (harvested 30 and 36 days postanthesis, respectively) were stored at chilling (2°C) or nonchilling (15°C) temperature for 0, 4 or 12 days. Lipids extracted from pericarp tissue were analyzed for mono- and digalactosyldiacylglycerol (MGDG and DGDG) and total phospholipids (PL). Results were similar for MG2 and K4/BK fruit. At 2ºC PL increased by ca 8-10% during the first 4 days in storage, declining slightly by 12 days. In contrast, PL declined by ca 10-15% during storage at 15°C, mostly over the first 4 days. Total galactolipids (GL = MGDG + DGDG) declined at both 2° and 15°C, but losses were far greater (ca 25-35%) at 15°C. Loss of GL at 15°C was more rapid for MG4/BK compared with MG2 fruit, reflecting the more advanced stages of ripening after 4 and 12 days of storage. The ratio of MGDG to DGDG had dropped after 12 days at either 2° or 15°C. The decline was greatest (from ca 1.8:l to 1.2:l) in MG4/BK fruit stored at 15°C, which had ripened to the pink stage. These results conflict with a recent report that loss of MGDG is specifically associated with chilling injury of tomato fruit.

114 (PS 4)
EVALUATING PRE-EMERGENCE HERBICIDES FOR USE ON SELECTED WILDFLOWER AND NATIVE GRABS SPECIES
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TO identify potential labor-saving means of weed control in wildflower plantings, 8 species of native grasses (Andropogon gerardii, Bouteloua certipendula, Bouteloua gracilis, Buchloe dactyloides, Panicum virgatum, Schizachyrium scoparium, Sorcghastrum nutans, Sporbolis heterolepis) and 7 species common to wildflower mixes (Centaurea cyanus, Coreopsis tinctoria, Echinacea purpurea, Eschscholzia californica, Gaillardia pulchella, Linum perenne, Lobularia maritima) were seeded into a silt loam soil in 20 × 15 cm peat trays in the greenhouse and treated with pre-emergent herbicides, (alachlor, atrazine, benefin, bensulide, DCPA, metolachlor, oryzalin, oxadiazon, siduron, simazine and trifluralin). Herbicides were applied as sprays in 20 ml/tray or granules. The herbicides were applied either immediately after seeding or 2 weeks after emergence. The grasses and broadleaves were treated as separate studies. Treatment combinations were repeated 3 times in a completely randomized design. All native grasses except Andropogon gerardii suffered significant population and quality loss with all herbicides applied at the time of seeding. Andropogon gerardii was not significantly injured by 1.1-4.5 kg/ha atrazine and 1.7-6.7 kg/ha alachlor. Data on seedling population and phytotoxicity response of the grasses to delayed application of herbicide, and broadleaf response to both treatment times will be presented.

115 (PS 5)
AN EXPERT SYSTEM FOR DIAGNOSING CHILLING INJURY OF VEGETABLES
K. Bergsma*, S. Sargent, J. Brecht and R. Peart
Vegetable Crops Department, University of Florida, Gainesville, FL 32611-0514

Temperature management is the most widely used method to extend the postharvest life of vegetables. Unfortunately, during less than optimal commercial conditions, certain commodities can be exposed to low, nonfreezing temperatures that may shorten their market life due to chilling injury (CI). CI is difficult to diagnose since not all commodities exhibit the same symptoms. Environmental factors may also affect the expression of CI The services of an expert are usually required to positively diagnose CI, however, experts are not always readily available, particularly during routine commercial handling. An expert system, a computer program that emulates a human expert's thought processes, will be developed to diagnose CI symptoms for several commodities. A prototype developed with Level5 Object, an expert system shell, will be presented. Diagnosis is determined by applying rules and certainty factors based on user responses to queries on the type and extent of visual symptoms. The applicability and advantages of this system will be discussed.

116 (PS 6)
TURGOR-SENSITIVE ACC TRANSPORT AND ETHYLENE PRODUCTION BY TOMATO PERICARP SLICES.
Robert A. Saftner*, United States Department of Agriculture, Agricultural Research Service, Plant-Hormone Laboratory, B-050, Beltsville, MD 20705-2325.

Mature green pericarp isolated from tomato (Lycopersicon esculentum Mill.) were used to investigate the regulation of ACC uptake into the vacuole and ethylene production by turgor (manipulated by 39-627 milliosmolal solutions of nonpermeable mannitol, polyethylene glycol and/or permeable ethylene glycol osmotica). Both ACC uptake and ethylene production were optimal at intermediate (120-140 kpa) turgor. Low (<80 kPa) turgor rarely inhibited ACC uptake and ethylene production by more than 70% while high (>300 kpa) turgor had greater inhibitory effects. Turgor charges caused by adjusting solution osmolality with nonpermeable osmotica were accompanied by changes in the osmotic potential and water potential per se of the tissue. Ethylene glycol-mannitol mixtures had similar effects on the osmotic and water potentials of the tissue as nonpermeable osmotica but had lesser effects on cell turgor, ACC uptake and ethylene production. The results indicate that cell turgor an important factor affecting the kinetics of ACC uptake and ethylene production by tomato pericarp.

117 (PS 5)
NUCLEAR MAGNETIC RESONANCE (NMR) IMAGING OF CHILLED AND NONCHILLED ZUCCHINI SQUASH
Chien Yi Wang*, Horticultural Crops Quality Lab., PQDI, U. S. Department of Agriculture, Beltsville, MD 20705 and Paul C. Wang, Department of Radiology, Howard University, Washington, D. C. 20060

Zucchini squash were stored at either 2.5C or 12.5C. A 4.7 Tesla, 33 cm bore size, NMR imaging system Was used to generate images of the squash. The chilled squash produced an image with high intensity in the skin region. The Tl weighted images, obtained by the inversion recovery technique, showed that cortex tissue of the chilled squash also had higher intensity than that of the nonchilled squash, indicating a shorter Tl relaxation time and a greater mobility of water in the chilled tissue. The T2 weighted images, obtained by the spin echo technique, also showed higher intensity in the chilled squash than in the nonchilled samples, implying a longer T2 relaxation time for the chilled tissue. These results suggest that the intensity of the NMR images or Tl and T2 relaxation times may serve as a nondestructive index for chilling injury.

118 (PS 6)
EFFECT OF CALCIUM ON ETHYLENE BIOSYNTHESIS IN TOMATO FRUIT
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Tomato fruit (Cv. Caruso) at the mature green, pink and red stages were vacuum infiltrated with 0.75 and 1.5% $CaCl_2$ for 5 min. Treatment with both levels of calcium resulted in reduced respiration and ethylene production rates during a 6 day period at 20°C. For all maturity stages, treatment with 1.5% $CaCl_2$ resulted in: accumulation of ACC levels, no change in ACC-Synthase activity, reduction in EFE activity, and reduction in MACC levels (pink fruit only). When mature green fruit were treated with Trifluorperazine or W-7, which are considered specific antagonists of calcium-mediated calmodulin regulation of enzyme activity, increases in ethylene production and in EFE activity were noticed. These results are discussed in light of a possible role and interaction between calcium and calmodulin in regulating ethylene biosynthesis.

119 (PS 5)
CHILLING INJURY, AND POLYAMINES IN SUMMER SQUASH FRUIT AS INFLUENCED BY GENE B AND TEMPERATURE CONDITIONING
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Effects of temperature conditioning treatment (2 days at 10C) on the development of chilling injury (CI), ethylene evolution and polyamine content were compared in 'Caserta' (B^+/B^+) and 'Precocious Caserta' (B/B) summer squash fruit which are known to differ in chilling sensitivity. mature conditioning delayed the development of CI and suppressed chilling-induced ethylene evolution in both genotypes. Putrescine content of nonconditioned fruit remained fairly constant during storage at 5C in both genotypes. Putrescine content increased and then decreased in conditioned B/B fruit but increased continuously in conditioned B^+/B^+ fruit. Spermidine content of nonconditioned B/B and B+/B+ fruit and conditioned B/B fruit decreased during storage at 5C, but remained constant in conditioned B+/B+ fruit. Spermine content tended to be higher in conditioned than nonconditioned fruit and may have a preventive effect on CI.

120 (PS 6)
EFFECT OF ETHYLENE TREATMENT DELAY ON SOME QUALITY ATTRIBUTES OF TOMATO FRUITS
Sasivimon Chomchalow*, Jeffrey K. Brecht, and Steven A. Sargent, Vegetable Crops Department, IFAS, University of Florida, Gainesville, FL 32611

Maturity stages of tomato *(Lycopersicon esculentum* M.) fruits harvested green were determined based on their internal morphology. The maturity stage distribution in a particular lot was compared to day-to-breaker distribution. Ethylene treatment at 20°C began immediately after harvest or after 1, 3, 5, or 7 days at 12.5°. The fruits were subsequently kept at 20° and samples were taken at ripe stage for analyses which included firmness, color, weight loss, soluble solids (SSC) and ascorbic acid content, titratable acidity (TA), and pH. Storage life was also determined. Average days to ripe stage increased from 11.4 to 17.7 days as the ethylene treatment delay was increased. Firmness decreased with increasing delays at 12.5°. TA was higher in mature or partially mature green fruit held for 5 or 7 days at 12.5°, but SSC and SSC:TA ratio were unaffected by delays at 12.5°. Current research is underway to determine the effect of exposure of fruits to chilling temperatures during the ethylene treatment delay.

121 (PS 5)
SURFACE TREATMENTS AND TEMPERATURE CONDITIONING AFFECT WEIGHT LOSS AND CHILLING INJURY ON GRAPEFRUIT
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The effects of temperature conditioning (7 days at 15C), dewaxing with hexane, application of squalene (10% in hexane spray), and commercial fruit wax (Flavorseal) on weight loss and chilling injury (CI) on 'Marsh' grapefruit (Citrus paradisi Macf.) were determined. Following 3 weeks' storage at 5C, dewaxing resulted in a significant increase in weight loss, but not CI. Temperature conditioning and Flavorseal independently inhibited weight loss and CI. Squalene inhibited CI, but not weight loss. The effects of temperature conditioning and squalene were not synergistic. Chilling injury in fruit treated with squalene or Flavorseal was similar, but significantly less than in nontreated fruit. Taken together, these data indicate that water loss is less important to the development of CI than has been previously suggested and that the beneficial effects of squalene are not the result of an inhibition of water loss.

122 (PS 6)
EVALUATION OF FIVE POTATO CULTIVARS FOR YIELD AND SPECIFIC GRAVITY AT HARVEST, FOLLOWING COLD STORAGE, AND DURING RECONDITIONING.
James Okeyo*, Mosbah M. Kushad, Ronald Morse, and Charles R. O'Dell, Department of Horticulture, VPI & SU, Blacksburg, VA 24061, USA.
Five potato cultivars grown at six locations in Southwest Virginia in 1990 were evaluated for yield, specific gravity, and dry matter content immediately after harvest, following cold storage, and after reconditioning. Tuber yield was significantly affected by cultivar and location. The yields were 17.1; 16.6; 16.0, 13.6 and 6.8 (metric tons/ha) for Kennebec, Atlantic, Yukon Gold, Superior and BelRus, respectively. BelRus, with the highest number of stems per plant had the lowest yield while Kennebec with medium number of stems per plant had the highest yield. Specific gravity and percent dry weight at harvest, after cold storage, and reconditioning varied among the varieties and locations. Specific gravity during harvest for Atlantic, BelRus, Yukon Gold, Superior, and Kennebec were 1.097, 1.096, 1.092, 1.091, and 1.083, respectively. There were significant changes in specific gravity and percent dry weight; Kennebec had the highest increase in both specific gravity and percent dry weight during cold storage while Yukon Gold had the highest increase during reconditioning.

123 (PS 5)
FLORA OF THE SOUTHERN HEMISPHERE AS CUT FOLIAGE
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26 species and hybrids of 7 genera, native to the Southern Hemisphere were evaluated for use as cut foliages in commercial floriculture. Criteria used in determining vaselife were leaf loss, color retention, wilting, and dessication on branches held for 30 days in water or commercial floral preservatives in June and December. Holding solutions were changed 2 times per week but the stems were not recut. Of the Proteaceae included in the test, Adenanthos sericeus, Grevillea diminuta, G. cv Ivanhoe, G. cv Poorinda Peter, Leucadendron cv Pisa, L. meridianurn and L. nobile were the hardiest, exhibiting excellent keeping qualities in both water and preservative solution throughout the 30 days of the tests. In preservative, Leucadendron cv Red Gem, L. cv Safari Sunset, and L.salignum cv Yellow Bird were also still useful at the conclusion of the trials. In the "non-protea" group, the Coprosma repens cultivars lasted equally well in both water and preservatives for 30 days.

124 (PS 6)
ESTIMATING MECHANICAL INJURY POTENTIAL FOR BELL PEPPER HANDLING OPERATIONS USING THE INSTRUMENTED SPHERE
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32611-0514
Transfer points on several bell pepper (Capsicum annuum) packing lines were analyzed using the Instrumented Sphere (IS) data logger. Impact accelerations ranged from <25 g's to >250 g's; velocity changes (VC, a measure of surface hardness) ranged from 0.3 to 4.3 m/s. Correlation of IS data with actual mechanical injury to peppers is necessary to permit the IS to be a rapid, reliable diagnostic tool for the industry. Peppers with stems trimmed (cv. Bellmont, 6.3-7.4 cm diameter) were dropped on the shoulders 24 hr postharvest (n=20). Using drop height/surface combinations (no padding, 1.6 mm or 3.2 mm closed-cell padding), impact characteristics equivalent to the packing lines were simulated. Drops from 10 cm caused 204, 15% and 5% bruising incidence for surfaces with no padding, 1.6 mm and 3.2 mm padding, respectively. This last equivalent impact surface indicates that maximum impacts should be <120 g's and VC 12.0 to avoid >5% bruising on bell pepper shoulders.

125 (PS 5)
SENESCENCE OF EASTER LILY FLOWERS
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Ethylene is not the primary factor causing senescence of Easter lily flowers. A time course experiment was conducted to investigate the role of carbohydrates (CHOs) in Easter lily flower senescence. Flowers of greenhouse grown plants were tagged the day of opening and moved to a post-production room. At daily intervals for 7 days, flowers were collected and analyzed for CHOs. Seven days after opening (DAO), fresh wt decreased 46% to a final weight of 6.4 g. Dry wt declined from 1.3 to 0.9 g in 7 days. Sucrose concentration increased through 3 DAO, then decreased by 34%. Glucose and fructose, initially 175 mg/g dry wt, declined linearly through 7 DAO to 16 mg/g, a 91% reduction. Total soluble CHO concentration fell 77% in 7 days. Starch concentration did not change as much, with only a 21% decrease in 7 days. Total CHO per bud decreased from 362 mg to 80 mg in 7 days, a 78% decrease. Flowers showed obvious signs of quality loss 5 to 6 DAO. In Easter lilies, loss of tepal quality and flower senescence may be closely related to loss of respirable substrate.

126 (PS 6)
RESPIRATION AND POSTHARVEST WATER LOSS IN su1 AND sh2 SWEET CORN
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Two su1 (Jubilee and Silver Queen), and four sh2 (7210, Florida Staysweet, SS Jubilee and Zenith) sweet corn cultivars were hand pollinated, tagged, and harvested at known numbers of days after pollination (DAP). Respiration rates increased between 15 and 24 DAP in Jubilee, Silver Queen, Florida Staysweet, SS Jubilee and Zenith, and decreased in 7210, ranging from 120 to 180 ml $CO_2 kg^{-1} hr^{-1}$. Husk plus shank tissue accounted for about one-fourth, and cob plus kernels for three-fourths of the CO, production by 18-DAP ears. Initial rates of weight loss in intact 18-DAP ears ranged among cultivars from 1.62 to 2.11% day^{-1}; severing the husk leaves from the shanks had no effect on the initial rate of weight loss or the total weight lost in 4 days storage at l°C, but severed husks lost more water than intact husks. Initial rates of weight loss in stripped ears ranged from 0.65 to 1.31% day^{-1} and were not affected by sealing the cut shank end with paraffin wax.

127 (PS 5)
POSTHARVEST LONGEVITY OF BAILEYA MULTIRADIATA AND ASTER BIGELOVII

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Studies were conducted to determine postharvest longevity of field grown Desert Marigold (Baileya multiradiata) and perennial Aster (Aster bigelovii) cut flowers. Flower stems were cut and placed into storage at 4, 7, 15 and 24C in the dark. Storage treatments included DI water, citric acid (CA), floralife (F), silver thiosulfate (STS) and modified atmosphere packaging (MAP). Flowers were rated daily using a scale of 1 (optimum condition) to 4 (unsaleable). Postharvest longevity of Baileya decreased quadratically with increasing temperature, (r^2=0.67, P=0.001) between 4 and 24C. For Aster, postharvest longevity was greatest at 7C (13.3 days), slightly less at 4C (10.5 days) and only 5 days at 15 and 24C. Postharvest longevity of Baileya at 4C was doubled using STS, but was not affected by CA or F. MAP increased postharvest longevity of Aster 1.6- to 2.2-fold at each temperature. Other storage treatments for Aster were ineffective. The results suggest MAP may have potential as a storage technique for commercial cut flowers.

128 (PS 6)
CHEMICAL AND SENSORY DETERMINANTS OF 'HONEY DEW' MELON FRUIT QUALITY AND CONSUMER PREFERENCE

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Chemical and sensor-v attributes of fruit from eight 'Honey Dew' commercial melon (Cucumis melo L. cv inodorus Naud.) cultivars were evaluated from plants grown in 3 locations and fruit harvested at 50 days post anthesis. Chemical attributes ware dry weight, fresh weight, soluble solids, total sugars, and firmness. A taste panel evaluated fruit external appearance, internal color, odor, flavor, texture, and overall fruit acceptance. Flavor corresponded most strongly with overall fruit acceptance while odor and texture were secondary. External appearance and internal color of U.S. No. 1 Grade fruits ware quite homogeneous and did not correspond strongly with overall fruit acceptance. Total sugars per gram fresh weight had a higher correlation with overall fruit acceptance and wild flavor than any of the other chemical attributes. The most important determinants of 'Honey Dew' melon fruit quality, total sugars per gram fresh weight and flavor, lack visible indicators to guide consumer selection in the marketplace. The market potential of 'Honey Dew' melons could be enhanced with a visible indicator of fruit quality.

129 (PS 5)
INFLUENCE OF DAY/NIGHT TEMPERATURE REGIME ON POST-PRODUCTION LONGEVITY OF CHYRSANTHEMUM AND POINSETTIA

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Dendranthema grandiflora 'Dana' and Euphorbia pulcherima 'Yuletide' were grown under 5 day/night (DT/NT) temperature regimes (17/17, 17/23, 23/17, 23/23 from 1 week after pinching through anthesis, and 17/23 from 1 week after pinching through visible bud and 23/17C from visible bud through anthesis), a 10hr photoperiod and 200 µmol $m^{-2}s^{-1}$ PPF. Leaf chlorophyll was extracted weekly and measured spectrophotometrically. At anthesis, plants were sleeved and boxed for 3 days and subsequently placed in a post-production environment at 20C with 12hr irradiance at 1.5 µmol m^{-2} s^{-1} PPF. Chlorophyll content, plant dry weight and post-production longevity were influenced by temperature. Chlorophyll in chrysanthemum increased over time, particularly in plants moved at visible bud and longevity was reduced in plants grown at 17/17, but was not correlated with DIF (DT-NT) or chlorophyll content. Poinsettia bract fading was enhanced in plants finished with 17C DT.

130 (PS 6)
CONDITION OF EARLY SEASON GRAPEFRUIT AFTER EXPOSURE TO VAPOR HEAT, FORCED AIR TREATMENT

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A vapor heat (VH) treatment (43.5C, 100% RH for 240 min) is approved for disinfestation of the Caribbean fruit fly (Anastrepha suspensa Loew) in grapefruit; but, it is recommended only for fruit harvested in late season. Early season 'Marsh' white and 'Ruby Red' grapefruit (Citrus paradisi Macf.) were degreened (30C, 90% RH and 5 ppm ethylene) for 72 hr and then VH treated. No VH effect was found for total soluble solids, acidity, and pH, or on juice taste. Vapor heat-treated fruit had higher Hunter 'a' values than non-VH fruit indicating less green peel color, but no change was observed in Hunter 'L' or 'b' values. Although fruit were waxed, those that were VH treated had more aging (senescence) than non-VH fruit. No VH effect on fruit firmness was observed. Incidence of decay was low in all treatments. Grapefruit that were inoculated with spores of green mold and exposed to the VH had lower incidence of decay than non-VH treated fruit.

131 (PS 5)
RELATIONSHIP OF CARBOHYDRATE LEVELS TO LEAF AND CYATHIA ABSCISSION OF POINSETTIA.

Terril A. Nell*, Ria T. Leonard and James E. Barrett, University of Florida, Gainesville, FL 32611

The relationship of carbohydrates to cyathia and leaf abscission which occurred in the postproduction environment is evaluated for 'Annette Hegg Lady' and 'Gutbier V-l4 Glory' poinsettias. Leaf and cyathia were counted and collected for carbohydrate analyses at anthesis and over time in interior conditions (20C, 12 $umols^{-1}m^{-2}$). Cyathia drop was 30% greater in 'Annette Hegg Lady' than 'Gutbier V-14 Glory' after 20 days in interior conditions. No significant differences in cyathia glucose or sucrose content were observed between cultivars, however, differences in fructose content were evident. Although the average amount of cyathia fructose content was twice as much in 'Annette Hegg Lady' (13 mg/g dry weight) compared to 'Gutbier V-l4 Glory' (7 mg/g dry weight), cyathia abscission was greater in 'Annette Hegg Lady'. No differences were observed in cyathia sugar content over time in either cultivar. Results indicate cyathia carbohydrate levels do not account for cyathia abscission or the differences in cyathia abscission between the varieties.

132 (PS 6)
MODIFIED ATMOSPHERE PACKAGING (MAP) OF SWEET CHERRIES: EFFECTS OF TEMPERATURE AND OXYGEN

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Low O_2 atmosphere can extend the storage life of some commodities by reducing the rates of respiration or other metabolic processes. By balancing 0, respiration rates and film permeability, modified atmosphere packages can produce steady-state low O_2 environments. Accordingly, we examined the response of sweet cherries to low O_2 using MAP.

A range of steady-state O_2 (» 0.5 to 15 kPa) levels was obtained by varying fruit weight within packages made of low density polyethylene film for fruit held at 0, 5, 10, 15, 20, and 25C. Steady-state O_2 vs. O_2 respiration curves were biphasic. At low O_2 (< 2 kPa), respiration sharply increased as O_2 increased. At high O_2, respiration reached a plateau. The respiratory quotient breakpoint and ethanol production were used to identify low O_2 storage limits. The low O_2 limit was about 1.5 kPa at 25C and decreased slightly with temperature.

Based on respiration rates, sweet cherry storage did not benefit from low O_2 atmospheres. When O_2 levels were high, respiration rates were high. When O_2 was low, respiration rates were suppressed, but the fruits respired anaerobically. In contrast, as temperature decreased 10C, respiration rates were halved. Coincidentally, fruit storage life increased linearly with decrease in temperature, but were unaffected by oxygen level.

133 (PS 5)
ANATOMY OF PETAL ABSCISSION IN PELARGONIUM X HORTORUM.

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The zonal geranium, Pelargonium × hortorum, was shown to respond to ethylene treatment by rapidly abscinding petals. The response was similar to that previously found in P. domesticum in speed and in the increased responsiveness to ethylene as the florets aged. Separation force (force required to remove the petals from the receptacle) declined after a lag period of about 45 minutes. Scanning electron micrographs show rounding of cells in the abscission zones following ethylene treatment. Transmission electron micrographs show evidence of cell wall degradation in the petal abscission zones of florets treated with ethylene. Micrographic evidence is therefore consistent with the hypothesis that separation is caused by enzymatic degradation of the cell walls.

134 (PS 6)
EFFECTS OF STORAGE ON THE PHYSICAL/CHEMICAL CHARACTERISTICS AND SENSORY QUALITY OF STRAWBERRIES
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Freshly-harvested and stored (5 days at 3.3°C → 2 days at 20°C) berries of 20 strawberry *(Fragaria* X *ananassa* Duch.) cultivars were compared to study the effects of storage on fruit physical/chemical characteristics and sensory quality. Fruit with tougher skin lost less weight during storage. Skin cell size was unrelated to skin toughness of fresh or stored fruit. Among cultivars, flesh firmness of fresh berries was highly correlated (r= +0.82) to values determined after storage. Within cultivars, storage did not alter firmness of individual intact berries, but pectic fraction analysis and sensory evaluation of fresh vs. stored fruits indicated softening to have occurred during treatment. Panelist's texture ratings were highly correlated with skin toughness and flesh firmness of stored fruit (r=-0.81 and -0.74, resp.). Stored fruit were darker in color and possessed lower levels of soluble solids than fresh fruit. Panelists judged stored fruit to be inferior to freshly-harvested fruit for visual, textural and flavor quality. Although overall appearance and overall eating quality were not well-correlated, cultivars were identified that were superior or inferior in both categories.

135 (PS 7)
CRITICAL LEAF NITROGEN CONCENTRATION FOR GREEN BUNCHING ONIONS AND INFLUENCE OF HIGH NITROGEN RATES ON GROWTH
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Experiments were conducted at the Clemson Experiment Station and On a grower's farm, on a Lakeland sand soil (Thermic typic quartzipsamments), near Columbia, SC. The critical leaf N concentration was determined to be 3.9%, based on plant height and leaf dry weight as growth measurements. Plant height and leaf dry weight were more highly correlated to leaf N concentration than was total plant dry weight. In both studies, increasing the postplant nitrogen rate. from 0 to 22 $kg \cdot ha^{-1}$ per application, applied every 2 weeks, increased plant height and dry weight; leaf N concentration, and chlorophyll content. In the study conducted at the Clemson Experiment Station (soil organic matter content 0.5%) further increases in N rate resulted in small increases in plant growth. However, in the experiment conducted on the grower's farm (soil organic matter content 0.2%), N rates above 22 $kg \cdot ha^{-1}$ reduced plant growth. The reason for the difference in green bunching onion response to the N treatments at the two locations is probably due to differences in soil organic matter content. In the experiment at the grower's farm increasing the N rate from 0 to 90 $kg \cdot ha^{-1}$ resulted in a decrease in soil pH from 5.3 to 4.7. This low soil pH at the high N rates probably increased aluminum availability, killed the roots, and thus reduced plant growth.

136 (PS 6)
RELATIONSHIP BETWEEN CHROMATICITY VALUES AT HARVEST AND SUPERFICIAL SCALD INTENSITY AFTER STORAGE IN 'ROMS' APPLES
Mervyn C. D'Souza* and Morris Ingle, Division of Plant and Soil Sciences, West Virginia University, Morgantown, WV 26506-6108 and Suman Singha, Department of Plant Science, The University of Connecticut, Storrs, CT 06269-4067.

Superficial scald of apples is a physiological storage disorder influenced by many environmental and physiological factors at or before harvest. Color of the fruit at harvest is thought to be related to scald in storage. It is generally true that the non-blushed skin surface of apples develops scald more often or more intensely than the blushed surface. Fruit color at harvest was measured at four locations on each of eighty fruits at the midpoint between the stem and calyx ends with a Minolta Chroma Meter CR-200b portable tristimulus calorimeter. Skin areas corresponding to each location of color measurement were evaluated for scald itensities after four months in refrigerated storage. The L* value at harvest (a measure of lightness) was determined to be positively correlated with scald intensity while the a* value (a measure of redness) was negatively correlated. Higher coefficients of correlation were obtained when the ratio of (a*/b*) was used. It may be possible to sort fruit based on color and consequently varying scald potentials.

137 (PS 7)
INTERACTION OF SULFUR AND NITROGEN IN LEAF LETTUCE
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The importance of N and S as essential nutrients in the growth and development of plants is well documented. Previous research on agronomic crops and poinsettias has shown that altering the N:S has an effect on plant growth and development.

The leaf lettuce cultivar 'Grand Rapids' was grown hydroponically at six logarithmic rates of S (0-12 ppm) in combination with four logarithmic rates of N (30-240ppm). SO_2 content in the greenhouse was monitored weekly. EC and pH of nutrient solutions were taken before and after solution changes. After nine weeks, plants were harvested, leaf fresh and dry weights determined. Color analysis was performed using a chromameter. Total S was determined using ICP-ES. Total N was determined using micro-kjeldahl.

Treatments at low levels of N and S were yellow to pale yellow green while treatments at the high level of N were dark green. Plants grown in the mid levels had equal or better color (visually) as compared to plants grown at the high levels of N and S. Relationship of this quantitative data with N and S will be discussed.

138 (PS 6)
MODIFIED ATMOSPHERE PACKAGING OF POST-CA APPLES
Ahmed Ait Oubahou*, D.R. Dilley and A. Cameron, I.A.V. Hassan II, Agadir, Morocco and Dept. of Hort., MSU, E. Lansing, U.S.A.

This work aimed to evaluate the effect of MAP on post-ca stored apples *(Malus domestica,* Borkh, c.v. Empire). The fruits were stored under CA conditions of 1.5 0, and 1.8% CO, and more than 96% rh at 0°C for 4 mo. Four LDPE films of various thicknesses (1, 1.75, 2 & 3 mil) were tested at 5 different temperatures 0, 5, 10, 15 and 2093. Another factor was the addition or not of CO_2 scrubber within the bags. Different parameters that include flesh firmness, weight loss, O_2 concentration, CO_2 and ethanol buildup within the package units and the non ethylenic volatiles profile changes were studied at weekly intervals up to 3 weeks storage. All packaged fruits retained better flesh firmness and showed reduced weight loss than the control. Other results indicated good correlation between gaseous equilibrium and the volatiles profile. Less permeable films at high temperatures, 15 and 20°C, tended to produce profiles of volatiles symptomatic of incipient fermentation, while films with intermediate permeabilities produced similar profile to non packaged fruits with a certain time lag due to ripening delay. This study demonstrated that MAP can be a useful means to retard the deterioration of post-CA storage apples often observed in commercial stores.

139 (PS 6)
MODIFIED ATMOSPHERE PACKAGING OF CLEMENTINE MANDARIN FRUIT
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Individual film wrapping of some horticultural commodities was demonstrated to be excellent in keeping quality and extending shelf life. Several researchers reported significant reduction of weight loss, peel disorders and retaining favorable internal quality of several produce such as peppers, oranges and grapefruit. Results of our study on Modified Atmosphere Packaging (MAP) using LDPE films on clementine orange showed better retention of rind firmness, green and orange color and total acidity of the fruit. After 78 days of storage at ambient temperature, control fruits kept in air were almost dried with dull color, while packaged fruits retained their external and internal quality at satisfactory levels. Weight loss from packs made of 1.75 mil LDPE was insignificant. At 4 and 20°C packaged fruits lost respectively 1.35 and 4.1% while the control for the same temperatures lost 8 and 41%. O_2 concentration at equilibrium using different fruit weights varies from 8 to 4.7% respectively for 1 and 8 fruits in 702 cm2 pack surface. Surprisingly, modeling studies based on oxygen depletion method, in closed system, gave to some extent very close levels of O_2 depending on fruit weight for fixed parameters of surface and film thickness.

140 (PS 6)
IDENTIFICATION OFVOLATILE COMPOUNDS RESPONSIBLE FOR OFF-ODORS PRODUCED BY BROCCOLI STORED IN ANAEROBIC CONDITIONS
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Broccoli *(Brassica oleracea* L., ltalica Group) produces severe off-odors when it is stored under anaerobic conditions which can develop in modified atmosphere packages. The compounds responsible for these off-odors, which render the broccoli unmarketable, were produced after sealing 50 g of fresh broccoli florets in glass pint jars held at 15C. Twenty-four hours after sealing oxygen concentration dropped to around

0.5% and remained at this concentration for 6 days. Volatile compounds found in the head space of the jars were identified using gas chromatography with flame photometric and mass spectroscopic detection. Volatile compounds produced were identified as methanethiol, hydrogen sulfide, dimethyl disulfide, acetaldehyde, acetone, ethanol, and ethyl acetate. Methanethiol was detected 48 hours after sealing and appears through olfactory evaluation to be the primary compound responsible for the objectionable odor.

141 (PS 7)
OPTIMIZATION OF THE MACRO-NUTRIENT ELEMENT REQUIREMENTS FOR THE HYDROPONIC CULTIVATION OF BUTTERHEAD LETTUCE (LACTUCA SATIVA L. CV CAPITATA), MAKING USE OF "MIXTURE" THEORY
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The major objective of 'mixture experiments' in hydroponic plant nutrition is the optimization of the ion composition of the nutrient solution in function of well defined response variables. In the context of mineral plant nutrition, optimization in general means finding a zone of feasible nutrient solutions, where the response variable is optimal and is not affected by the levels of the different factors. This optimization assumes an as accurate as possible estimation of the response surface, that describes the process under study. This was accomplished by an adaptation of the 'steepest ascent method' to the mixture case. Starting with the existing 'suboptimal' working conditions for lettuce, both in anion and in cation space, constrained mixture experiments were setup. The production, the biomass distribution within the plant, the mineral content and the distribution of minerals within the plant were investigated. As a result of a series of consecutive, optimization experiments a zone of optimal macro-element composition for lettuce cultivation, could be established.

142 (PS 7)
AN INTERACTIONAL STUDY OF THE FE, MN, ZN AND C_o STATUS IN THE HYDROPONIC CULTIVATION OF BUTTERHEAD LETTUCE (LACTUCA SATIVA L. CV CAPITATA).
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The aim of this study is firstly, the investigation of interactional structures between Fe, Mn, Zn and Cu in the NFT hydroponic cropping of lettuce and secondly, to outline the zone of optimal micro-element composition of the nutrient solution. The production, the biomass distribution within the plant, the mineral content and the mineral distribution within the plant were measured. In a first screening experiment a 24 factorial design is used. To evaluate and elaborate the results of the previous experiment, for a second run, a rotatable, central composite design, consisting of a l/2 replication of a full 2^4 factorial, 8 starpoints and 8 replications of the center point, was used. It was found that the micro-element concentrations could be varied over a wide interval without significant effects on the variables under study. Nevertheless the Fe*Mn*Zn and Fe*Zn*Cu interactions were predominant. Production and biomass distribution were not as sensitive to changes of micro-nutrient composition as mineral content and mineral distribution within the plant were. Especially the mineral gradients within the plant elucidated the micro-nutrient interactions.

143 (PS 7)
NON-DESTRUCTIVE PLANT CHARACTERISTICS FOR PREDICTION OF TOTAL NITROGEN UPTAKE BY POTATO CULTIVARS.
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Nitrogen requirements for new potato (Solanum tubersum L.) cultivars are seldom determined until several years after release, making it difficult for growers to optimize yield and quality. Research is underway to construct a model that provides a rapid estimate of nitrogen requirements, utilizing non-destructive plant characteristics. Nitrogen rate studies were conducted with five potato cultivars (Russet Norkotah, Frontier Russet, Russet Burbank, Lemhi Russet and Gemchip). During the growing season destructive and non-destructive measurements were recorded for 14 plant characteristics. Correlation analysis was used to determine the relationship between total nitrogen uptake and each characteristic. Those non-destructive characteristics with significant r values were subjected to a forward stepwise multiple regression procedure. Stem number/hill, stem diameter, plant height, leaf color 80 days after planting (DAP), petiole nitrate level 73 DAP and tuber yield contributed significantly ($p = .15$) to the model with a final r value of 0.75. This compared favorably to a previously developed model requiring destructively measured characteristics ($r^2 = 74$).

144 (PS 6)
PREDICTION OF OXYGEN CONCENTRATIONS IN MODIFIED ATMOSPHERE PACKAGES OF CABBAGE
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A model was developed to predict steady state oxygen concentrations inside modified atmosphere (MA) packages of cabbage *(Brassica oleracea* L. *'Espress').* An anaerobic conversion point of 2.3% external O_2 at 10°C was measured as determined by O_2 and CO_2 concn gradients under different external O_2 concn. Input variables for the model were oxygen consumption rates at different oxygen concn (RRo_2), film permeability to oxygen (Po_2), film area (A), and commodity weights within packages (W). Nonsteady state oxygen depletion data were used to develop RRo_2 functions and for construction of the final predictive model based on Fick's law of gas diffusion. Film permeabilities to O_2 and CO_2 were measured using a permeability cell ($Po_2 = 0.0314$ ml $cm^{-2} hr^{-1} atm^{-1}$; $Pco_2 = 0.0793$ ml $cm^{-2} hr^{-1} atm^{-1}$). The model was tested by packaging different amounts of cabbage inside film bags with an oxygen permeability factor of 110 ml $cm^{-2} hr^{-1} atm^{-1}$. Steady state oxygen concn inside MA packages predicted by the model were within an average of 10% of experimentally determined values and desired oxygen concn (3.5 ± 0.5%) were achieved with 4 to 4.5 kg cabbage.

145 (PS 7)
COMPARISON OF NITRATE SAP TESTS FOR DETERMINING NITROGEN STATUS OF POTATO
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Two nitrate electrodes designed for "quick" nitrate analysis, the Hach electrode and the Horiba/Cardy electrode, were compared with a Wescan conductimetric nitrate analysis for their ability to determine nitrate concentration in the sap of potato petioles. Petiole samples were collected from an N rate study at tuber initiation and from growers' fields at ten day intervals through the growing season. Half the petioles were crushed to express the sap and the remaining petioles were dried in an oven at 60C. The dried petioles were used to determine petiole nitrate by conventional procedures. Both conventional and sap test methods detected relative differences due to N rate and sampling date. Nitrate concentrations in the sap were similar when the Hach method and the Wescan method were used. In contrast, the Horiba/Cardy method resulted in consistently higher readings for the same sample. Using current sample preparation procedures, a different set of sap nitrate critical values would have to be established for the Horiba/Cardy electrode compared to the Hach electrode.

146 (PS 6)
EFFECT OF LOW O_2 ATMOSPHERE ON SUGAR CONTENTS OF POTATO TUBERS STORED AT LOW TEMPERATURE
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It is known that during the storage of potato tubers at low temperatures (0-3 C), there is an accumulation of glucose, fructose and sucrose in the tissue. In the present experiments we studied the effect of 1.5% 0, on respiration and sugar accumulation during storage of potato tubers (Russet Burbank) at 1 C. Low O_2 environment suppressed the rise in respiration attending the transfer of tubers from 10 C to 1 C, and the rate of CO_2 output declined gradually with time. Calculations based on the diffusivity of O_2 through the skin and flesh of the tubers together with the rate of respiration indicate that 1.5% O_2 is not expected to limit any of the known mitochondrial terminal oxidases. In addition low O_2 environment diminished significantly the rate of sugar accumulation.

147 (PS 7)
EVALUATION OF YIELD AND YIELD COMPONENTS OF CORN, BEANS AND POTATO IN A TRIPLE CROP INTERCROPPING SYSTEM AT LOW SOIL NITROGEN
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The response of corn, beans and potato was evaluated in a 3 crop intercropping system at constant population density of corn (37,050 plants/ha) and three densities of beans (66,000 132,000 200,000 plants/ha) and potato (13,000, 36,000, 44,000 plants/ha) at low soil nitrogen in 2 seasons. Intercropping at the highest plant densities of beans and potatoes reduced the yield of corn, beans and

potatoes by 65, 80 and 51 per cent respectively and produced a land equivalent ratio (LER) of one. The LER increased with decrease in the density of companion crops up to 1.24, indicating that intercropping at lower densities was more beneficial than monocultures. Increasing the density of beans and potatoes reduced corn height, leaf width and size of ears as well as leaf N, P and K. In beans the number of pods per plant was reduced while seeds per plant and seed weight were constant. In potatoes tuber size and numbers per plant declined.. The results indicate that the triple crop density which maximizes yield and income should not exceed 2/3 of optimum bean and potato sole crop densities.

148 (PS 6)
MODIFIED-ATMOSPHERE STORAGE DOES NOT SUBSTITUTE FOR LOW-TEMPERATURE STORAGE OF STRAWBERRY
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'Honeoye' (June-bearing) and 'Tristar' (day-neutral) strawberries were harvested, graded, and then stored for 7 days et 2C or 21C in air (control) or each of these 8 modified atmospheres: 1.5% O_2, 3.5% O_2, 15% CO_2, 25% CO_2, 1.5% O_2 + 15% CO_2, 1.5% O_2 + 25% CO_2, 3.5% O_2 + 15% CO_2, and 3.5% O_2 + 25% CO_2; all balance N_2. When compared with storage at 21C, storage at 2C reduced weight loss and gray mold growth in all corresponding sets of storage atmosphere treatments. The combination of increased CO_2 and decreased O_2 controlled weight loss and gray mold growth more effectively than treatment with reduced O_2 alone. Storage at 2C (versus 21C) reduced respiration of both cultivars. Respiration decreased as the O_2 concentration decreased. 'Tristar' did not produce C_2H_4 at either temperature, whereas 'Honeoye' produced more C_2H_4 at 21C than it did at 2C. Increased CO_2 and/or decreased O_2 concentrations in the storage atmosphere are not satisfactory substitutes for proper low-temperature storage of strawberries.

149 (PS 7)
BOEHMERYL ACETATE (BAc) ACCUMULATION IN SWEETPOTATO STORAGE ROOTS AS INFLUENCED BY PLANT NUTRITION
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BAc is a pentacyclic triterpenoid which has been found to be an ovipositional stimulant for the sweetpotato weevil. It is found on the surface of storage roots (SR) of susceptible cultivars, but it is absent or at very low concentration in cultivars showing moderate resistance to the weevil. A field study was carried on to determine the effects of N (56 or 112 kg/ha) and K (0, 112, and 224 kg/ha) fertilization on the SR concentration of BAc (cv. Centennial). At 56 kg N, no significant K effect was detected, but at 112 kg N there was a significant (0.1 %) K quadratic effect. Significant single correlation coefficients (r) were found between nutrient concentrations in plant parts and SR concentration of BAc. Nutrition may be a significant factor modulating differences in weevil susceptibility over location and time for individual lines, and, in part, explain inconsistencies in published estimates of field resistance to the weevil.

150 (PS 6)
EFFECT OF TEMPERATURE, MODIFIED ATMOSPHERE AND PYRROLNITRIN ON BLACK AND RED RASPBERRY SHELFLIFE
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Two experiments were conducted, one on 'Bristol' black raspberry in 1989, and one on 'Heritage' red raspberry in 1990, to evaluate the effects of pyrrolnitrin (a biologically derived fungicide), modified atmospheres and different temperature regimes on postharvest longevity. For preharvest fungicide treatments, 200 ppm pyrrolnitrin, a standard fungicide treatment (Captan/Benlate in 1989, Rovral in 1990) or a distilled water control was applied one day prior to first harvest. Postharvest temperature treatments were 18 or 0 ± 1 C. Modified atmosphere treatments (1989 only) were air, 20% CO_2 in air or 20% CO_2 + 5% O_2. Both modified atmosphere treatments resulted in extended raspberry shelflife, particularly at the lower temperature. Pyrrolnitrin treated berries consistently had less disease development in storage than the control, but more. than the commercially treated berries. Lowering the temperature increased raspberry shelflife the most.

151 (PS 7)
SPOKE WHEEL FERTILIZER SIDEDRESS INJECTION TO IMPROVE YIELDS OF DIRECT-SEEDED BROCCOLI AND REDUCE RATES/INPUTS
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Leaf analyses of commercial growers' fields the season preceeding these tests showed nitrogen deficiency at heading. Growers applied in-season nitrogen-potash fertilizers by broadcast methods which proved to be inefficient for recovery by the small broccoli root system. At 32 days after seeding (das) broccoli roots extended only 7" laterally from stems. A one-time spoke wheel sidedress fertilizer injection at 32 das of 1:1 ratio of nitrate nitrogen and potash 6" from stems et l/3 of broadcast rates significantly increased yields while maintaining leaf nitrogen and potash at or above nutrient sufficiency levels through harvests.

152 (PS 6)
MODIFIED ATMOSPHERE PACKAGING OF BLUEBERRIES: EFFECTS OF TEMPERATURE AND INTERNAL OXYGEN CONCENTRATION ON RESPIRATION RATE
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Packaged blueberries respond favorably to O_2 partial pressures of 2 to 4 kPa. Low O_2 limits availability of oxygen within the tissue, slows respiration and extends fruit storage life of blueberries. Desirable partial pressures of internal O_2 have not been reported previously. A range of O_2 concentrations was generated in modified atmosphere packages at 0, 5, 10, 15, 20, and 25C. When O_2 and CO_2 levels had reached steady state, fruit internal O_2 was determined by vacuum extraction. Oxygen uptake rates were calculated using package permeability and steady state O_2 concentrations. As the internal partial pressure of O_2 approached zero, the respiratory quotient (RQ) sharply increased. The upwards deflection in RQ was accompanied by a sharp decrease in O_2 uptake, which occurred at internal O_2 partial pressures of approximately 0.5 kPa for all storage temperatures. At each temperature, O_2 gradient across the fruit skin increased with an increase in O_2 uptake. However, for a given rate of O_2 uptake, the O_2 gradient increased as temperature decreased. This temperature sensitivity suggests that most gas diffusion for blueberry fruit occurs through a semi-permeable membrane. Discussion on the effects of internal O_2 concentrations on gas diffusion and anaerobic processes in blueberry fruits will be presented.

153 (PS 7)
INFLUENCE OF ENDOGENOUS CALCIUM ON POST-PROCESSING TEXTURAL QUALITY OF PICKLING CUCUMBER FRUIT
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Sand culture experiments were conducted in controlled environments to determine the effects of endogenous fruit Ca concentration on tissue firmness and the rates of softening following fresh-pack processing of pickling cucumbers. Fruit Ca status was modified by exposing the cucumber plants to 0.01, 0.1, 10, and 20 mM Ca in the nutrient solutions from fruit set to harvest. Ca concentrations were measured in pericarp and endocarp tissue. Spears were 4.5 cm diam. fruit were fresh-pack processed in 0, 5 or 20 mM $CaC1_2$ solutions. Tissue texture during incubation at 46°C was measured at 0, 5 and 20 days using a shear press (TMS-90, Food Tech. Corp.). Pericarp tissue Ca concentrations were positively correlated with tissue firmness immediately following fresh-pack processing. High endogenous Ca levels, however, were correlated with high rates of pericarp softening during accelerated aging. Refrigeration extended the Ca effect on texture for 3 weeks following processing.

154 (PS 6)
POSTHARVEST FUMIGATION OF TABLE GRAPES WITH DECCODIONE SMOKE TABLETS FOR PROLONGING THE STORAGE LIFE
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Table grape cultivars Thompson Seedless, Red Malaga, and Black Monukka were fumigated with three levels of Deccodione smoke tablets (Pennwalt Decco) for 30 minutes. Grapes were packed in TKV lugs with Botrytis inoculum planted among the clusters and stored at 0 C and high relative humidity up to 12 weeks. Size of the smoke particles were determined. Fruit was evaluated at biweekly intervals for decay and quality parameters. Deccodione residues on fruit were determined and found to be within acceptable limits. It was possible to store grapes up to 10 weeks at 0 C in good condition with the high dose (3X). Low level (1X) was ineffective. There was no perceptible change in taste due to treatments. The smoke tablets have the potential of overcoming the disadvantages of sulfur dioxide fumigation.

155 (PS 7)
EFFECT OF SALT-SHOCKS AND MACRONUTRIENT CONCENTRATION ON TOMATO FRUIT QUALITY AND PREDICTION BY PRE-FLOWER LEAF ORGANIC ACID CONTENT
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Tomato *(Lycopersicon esculentum* Mill.) 'Laura' was grown at 0.25X and 1X macronutrient concentrations in a nutrient film technique (NFT) system. The 1X macronutrient concentrations (mM) were 13 NO_3, 2 NH_4, 1.5 H_2PO_4, 7.7 K, 5 Ca, 2 Mg, and 2 SO_4. In 1X solutions, 5.2 mM Cl balanced macronutrient cations and was adjusted for concentration changes. The micronutrient concentrations (μM) were 107 Fe, 32 BO_3, 9 Mn, 1.6 Cu, 0.8 Zn, and 0.6 MoO_4 in all solutions. Four treatments were applied: two maintained constant at 0.25X and 1X and two salt-shocked twice daily for 30 minutes (4 times the ambient 0.25 X or 1X concentration). Increasing macronutrient concentrations significantly increased the percent dry matter, titratable acidity, and soluble solids of fruit while lowering pH. Salt-shocks significantly increased percent dry matter of fruit. The citrate-malate ratio of leaf tissue early in the production cycle was significantly higher in plants grown at 1X concentration. Fruit quality (percent dry matter, titratable acidity, and soluble solids) could be predicted before flowering by the leaf citrate-malate ratio and citrate concentration on a fresh weight basis (R^2=0.37 0.55 Leaf citrate on a dry weight basis was correlated with pH of fruit (R^2= 0.49).

156 (PS 8)
YIELD RESPONSE OF GREENHOUSE CANTALOUPE TO CLEAR AND BLACK PLASTIC MULCHES.
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Fruit yield of cantaloup (Cucumis melo L.cv. PSF 189) was not affected by the application of clear (C) or black (B) plastic mulches. in comparison to unmulched soil (U). when grown inside an unheated greenhouse located in a region with a cold early spring in the Mediterranean mountains. Comparable marketable yields of 30.5, 28.06 and 25.03 t/ha were achieved under the C, B and U treatments, respectively, during 1990. The mulches enhanced vegetative growth during the cold early spring: however, fruiting occured later on when the weather warmed and thus no significant effect on yield occured due to the mulches. Soil temperature at 10 cm depth under the C treatment was warmer by 1-2 degrees celsius and 7-10 degrees Celsius than temperature under the B and U treatments respectively, when the plant canopy did not cover the mulches. but became comparable among the mulches when they became covered by the plant canopy.

157 (PS 7)
INFLUENCE OF BIOCIDES ON NITRIFICATION, DENITRIFICATION, AND TOMATO N UPTAKE
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As a result of long-term application, some fungicides may accumulate in the soil to levels that can affect soil N transformations and plant growth. Studies were initiated to compare benomyl, captan, and lime-sulfur fungicides with the biological nitrification inhibitors (NI) nitrapyrin and terrazole for their effects on biological nitrification and denitrification, and tomato *(Lycopersicon esculentum* Mill.) growth and N uptake. In laboratory studies, inhibition of nitrification was less than 5% in a Tifton l.s. soil incubated with 10 μg g^{-1} a.i. of benomyl but was about 51%, 72%, and more than 85% when amended with lime-sulfur, captan, and NI, respectively. Similarly, increased inhibitory effects on denitrification of NO_3 were obtained in a liquid media incubated anaerobically with either NI (37%) than captan or lime-sulfur (25%) while benomyl had no significant effect. In greenhouse studies with tomato plants, weekly drench applications of 0.25 μg a.i. g^{-1} soil of the appropriate chemical for 4 weeks with three NH_4:NO_3 ratios showed that the NI and captan produced the greatest plant biomass and N uptake, but benomyl and lime-sulfur had no main effect while all fungicides interacted with the N ratio to affect plant growth and N uptake.

158 (PS 8)
POTASSIUM EFFECTS ON CARBOHYDRATE METABOLISM OF TOMATO FRUIT
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During the early development of tomato fruit, the starch content rapidly increases. As the fruit matures, prior to ripening, this starch is broken down as the hexose level rises. Tomatoes grown under conditions of high salinity (E.C. 8.0-12.0mS) have been shown to produce more starch than under control conditions (E.C. 2.0mS). We have investigated the possibility that the high potassium level in the nutrient solution may be responsible for this phenomenon. Our data indicate that slices from tomato pericarp tissues, when fed ^{14}C-sucrose, converted more of that sucrose to starch with the addition of 5mM KC1 to the bathing solution. Furthermore, starch synthase activity of tomatoes is stimulated by K^+ and may offer an explanation for the high salinity effects on starch synthesis.

159 (PS 7)
N-FORM EFFECTS ON NUTRITION OF WATERMELON
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Watermelon *(Lunatus sativus* L.) cv. 'Bush Jubilee' were grown under three NO_3:NH_4 ratios (3:1, 1:1, and 1:3) to determine effects on macronutrient nutrition. Plants were grown in solution culture under greenhouse conditions. Phosphorus uptake increased until bloom and remained high through fruit development. Calcium and magnesium uptake increased until bloom and then declined. Potassium uptake increased until bloom and remained high through fruit development. Both NO_3 and NH_4 uptake were higher after bloom than before. Water use increased until bloom, then declined during bloom and then increased after bloom. Dry matter production was highest with the high NO_3 treatment. Sugar content was reduced with NH_4 as the principle N-form. Nitrate, P, K and Ca were higher at the stem end of the fruit vs. the blossom end.

160 (PS 8)
BORON AND MANGANESE NUTRITIONAL EFFECTS ON LEAF NECROSIS IN HYDROPONICALLY GROWN BIBB LETTUCE
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The effects of boron and manganese nutrition on the severity and incidence of leaf necrosis in hydroponically grown Bibb lettuce (Lactuca sativa L. cv. 'Ostinata') were investigated. Boron toxicity was characterized by areas of necrotic tissue on the lower leaf edges, spreading inwards and to younger leaves with age. Symptoms occurred at solution B levels of 2.0 μg/ml, and were associated with tissue B concentration of 97 μg/ml (dry wt). Manganese toxicity was characterized by small brown lesions, beginning as pinhole size spots, randomly distributed along the outer leaf edge and throughout the internal portions of the older and younger leaves. Symptoms occurred at solution Mn levels of 10 μg/ml, and were associated with tissue Mn of 600 μg/ml (dry wt). In each case, the application of supplemental lighting increased symptom severity and the number of affected leaves.

161 (PS 7)
TIMING MICRONUTRIENT APPLICATIONS USING A LISA APPROACH
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Arkansas soils can range in pH from the low 4's to 7 depending on the location and liming history. Deficiency of zinc, boron and molybdenum coupled with the soil acidity complex of manganese toxicity had been previously identified as a severe limiting factor in production of quality brassica crops on our farmer cooperator's land. During the fall of 1990 three preplant fertilizer treatments were split for four timing treatments of micronutrients to determine the effect on the development of nutrient disorders on broccoli and cabbage. The experiment was designed as a split-plot with the main plots being the three levels of preplant NPK and the sub-plots being the four timings of micronutrient applications replicated four times. The results showed that earliness and quality seem to be dependant on both the availability of micronutrients and the timing of applying micronutrients.

162 (PS 8)
MECHANICAL BUD DAMAGE TO BRANCHED AND UNBRANCHED 'BRADFORD' PEAR TREES DURING POST HARVEST HANDLING
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Branched (B) and unbranched (UB) one-year-old 'Bradford'/'OHFx97' trees were examined at intervals between preparation for bare root harvest and long term storage to determine the extent of mechanical bud damage caused by the various handling steps.

After hand stripping of leaves, digging, transportation to the storage facility, and grading, and tying of bundles, there was a marked difference in the percentage of damaged buds between branched (26%) and unbranched (53%) trees. The B/UB live bud ratio before and after harvest was 1:0.45 and 1:0.26, respectively. This difference may have been due to a various morphological growth pattern which both types of trees had produced.

163 (PS 7)

NITROGEN INFLUENCE ON BIOMASS PRODUCTION OF COVER CROPS.

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The potential for biomass production and N accumulation by summer and winter cover crops was examined in greenhouse and field studies using a Bojac sandy loam soil. Biomass production and N accumulation of 19 cover crops were determined at two rates of applied N (20 and 60 mg N/kg soil) at 42 DAP (days after planting) in a greenhouse pot study. The greatest biomass accumulation was noted for German and pearl millet, buckwheat, corn, and sorghum. Significantly greater N accumulation occurred with buckwheat and German millet. Also, increased applied nitrogen resulted in greater biomass production and accumulated N. In the field study, greater biomass accumulated in cover crops planted after potato than after spring fallow (plots plowed in spring but not planted). Significantly greater biomass production occurred with sorghum than soybeans or summer fallow (plots disked, but not planted), particularly 35 DAP of the summer cover crops. After 56 DAP, biomass production of summer cover crops was similar in plots previously planted in potatoes or left fallow in the spring.

164 (PS 8)

USE OF COMPOST IN COMMERCIAL NURSERIES

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Organic substrates have low anion and cation exchange capacities. Composts appear to have characteristics which can improve these properties. A study was conducted to test the addition of a poultry litter compost to media used at a commercial nursery. The standard medium of pine bark and peatmoss (5: 1 by volume) was compared to the standard medium with 10% (by volume) addition of compost, and pine bark plus additions of l0, 20 and 40% (by volume) compost. Pine bark was amended with 0.5, 6.3 and 4.2 kg/m^3 Scots Step, ProKote (20.0N-1.3P-8.3K) and dolomitic limestone, respectively before blending with other components. Rhododendron cultivars 'Nova Zembla', 'PJM' and 'Chinoides' and *Kalmia lutifolia* 'Nipmuck' were potted in 11.4 liter containers in one of 5 media and placed in 5 randomized complete blocks under 20% shade cloth. Media pH levels ranged from 5.7 to 6.7 while EC for all compost containing media was initially above 2.0 mmhos and ranged between 1.5 and 0.7 through the growing season. Container leachate and foliar tissue levels were also analyzed. Visual ratings of all four test plants and top dry weight of 'Nipmuck' indicated that plants preformed as well or better in media containing 10% compost as the nursery standard.

165 (PS 7)

A MODEL FOR NUTRIENT MANAGEMENT IN RECIRCULATING, LIQUID HYDROPONIC CULTURE

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Traditional nutrient solution recipes (such as Hoaglands solution) are inappropriate for long-term studies in which the nutrient solution is recycled. Here we describe problems with traditional recipes and present a model to develop nutrient solution recipes based on plant requirements rather than set-point concentrations in the solution. The *ratio* of ions in the solution is based on ideal concentrations in plant tissues. It is useful and sometimes necessary to alter the solution composition with the growth stage of the crop. The *concentration* of ions in solution is determined by the transpiration/photosynthesis ratio (ratio of water uptake to nutrient demand, based on photosynthetic incorporation of carbon). Total ion concentration is maintained by controlling solution conductivity. This approach requires continuous monitoring and control of solution pH and daily monitoring of electrical conductivity, but it does not require monitoring of individual ions in solution. This approach has been used successfully in 90-day studies without discarding solution.

166 (PS 8)

EFFECTS OF CONTAINER SIZE ON THE GROWTH OF SHADE AND ORNAMENTAL TREES OVER A THREE-YEAR PERIOD.

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The effects of container size on height, caliper, fresh and dry weight of flowering dogwood, blackgum, sweetgum, river birch, and loblolly pine was investigated over a three year period. Tube grown seedlings were transplanted to 1, 3, 5, 7, or 10 gallon (3.8, 11.4, 19, 26.6, 38 1.) nursery containers in year 1. In year 2, trees were shifted into a variety of larger container sizes. In year 3, all trees were finished in 38 1. nursery containers. Small initial container size severely retarded subsequent growth of flowering dogwood and blackgum. Loblolly pine was able to partially recover from the stunting effect of small initial container size, but trees started in larger containers maintained a growth advantage. Height of birch and sweetgum was not affected by small initial container size, but caliper and weight were reduced. Comparative data for field grown trees will also be presented.

167 (PS 7)

EVALUATION OF CONTROLLED-RELEASE FERTILIZERS FOR CITRUS

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In Florida, because soil and climatic conditions make soluble fertilizers prone to substantial leaching losses, young citrus trees need to be fertilized more frequently with soluble fertilizers to obtain good growth, high yield, and good quality fruit. The effects of several controlled release fertilizers were compared to soluble fertilizers to see if application frequency could be reduced without causing inadequate nutrition. Sulfur coated urea (SCU) and methylene urea (MU) were compared to ammonium nitrate (NH_4NO_3). Sulfur coated potassium (SCK) was compared to potassium chloride (KC1). The soluble fertilizers (NH_4NO_3, KCl) were more easily available and had shorter residual effects on leaf and soil N and K contents than the controlled release fertilizers (SCU, MU, SCK). These controlled release fertilizers have the potential to reduce application frequency by more than one-half (from 15 to 6 applications) without decreasing tree growth, fruit production, and fruit quality during the first 3 years.

168 (PS 7)

CITRUS IRRIGATION WITH TREATED MUNICIPAL WASTEWATER

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Because agricultural use of available groundwater is becoming more restricted, use of wastewater for crop irrigation is increasing. However, there is a concern about the effects of treated wastewater on crops intended for human consumption. Hence, research has been conducted for 4 consecutive years to compare the effects of reclaimed municipal wastewater (Conserv II) with well-water on citrus. Conserv II samples were higher in soil pH, in leaf P, Na, and Fe contents, and in soil P, K, Ca, Mg, and Na levels than those taken from well-water irrigated groves. This was attributed to the higher concentrations of these elements in Conserv II than in well-water. The higher K, Ca, and Mg contents in Conserv II soil samples were not reflected in leaf samples probably due to the heavy fruit crop load on the trees in Conserv II groves. The supply of N in Conserv II water was not significantly reflected in leaf and soil contents because both irrigated groves were on a high **N** fertilizer program. Soil water content, generally maintained higher in Conserv II groves, increased fruit yield but decreased soluble solids in the juice.

169 (PS 7)

FLOODING AND MINERAL NUTRITION OF MANGO TREES

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Potted two-year-old 'Peach' mango *(Mangifera indica* L.) trees were grown with (+ Fe) or without (-Fe) chelated Fe in limestone soil, and exposed to one of 3 flooding regimes: nonflooded (control), 10 days flooding, or 20 days flooding. Prior to the imposition of flooding, and 80 days later, total leaf chlorophyll (Chl) and foliar concentrations of N, P, K, Ca, Mg, Fe, Mn, Cu and Zn were determined. Initial Chl, Fe and Mn contents were greater, but K, Ca and Mg contents were less, for +Fe trees. Chl decreased between sampling dates for all treatments except flooded -Fe trees. Significant increases in foliar Fe occurred only for flooded trees. Foliar Mn increased only for flooded, -Fe trees. Foliar P and Mg increased for all treatments, but Mg was greatest for trees flooded for 20 days. Regardless of flooding treatment, K and Ca increased for + Fe trees, and decreased for -Fe trees. Foliar Cu increased only for + Fe trees, and there was little effect on N or Zn. Prior to flooding, net CO_2 assimilation (A) was greatest for +Fe trees. Six months after the imposition of flooding, A of flooded, -Fe trees was similar to that of +Fe trees. Thus, short-term flooding can increase foliar concentration of some mineral elements in mango trees grown in limestone soil.

170 (PS 8)
THE EFFECTS OF FERTILIZER RATE AND PRODUCTION SYSTEM ON GROWTH OF ACER RUBRUM 'RED SUNSET, BETULA NIGRA 'HERITAGE' AND MALUS X 'SNOWDRIFT'
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Nursery liners of 'Red Sunset' maple, 'Heritage' birch, and 'Snowdrift' crabapple were grown from rooted microcuttings in the greenhouse. They were planted into 10 gal (38 l) containers using standard bark media and to the field in June, 1988. Fertilizer was applied 2X/week (container) or 1X/week (field) at 100, 200 or 400 ppm N liquid 20-10-20 as a drip (container and field) or 18-6-12 slow release as a topdressing (container only) for two growing seasons (1988-89). Container plants were overwintered beginning in December, 1988 and transplanted to 25 gal (95 l) containers in mid April, 1989. Height and caliper were recorded December, 1989. Mean stem height of container-grown 'Red Sunset' maple was 8.77 ft (2.67 m) using 300 ppm N; field-grown 'Heritage' birch 12.7 ft (3.9 m) using 100 ppm N, and container grown 'Snowdrift' crabapple 8.85 ft (2.7 m) using 150 ppm N. All container fertilizer treatments were superior to field treatments for stem height except for field-grown 'Heritage' birch. Stem heights for most field-grown 'Heritage' birch fertilizer treatments (100 ppm N, 200 ppm N, 400 ppm N) were greater than those in containers.

171 (PS 7)
SOIL PROFILE NO3 AND NH4 IN A TRICKLE- AND FLOOD- IRRIGATED YOUNG GRAPEFRUIT ORCHARD WITH VARIABLE N FERTIGATION.
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Inorganic N pool was quantified in a 3 m deep soil profile at the end of a 4-year-long irrigation experiment conducted in a grapefruit orchard growing in Raymondville sandy clay. NO (no nitrogen), N1 (20, 40, 80, 160 g N/tree/year in the 4 consecutive years) and N2 (twice the N1 levels) treatments were superimposed on trickle and flood irrigation. Nitrogen was injected into the trickle lines or. under flood, applied beneath the trees. The surface area fertilized was similar for both irrigations the first 2 years of study but was 2.5 and 6.9 times larger under flood the 3rd and 4th year, respectively. N1 and N2 treatments led to NO_3 accumulation especially at 120-300 cm depth. NO_3 concentrations were higher under trickle than flood at depths greater than 180 cm. The net amount of NO_3 recovered (N1 or N2 - NO) in the soil profile within the fertilized areas constituted on average 11.7 and 9.3% of the amount of fertilizer N added in the flood and trickle treatment, respectively. Thus, the elevated soil NO_3 concentrations under trickle reflected the smaller soil surface area fertilized rather than decreased NO_3 leaching.

172 (PS 8)
BIRCH SEEDLING RESPONSE TO IRRIGATION FREQUENCY AND A HYDROPHILIC POLYMER AMENDMENT IN A CONTAINER MEDIUM
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European birch *(Betula pendula* Roth) seedlings (1+ 0 plugs) were planted in a container growth medium amended with 0, 1.2, 2.4, or 3.6 kg/m^3 of a commercial hydrogel and watered either daily or once every 3 or 5 days. When hydrogel was incorporated in the growth medium, shoot and root dry weights and lea area were reduced by 19, 29 and 18%, respectively, compared to controls. Shoot height, stem diameter and shoot:root ratio were unaffected by hydrogel amendment rate. Compared to seedlings in polymer-amended media, plants growing in medium without hydrogel had significantly lower stomata1 conductance and transpiration on fewer than 25% of the measurement dates. Irrigation frequency significantly affected all plant growth Indices and stomata1 parameters; seedlings irrigated daily grew the most and had the highest stomata1 conductance and transpiration. Although polymer-amended media held more water than the medium without hydrogel at all measured tensions, this moisture was retained in the expanded gel rather than being available for plant uptake at higher tensions. The hydrogel appeared to have little benefit for container production of birch.

173 (PS 7)
INVESTIGATIONS OF BANANA-BEAN INTERCROPPING IN UGANDA.
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The intercropping of bananas and beans is a common cropping system in Uganda. Experimentation was conducted for three seasons to determine cropping system effects on: relative performance of bean cultivars; productivity; relationships between physiological traits and bean yield; and pest levels. Rank correlation coefficients for cultivar yields in monoculture to cultivar yields in association were significant ranging from 0.50 to 0.84. The results have shown that evaluation of genotypes for yield in monoculture is sufficient to efficiently select cultivars for the banana-bean system. Bean yield in the banana-bean system averaged 0.63 t ha^{-1} and 53% of the sole crop yield. Shading reduced bean yield, but bean stem starch levels, leaf chlorophyll content, and the chl. a/b ratio were not related to bean yield in either system. LAI was linearly related to bean yield in association. Bean foliar analysis indicated that low K and high Mn availability constrained intercrop bean yield. Mn levels in bean tissue were high and toxic under bananas. Competition for other nutrients and soil H_20 did not appear to affect bean yield. Mean competitive ratios of bananas and beans were 1.39 and 0.85, respectively. The LER of the system was 1.60. Disease and insect levels were similar in the two systems.

174 (PS 8)
EFFECT OF FERTILIZER TYPE ON SOIL NITRATE-N PROFILES UNDERLYING TWO CONTAINERIZED NURSERY CROPS
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Cornus amomum and *Rhododendron* 'Cary's Red' were produced on top of bottomless 7 lm^3 soil-filled boxes that were recessed into the soil. Plants were grown in 2 gallon containers in a 3 pine bark:2 peat:1 sand medium. Fertilization was either a single 60g/pot surface application of Osmocote 18-6-12 (SR) or biweekly 200ppm N applications of 20-20-20 soluble fertilizer (LF). Irrigation or fertigation was applied over the top of the plants for a set time period to simulate nursery overhead irrigation. Soil core samples were removed at 30cm increments to a depth of 90cm from replicate treatment boxes at two week intervals. Soil, plant tissue and potting medium samples were analyzed for nitrate content. Few crop-dependent differences in nitrate movement or accumulation could be detected. Nitrate levels in the 0-30cm layer tended to elevate quickly, while levels in the 60-90cm layer were slower to elevate. For both SR and LF treatments, nitrate levels rose steadily and reached a maximum in the 30-60cm layer after 9 weeks. Maximum nitrate levels were over 50% greater for SR than for LF treatments and were over four times baseline levels.

175 (PS 7)
CANOPY NUTRIENT ALLOCATION IN BOROJÓ
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Borojó *(Borojoa patinoi*, Rubiacea) is a tropical fruit tree native to rainforests on infertile soils. We hypothesized that Borojó would distribute mineral nutrients to better-illuminated regions of its canopy as a mechanism of efficient light and nutrient use. To test this hypothesis we analyzed leaf nutrient content in relation to incident light in Borojó canopies in the *Chocó* rainforest of Colombia. Canopy P allocation was positively correlated with incident light, due principally to increased leaf frequency brought about by local branching, with a smaller contribution from increased specific leaf weight (SLW). The chemical fractionation of P within leaves did not respond to incident light. Canopy N allocation was also positively correlated with incident light due to increased leaf frequency and SLW. Nitrogen partitioning to soluble protein rather than chlorophyll was positively correlated with incident light The allocation of K, Ca, Mg, S, Mn, and Cu also was positively correlated with incident light due primarily to increased leaf frequency and secondarily to increased SLW. Our observations support the hypothesis stated above, and suggest that leaf frequency caused by local branching, followed by changes in SLW, are the primary determinants of canopy nutrient allocation in this rainforest tree.

176 (PS 8)
CULTIVAR DIFFERENCES IN THE DEVELOPMENT OF RED MAPLE PLANTS FROM SINGLE-NODE CUTTINGS
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Single-node cuttings of nine red maple *(Acer rubrum* L. and *Acer x Freemanii)* cultivars were treated with 3000 or 8000 mg kg^{-1} IBA and placed under mist in flats of perlite for four weeks. The higher rate of IBA increased rooting for most cultivars. Rooting varied from 22% for cv. Scarlet Sentinel to 100% for cv. Schlesinger. Rooted cuttings were transplanted after the number and length of roots were recorded, and shoot development in nursery, greenhouse, and growth chamber environments was assessed after ten weeks. Shoot initiation varied among cultivars and was delayed by poor root development. In general, environment did not influence shoot initiation, but for cv. Armstrong and cv. Northwood, initiation was reduced in the growth chamber even though root growth continued after planting. We conclude that the success of propagating red maples from single-node cuttings varies among cultivars.

177 (PS 7)
FERTILIZER REQUIREMENTS FOR GREENHOUSE-GROWN PASQUEFLOWER, PULSATILLA PATENS SEEDLINGS
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Pasqueflower, Pulsatilla patens, seeds collected from an indigenous population were grown on a commercial bedding plant mix with all possible combinations of 0, 50, 100, 150, and 200 mg/l of soluble N (NH_3NO_3), P (H_3PO_4) and K (K_2SO_4) fertilizer applied weekly. Seedlings were grown for 4 months in a greenhouse with a minimum constant air temperature of 20°C and with natural lighting supplemented in February with sodium vapor HID lamps positioned 1.2m above the bench providing a 16 hr photoperiod. On 10 June, 1990 seedlings were harvested, and the following data were recorded: petiole length; number of leaves; crown diameter; shoot, root and total dry weight; and leaf tissue N, P and K content. Nitrogen and phosphorus fertilizers had a significant effect on all parameters measured, whereas the potassium fertilizer did not. The best non-destructive indicator of plant nutritional status was petiole length. Theoretical response curves with predicted optimum values of fertilizer and tissue nutrient concentration will be presented.

178 (PS 8)
VERTICILLIUM WILT INFECTION IN CERCIS CANADENSIS.
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Cercis canadensis, Eastern Redbud, is very susceptible to infection by Verticillium Wilt caused by the common soil-borne fungi Verticillium albo-atrum and Verticillium dahliae. Little is known about the inoculum levels, the time required for natural infection to occur and how fast the pathogen travels inside the host species. One-year-old Cercis canadensis seedlings were planted in 7.6 liter (2-gallon) containers with a 1:1:2 soil/sand/perlite mix inoculated with five levels (0, 10, 100, 500, and 1000 microsclerotia/g soil) of V. dahliae prior to planting. At the end of the first growing season, half of the plants were removed from the containers, surface sterilized, dissected and root sections plated out on a Verticillium selective media. The remaining plants were grown for a second season. Infection first occurred in plants which received 100, 500 or 1000 ms/g at the end of the first season. The infection had spread at least 5 cm during the first growing season.

179 (PS 7)
NITROGEN LEACHING FROM OSMOCOTE AS INFLUENCED BY IRRIGATION AMOUNT
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The amount of N in medium solution and leached from osmocote-fertilized pine bark in response to three irrigation amounts was measured. Pine bark (50 g)-filled pvc tubes (4.5 × 14 cm) fertilized with 0.5 g 14-14-14 Osmocote (3-4 month formulation) were drip-irrigated every three days with an amount of water equal to the amount lost from evaporation (E), E + 0.1E, or E + 0.2E. Gravimetric water content of bark at irrigations was approximately 80%. Leachate from tubes was collected throughout the 59 day experiment. Medium solution N content (pour-through method) was measured on days 15, 36, and 59. Tubes were stored in a growth chamber at 21°C. Forty-five percent more N was leached at the E + 0.2E treatment than from the E + 0.1E treatment. In most cases, very little leachate or no leachate was collected from the E treatment. Medium NH_4 concentrations were not different during the experiment for the irrigation treatments; however, NO_3 concentrations were higher in the E treatment than at E + 0.2 on days 36 and 59.

180 (PS 8)
LANDSCAPE TECHNICIAN JOB ANALYSIS TO ESTABLISH CERTIFICATION QUALIFICATIONS IN ARIZONA
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Job analysis interviews were conducted to provide an objective basis for educational programs and certification testing by the Arizona Certified Landscape Professional program. Landscape technicians and their supervisors were interviewed to determine tasks comprising the job and the knowledge, skills and abilities required to perform said tasks. Landscape contractors, maintenance companies, and in-house maintenance supervisors were surveyed as to the appropriateness of the interview-based job analysis and the importance of the tasks. Survey data was analyzed and used to develop educational and testing objectives for the certification program.

181 (PS 7)
TIMED FERTILIZER APPLICATIONS EFFECT DWARF YAUPON HOLLY NITROGEN UTILIZATION
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Multiple branched liners of *Ilex vomitoria* were greenhouse-grown in 3-liter containers with a common nursery medium and received either 2.5 g N surface-applied in 1 application as Osmocote (18N-2.6P-10K) or a total of 0, 0.5, 1.5 or 2.5 g N per container from a solution that contained N, P and K in a ratio of 6:1:3. The solution fertilizer was applied either 1, 2, or 4 times per week with total N applied per container equally divided among individual applications. After 26 weeks, plants fertilized with 1.5 or 2.5 g of N had larger shoot dry weights than plants that received 0.5 g N regardless of the number of applications. Shoot dry weights for the 1.5 and 2.5 g N treatments were similar to those of plants fertilized with Osmocote. Total N utilized by the plant system; shoots, roots and media, was similar for plants fertilized with Osmocote and all 2.5 g N treatments while N utilized by the 1.5 g N treatment applied 4 times per week was 20% more than the Osmocote treatment. Plants receiving the 0.5 g N treatment applied 1 or 2 times per week utilized the largest percentage of applied N, 76 and 77%, respectively.

182 (PS 8)
A SUMMARY OF SEVEN YEARS OF COVER CROP STUDIES AT PENN STATE
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In 1983 a research project was begun at Penn State to evaluate low growing plants for use as cover crops between rows of nursery stock. Plantings of grasses and legumes were established in fall, 1983 and spring and fall, 1984. All plantings were evaluated for establishment, growth, and competitiveness with weeds. The fall, 1984 planting is still being evaluated for persistence and weed encroachment under low maintenance conditions.

Additional studies relating to the establishment and use of cover crops have been conducted. Two studies were designed to determine the effects of different seeding techniques, mowing frequency, and selective herbicide use on establishment of several grasses. Another study was done to determine the competitiveness of the grasses with woody plants when the grass was grown as a solid sod or controlled in ships around the woody plants with herbicides. The sensitivities of the grasses to herbicides commonly used in nurseries were also determined. The fine fescues in general, and hard fescue in particular, proved to be the outstanding species for use as low maintenance cover crops with perennial crops grown at wide spacing. They were found to be extremely competitive with woody plants in solid sod, but did not significantly reduce woody plant growth if herbicide strips were maintained. A summary of the results of these studies will be presented.

183 (PS 9)
INFLUENCE OF MULCHING MATERIALS AND NITROGEN APPLICATION METHOD UPON THE GROWTH AND YIELD OF YELLOW CROOKNECKSQUASH
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The influence of nitrogen application method and mulching materials on the growth and yield of summer squash (Curcurbita pepo L) was investigated in the summer and fall of 1990. Black plastic, clear plastic and latex spray mulch treatments were evaluated. Nitrate was applied within mulching treatments 1) as a single broadcast application (112 kg N/ha) at planting or 2) 56 kg N/ha applied broadcast at planting plus 56 kg N/ha applied through drip irrigation four weeks later. Total yields were significantly greater for the spring season crop compared to the fall crop. This was due to increased viral disease incidence in the fall which resulted in smaller plants with reduced yields. Mulching treatments had a significant effect upon all yields in both fall and spring crops. Early, mid-season and total yields were greatest for plants grown on clear or black plastic mulches. Highest overall yield and fruit number were obtained using black plastic mulch. Fruit size was similar in all the treatments. Reduced yields were obtained when plants were produced on bare ground. Latex spray mulch provided little additional ground coverage and no differences in yield or other observations were reported when compared to the bare ground control. Weed suppression was greatest under black plastic mulch. Use of plastic mulches also resulted in decreased incidence of viral disease. Split application of ammonium nitrate had no major effects on yield or fruit number in either spring or fall experiments.

184 (PS 8)
IMPROVEMENT OF SEEDLING EMERGENCE OF LUPINUS TEXENSIS FOLLOWING SEED SCARIFICATION TREATMENT
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Seeds from 4 commercial seedlots of Lupinus texensis were placed in H_2SO_4 for 0-120 min. and then sown. Emergence was promoted by acid scarification in 3 of the 4 seedlots. For the lots that responded positively, the optimal scarification time was 30-60 min. In addition to increasing total emergence, acid scarification hastened emergence. The same aliquot of H_2SO_4 was used for five 60-min. scarification periods before its efficacy was reduced. Acid scarification did not reduce seed coat thickness or strength but created several small pores in the seed coat. Cutting, filing, or piercing the seed coat also promoted emergence. Brief placement of seeds in 85C water promoted emergence, but to a lesser extent than other scarification methods. Freezing and thawing of seeds had no effect on emergence. Results indicate that acid scarification functions by removing a mechanical rather than a chemical barrier to germination.

185 (PS 9)
EVALUATION OF SEVERAL NONIONIC SURFACTANTS FOR CONTROL OF CLUBROOT OF CABBAGE.
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Transplanter water applications of surfactants to control *Plasmodiophora brassicae*, Woronin on cabbage *(Brassica oleracea* Var. capitata, L.) in a naturally infested field were evaluated over four years. In 1987 and 1988, Renex™ (nonionic surfactant, ICI Americas, Inc.), Induce™ (nonionic surfactant, Helena Chemical Co.) and APSA 80™ (nonionic surfactant, Amway Corp.) significantly reduced the percent clubbing and the disease severity index (DSI) as compared to control and Terraclor ™ treatments. In 1989 and 1990, when the control DSI was low, percent clubbing and DSI were not significantly different among most treatments. Surfactant and fungicide treatments increased the number and weight of marketable heads over the control in 1988 when disease pressure was high. Higher rates (2% solution) of Induce™ and ASPA 80™ reduced the number and weight of marketable heads because of early season phytotoxicity on bare root transplants in 1989. No phytotoxicity was observed with lower rates (0.5% solution) in 1989 and 1990, but the weight of marketable heads was reduced by Induce™ and ASPA 80™ treatments in 1990 when bare root and plug mix transplants were used. Chemical names used: polyoxyethylene nonyl phenol (Renex™); alkyl polyoxylkane ether (Induce™); nonylphenoxypolyethoxyethanol (ASPA 80™); pentachloronitrobenzene (Terraclor™).

186 (PS 8)
EVALUATION OF IMPATIENS CULTIVARS FOR THE LANDSCAPE IN WEST-CENTRAL FLORIDA
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Impatiens (Impatiens wallerana) cultivars were evaluated for earliness of flowering, flower diameter and color, plant dimensions, uniformity, overall appearance and pest damage during the spring and fall of 1990. Sixty-nine cultivars in the spring and 56 cultivars in the fall were grown in micro-irrigated field plots under 30% shade cloth. Spring: The range of time from sowing to the first flower was 60 to 91 days. Seventeen cultivars flowered in 65 days or less, and two flowered 80 days or later. Plant heights ranged from 15.0 to 24.9 cm early in the season and 27.7 to 48.8 cm later. Cultivars were rated three times on a 1 to 10 scale (poorest to best) for overall appearance, uniformity and vigor. Good to excellent (8 or above) ratings were assigned to less than 20 cultivars each date. Thrips preferred no single series or flower color as evidenced by damage to the plants. Fall: The range of time from sowing to the first flower ranged from 55 to 81 days. Twenty-six cultivars flowered in 60 days or less, and two flowered after 75 days. Plant height at mid-season ranged from 18.3 to 37.4 cm. Subjective ratings at peak flowering were good to excellent for all but twelve cultivars.

187 (PS 9)
STORAGE CABBAGE AS AN ALTERNATIVE CROP FOR SOUTHWEST VIRGINIA
Gregory E. Welbaum*, Department of Horticulture, Virginia Polytechnic Institute & State University Blacksburg, VA 24061-0327.

The higher elevations of Southwest Virginia have lone been an important region for summer cabbage production. This is also an important tree fruit production region with refrigerated storage facilities that, in some cases, are underutilized because of declining tree fruit production. This study was conducted to investigate the potential for growing cabbage during the summer for storage, utilizing existing facilities, and sale during the winter months. Fourteen cultivars of cabbage *(Brassica oleracea* L., Capitata group) and one cultivar of Chinese cabbage *(Brassica rapa* L., Pekinensis group), reported to have superior storage qualities, were evaluated in the field and during storage. Transplants were set in the field in mid June using low nitrogen fertilization (75 lbs/acre) with no side dressing. Overhead irrigation was applied as required. Maturity ranged from 95 to 115 days after transplanting. The Chinese cabbage cultivar Wintertime did not head, possibly due to high late summer temperatures. All other cultivars tested performed satisfactorily, although there were dramatic differences in site, uniformity and quality. Average head weights varied from 3.7 lbs/head for Bartolo to 9.3 lbs/head for Atria. Cabbages were maintained in open storage bins at 1°C and near 100% humidity. Average weight loss in storage was 3% per month over the first two months. The cultivars Sagitta, Multikeeper, Hinova, Lennox, and Safekeeper performed particularly well and deserve future trial in this region.

188 (PS 8)
FIELD STUDIES OF STATICE AS AN OUTDOOR CUTFLOWER CROP
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Field studies were conducted in 1989 and 1990 on the potential of statice as an outdoor cutflower crop. In 1989, 7 cultivars were grown. Seeds were sown in the greenhouse on 4/7 and planted in Northwest Indiana on 5/22. Each of three replications contained 19 plants, which were offset planted (2 parallel rows with 1' between both plants and rows) in a 10' plot with black plastic mulch and trickle irrigation. Weekly harvesting began on 7/14 and ended on 10/9. Data on stem number and individual stem weight and length was recorded.

A follow-up study containing 43 (blue, apricot, and rose) cultivars was conducted in 1990. Similar cultural practices used in 1989 were followed, except seeds were sown on 4/l8 and field transplanted on 6/12. Weekly harvest began on 7/19 and ended on 10/l. Data was collected on total stem number and weight.

In 1989, the yellow cultivars had the highest yield with 535 stems per plot, followed by rose (419) apricot (253) and blue (185). 1990 had similar results, but the data showed tremendous cultivar differences, which is a factor that must be considered when selecting plants to grow.

189 (PS 9)
GROWTH RESPONSES OF BROCCOLI TO REFLECTED LIGHT FROM DIFFERENT MULCH COLORS.
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Spectral quality of light reflected from red, blue, white and black mulch on Premium Crop Hybrid broccoli was measured, and the predicted phytochrome photoequilibria (ø) of reflected light showed relatively small differences for each mulch color. Plants over a white mulch yielded an average 44.3% higher edible mass and averaged a 14.7% increase in total shoot biomass. None of the colors affected leaf thickness. There were no differences in total leaf area at maturity. The increase in reflected photosynthetic photon flux (PPF) decreased the leaf area needed per gram of shoot biomass produced in plants grown over the white mulch. The leaf mass per gram of total shoot biomass at maturity was significant only for plants over the black mulch. The white mulch reflected 55.6% of incident PPF and 28.9, 36.3, and 45.7% more PPF than the red, blue and black mulches, respectively. Plants grown over the white mulch averaged an increase of 5.9 mm in stem width and a decrease of 1.5 cm in stem height at 50 day harvest than plants over the other mulch colors. The observed differences were attributed to the increased amount of blue light reflected by the white mulch.

190 (PS 8)
SURVIVAL AND FLOWERING OF FALL-PLANTED PANSIES
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Thirty cultivars of fall-planted pansies were evaluated for their winter survival and subsequent blooming during spring and summer. Cell pack grown seedlings were planted in the field on 29 Sept. 1989, and irrigated as needed through the winter. The winter temperatures ranged from 24° to -30° C at the test site. The winter survival ranged from 94% (Maxim Yellow) to 25% (Super Majestic Giants Royal). Maxim Sherbert, Watercolors Mix, Imperial Silver Blue, Yellow Roc, Imperial Pink Shades, Crystal Bowl Mix, Springtime Azure, Crystal Bowl Yellow and Maxim Blue were among the top 10 winter hardy cultivars (> 83% survival). Cultivars with greatest number of flowers produced per plant on IO May, 1990, were Maxim Blue, Maxim Yellow, Crystal Bowl Yellow, Universal Beaconsfield and Springtime Azure in descending order.

191 (PS 9)
DEVELOPMENT OF A PRODUCTION SYSTEM FOR LUFFA SPONGE GOURDS

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Luffa sponge gourds (Luffa aegyptiaca) are used in the United States primarily as bath sponges. In other parts of the world, however, they are used to make a variety of household cleaning products. The fibers can also be processed for industrial uses such as filters, insulation and packing material. All of these products are biodegradable and could be used to replace similar petrochemical based foam materials. Luffa gourds grow well in North Carolina, but an economically feasible production system needs to be developed. In 1989 and 1990 luffa gourds were grown in western North Carolina with black plastic mulch and drip irrigation. Plants were trained onto a sturdy trellis consisting of 10 x 10 cm posts, 1.2 meters high. The top horizontal support was a 2.54 cm galvanized steel pipe. Bee hives were positioned near the plots at first bloom and remained there all season. In 1989, two planting methods, direct seeding versus transplanting, and three planting dates were examined. The highest total yields, largest gourds and highest sponge fiber density were obtained with four week old transplants field set on the earliest planting date of May 29. In 1990, three in-row spacings and three pruning treatments were examined. The highest total season yields were obtained when plants were spaced 12 inches apart in the row and the first four lateral shoots were removed.

192 (PS 8)
RESPONSE OF NEW POINSETTIAS TO PHOTOPERIOD, PLANTING DATE AND PINCHING METHOD

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The introduction of Celebrate II, Supjibi, Pink Peppermint and Angelika requires evaluation of the flowering response of these new cultivars compared to the industry standards. Studies were conducted during 1989 and 1990 to determine the critical photoperiod (PP), effect of planting date and response to pinching method on plant development. Whereas Amy and Dark Red Hegg flowered when PP was < 13 hr, Celebrate II, Supjibi and Angelika flowered at photoperiods ≤12 hr. The number of nodes subtending the bracts doubled from 6.2 to 12.2 as the photoperiod increased from 11 to 12 hr. Using a soft pinch, the date of anthesis (DOA) was delayed by 2.5 days, the plants were shorter and the number of flowers were reduced. Rooted cuttings were planted on 24 Aug or 14 Sept then pinched either 1 or 2 weeks after planting. Delaying planting by 3 weeks reduced the number of nodes subtending the bracts in half, the number of flowers in the floral display and delayed DOA by 9 days. Delaying the pinch date by one week did not affect the number of nodes but did delay flowering by 3 days.

193 (PS 9)
OPTIMUM PLANT DENSITY AND HARVEST TIME FOR 'LITTLE LEAF' AND 'LITTLE LEAF' HYBRID PICKLING CUCUMBERS ONCE-OVER MECHANICAL HARVEST.

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In 1989, 'little leaf' Ark. H-19 pickling cucumber was grown at plant densities of 9,800-196,500 pl./ha. Optimum yields based on total fruit number occurred at 59,000-98,340 pl./ha.

In 1990, a 'little leaf hybrid pickling cucumber (TAMU 884304 X Ark. H-19) was grown at four plant densities (25,375-94,570 pl./ha) at two locations and two seasons. Optimum yield based on marketable fruit number, grade distribution and fruit quality occurred at 94,570 pl./ha. Optimum harvest time depended on location and season. Delayed harvests were also evaluated. Harvests with fruit >5.lcm in diameter had severely reduced brining quality. Fruit did not enlarge or enlarged slowly to oversize resulting in a mixture of fruit ages within the largest marketable fruit grades. 'Little leaf' lines and their hybrids should be harvested before oversize fruit are produced.

194 (PS 8)
PHOTOPERIOD INFLUENCES LEAF CHLOROPHYLL CONTENT IN CHRYSANTHEMUM GROWN WITH A NEGATIVE DIF TEMPERATURE REGIME

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Dendranthema grandiflora 'Bright Golden Anne' plants were grown in controlled environment growth rooms with 17 day and 23C night temperature, photoperiods of 6, 12, 18 and 24 hr and PPF of 50, 100 and 200 µmol $m^{-2}s^{-1}$ during the photoperiod and either dark or 2 µmol $m^{-2}s^{-1}$ light from incandescent lights during the nyctoperiod. Chlorophyll a and b were extracted and measured spectrophotometrically. Total chlorophyll per cm^2 and per gram leaf dry weight were influenced by photoperiod, displaying asymptotic and quadratic relationships respectively. Total chlorophyll content was also influenced by PPF. Incandescent light during the nyctoperiod did not influence chlorophyll content.

195 (PS 9)
PERFORMANCE OF AMARANTH AT SIX IN-ROW PLANT DENSITIES

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In southeastern United States, leafy vegetables are mostly grown during the cool months of the year, leaving a void in the summer. This study was conducted to determine the potential of amaranth *(Amaranthus spp.),* a summer vegetable, to fill this niche. Seeds of amaranth genotype 'RRC 241' was planted on 12 June 1990 in 305 cm long and 91 cm wide rows at six in-row densities of 4 cm, 8 cm, 16 cm, 24 cm, 32 cm and 40 cm (D_1 - D_6) in a randomized complete block design with four replications. The plants were harvested after 40 days and yield on both per plant and unit area basis was determined. On a per plant basis, D_6 had the highest and D_1 the lowest total fresh weight, 128.6 g/plant and 54.8 g/plant, respectively. However, on an area basis, D_1 produced the highest fresh weight of 15.1 MT/ha. Yield of vegetable amaranth obtained in this study is comparable to the yield reported in literature for amaranth under favorable environmental conditions. The results suggest that amaranth can be successfully grown in Georgia as a summer leafy vegetable and the highest yield can be obtained by maintaining a 4 cm in-row plant density.

196 (PS 8)
PARASITIC NEMATODES FOR CONTROL OF FUNGUS GNAT AND *SHORE FLY* LARVAE IN POTTED FOLIAGE PLANTS

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Suspension solutions of the parasitic nematodes Steinernema carpocapsae and S. feltiae were applied as single or multiple application drenches to the growing medium of foliage plants infested with fungus gnat (Bradysia Coprophila) and shore fly (Scatella stagnalis) larvae to control the larvae. Efficacy of fungus gnat and shore fly control was compared to a diazinon drench, a standard commercial fungus gnat and shore fly treatment. only multiple applications of s. feltiae gave fungus gnat and shore fly control, albeit several weeks after treatment. When compared to quick-acting diazinon on a commercially-acceptable level, diazinon gave better control than S. feltiae. Trials are continuing to determine if an application technique can be developed to improve the efficacy of using parasitic nematodes as biological control agents for soil-borne pests of potted plants.

197 (PS 8)
EFFICACY OF INSECT GROWTH REGULATORS FOR FUNGUS GNAT LARVAE CONTROL IN POTTED FOLIAGE PLANTS

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The insect growth regulators (IGR's) Vectobac (Bacillus thuringiensis var. israeliensis), Avid (abamectin), Andalin (flucycloxuron), and Dimilin (diflubenzuron) were applied as drenches, at different concentrations, to the growing medium of foliage plants heavily-infested with fungus gnat (Bradysia coprophila) larvae to control the larvae. The efficacy and timing of fungus gnat larvae control in the growing medium were compared to a diazinon drench, a commercially-used fungus gnat treatment. All IGR's gave significant and commercially-acceptable fungus gnat control, comparable to diazinon, although the time required to effectively control larvae was 3-4 weeks with the IGR's, rather than the control that occurred in l-2 days with diazinon. None of the IGR's were phytotoxic at the concentrations used. Results suggest potential safer and viable pest control alternatives for soil-borne pest control.

198 (PS 8)

HORMONAL INTERACTIONS REGULATING LEAF ABSCISSION IN *RADERMACHERA SINICA* L.

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Radermachera sinica L. commercially known as 'China Doll' is an ornamental plant with demonstrated sensitivity to ethylene-induced leaf abscission. In this study, we examine the role of ethylene metabolism and abscisic acid in initiating the abscission response. Ethylene concentrations as low as 0.5 ml L^{-1} of air were sufficient to cause complete defoliation within 36 hours. Applying 0.125 mM silver thiosulfate (STS) to either the abscission zone or part of the leaflet blade prevented ethylene-induced abscission. Treatment with abscisic acid (ABA) also resulted in complete defoliation within 3 days. The ABA-induced abscission appears to be unaffected by treatment with aminoethoxyvinylglycine (AVG) or STS. Preliminary evidence suggests that cellulase activity is induced by treatment with ethylene and ABA. However, the induction of leaf abscission by ethylene and ABA may proceed through different mechanisms.

199 (PS 9)

EFFECTS OF MYCORRHIZAE, MEDIA AND CONTAINER TYPE ON THE GROWTH OF GREEN PEPPER AND LETTUCE TRANSPLANTS

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The effects of two mycorrhizal species (Glomus versiforme and Glomus intraradix) and a control on the growth of green pepper, Capsicum annuum, and lettuce, Lactuca sativa, seedlings have been evaluated using four types of growing media (Peatwool, Fafard bulk mix. Cornell mix and a compost based mix) and two types of containers, Cell Packs (125 cc volume) and Pro-Trays (65 cc volume) for green pepper and Cell Packs (125 cc volume) and Plug Flats (33 cc volume) for lettuce. The experiments were split plot randomized Complete block design with 6 blocks (lettuce) and 4 blocks (pepper). Seeds were sown directly into the containers of mycorrhizal inoculated media. All treatments received the same fertilizer regime.

Cell volume had no significant effects on green pepper fresh weight, dry weight, stem diameter, leaf area or leaf number but the lettuce Cell Pack plants had significantly higher fresh and dry weights, more leaves and higher leaf area. The Fafard Bulk and the Compost mix gave significantly higher fresh and dry weights than did the other two media for both green pepper and lettuce. Mycorrhizal species did not influence plant growth with the exception of leaf area in green peppers and shoot dry weight in lettuce.

200 (PS 8)

USING A COMPUTER SPREADSHEET AND COMPILER TO EXTEND CROP PRODUCTION MODELS TO GREENHOUSE PRODUCERS

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A freestanding application for the personal computer has been developed using the macro language of Lotus® 1-2-3 Release 2.2 and the spreadsheet compiler Baler XE™ Release 1.0A to provide greenhouse lily growers with a tool to track and predict the growth and development of their lily crop.

The program prompts Several inputs from the user regarding the crop and the temperature environment. Equations from recently published work on lily growth and development imbedded in the spreadsheet utilize the input variables to predict such events as visible bud date, final height, and days to flower. A graphical track of the crop's height can also be produced, updated, and printed.

This is intended to help the grower follow crop growth and make more informed decisions regarding the potential impact of temperature manipulation. The program also contains a context-sensitive help system that can be accessed by the user for more information concerning the use of the program.

201 (PS 9)

STRIP COVER CROPPING BETWEEN ROWS OF BLACK PLASTIC MULCH IN BELL PEPPER PRODUCTION

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Dutch white clover and turftype annual ryegrass were established between rows of black plastic mulch planted with bell peppers, cultivar, 'Lady Bell'. Cover crops were mowed every three days to maintain height below 15cm. Other treatments included a herbicide to maintain weed free plots and an untreated and unmowed control. Highest yields in both number and weights were achieved with the herbicide treated plots. Both cover crops significantly lowered yield and increased the number of unmarketable, culled fruit. No differences were observed in the average fruit weight. Yield losses were probably due to competition for available nutrients and water, though allelopathic effects cannot be ruled out. Little to no effect was seen on weed control.

202 (PS 10)

CATALASE POLYMORPSM AND INHERITANCE IN PEACH

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Catalase isozymes were examined in a wide range of peach [Prunus persica (L.) Batsch.] cultivars. All historical peach cultivars from the USA and those released from commercial breeding programs were fixed for the slow (Catl-2) allele, with the exception of 'Belle of Georgia', 'Honeygold' nectarine, and various cultivars from the University of Florida breeding program, which possessed a fast migrating (Catl-1) allele. Polymorphism was revealed in the 51 peach Plant Introduction (PI) clones examined, with allelic frequencies of 0.69 and 0.31 for the Catl-2 and Catl-1 alleles, respectively. Most PIs that originated directly from China were homozygous Catl-l/Catl-1, while most PI clones introduced from Europe were homozygous Catl-2/Catl-2. Examination of catalase genotype of cultivars previously proposed as the possible male parent of 'Belle of Georgia' ('Champion', 'Early Crawford', 'Late Crawford', 'Oldmixion Free', and 'Stump-the-World') revealed that none of the aforementioned cultivars could have been the male parent of 'Belle of Georgia'. Segregation data from various peach crosses was consistent with the hypothesis that catalase polymorphism could be explained by the presence of two alleles at a single locus.

203 (PS 9)

ALFALFA AS A LIVING/CUT MULCH FOR BROCCOLI AND PEPPER PRODUCTION

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A living mulch system using alfalfa was developed that minimizes competition with the cash crop and maximizes transfer of fixed N. In the spring, one week prior to planting the cash crop, strips 70 cm wide were rototilled in a field of fall planted alfalfa, leaving 70 cm strips of alfalfa as a living mulch. Three cuttings of alfalfa were made at late bud stage with a sickle mower modified with a V-plow to mechanically deliver the herbage to the base of the cash crop. Both spring and summer planted broccoli crops responded positively to the living mulch system. Yields were greater than the no N control, but less the 180 kg ha^{-1} N treatment. When supplied with additional fertilizer N, the mulched broccoli performed as well as the high N treatment, suggesting minimal competitive effects from the alfalfa. Pepper yields in the alfalfa mulch were depressed in early harvests, but then increased beyond the no N control late in the season, indicating a delayed maturity due to the living mulch. The living mulch provided weed control equivalent to one cultivation. Uptake of N by broccoli and pepper as affected by the living mulch will be presented.

204 (PS 10)

EVALUATION OF *PRUNUS* GERMPLASM FOR RESISTANCE TO LESION NEMATODE *(PRATYLENCHUS VULNUS)*

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Eighty-two *Prunus* accessions have been evaluated for resistance to lesion nematode *(Pratylenchus vulnus)*. Plants from either seed, hardwood or softwood cuttings are greenhouse grown in 650cm^3 pots in sterile 3:1 sand to sandy loam soil. Plants are treated with 150 *P. vulnus* per pot or left as uninoculated controls. All plants are destructively harvested at 90 and 150 days after inoculation. Shoot weight, root weight and number of nematodes per gram of root are sampled. Probable resistance has been identified in some apricots, plums, *Prunus* species and interspecific hybrids, while a few peaches appear to exhibit some tolerance. Forty more accessions will be evaluated in 1991.

205 (PS 9)
REDUCING LETTUCE CORKY ROOT SEVERITY BY USE OF TRANSPLANTS.
Ariena H.C. van Bruggen and Vincent E. Rubatzky,* Dept. Plant Pathology and Dept. Vegetable Crops, University of California, Davis, CA 95616.

Corky root (CR) of crisphead lettuce, a widespread disease in California coastal valleys, is caused by Rhizomonas suberifaciens. CR severity was reduced on roots of transplants, compared to those of directly-sown plants, in greenhouse, field microplots and production field experiments. Reduction of disease severity was associated with increased yield in lettuce crops with relatively high levels of CR but not in those with low CR severity. CR severity increased with time of exposure of plants to R. suberifaciens and decreased with plant age at time of transplanting. In some situations, CR is so severe that production of directly-sown lettuce is seriously limited. Transplants can provide lettuce growers an alternative method to reduce the impact of CR on production by reducing time of plant exposure and plant susceptibility to CR.

206 (PS 10)
PRUNUS ROOTSTOCK GERMPLASM WITH INCREASED LONGEVITY IN THE SOUTHEASTERN U.S.
W. R. Okie*, T. G. Beckman and A. P. Nyczepir, USDA Fruit & Tree Nut Research Lab, P. 0. Box 87, Byron, GA 31008

In a search for potentially long-lived rootstocks, a replicated unbudded planting of 130 diverse open-pollinated seedlings was established in 1983 on a site at Byron subject to Peach Tree Short Life (PTSL). PTSL has killed 60% of the 4885 trees originally planted; about 20% have been killed by oak root rot. After 8 years, Siberian C (1 of 48 alive =2% survival) and Tzim Pee Tao (4% survival) performed the worst. Nemaguard, a standard root-knot resistant rootstock, had 18% survival. Love11 and Halford, the rootstocks currently recommended for the Southeast, ranged in survival from 33-43%. Commercially budded trees of Pekin on Lovell included as controls had 60% survival. Selection BY520-9 survived the best at 65%. Sibling lines BY520-8 and BY520-3 also ranked in the top 20 for survival. These 3 lines also carry resistance to some root-knot species, in contrast to Lovell and Halford. Several plum lines also survived well, and had lower losses to oak root rot. Our results were corroborated by a sister planting at the Clemson University research farm at Elgin, SC.

207 (PS 9)
RESPONSE OF SWEET POTATOES TO TWO SOIL WATER POTENTIAL RANGES UNDER GREENHOUSE CONDITIONS.
Clarence Johnson Jr.*Agricutural Research Station, Fort Valley State College, Fort Valley GA. 31030

During the summer of 1989, one sweet potato slip of Georgia Jet cultivar was planted per 30 cm. pot filled with fine sandy loam soil subjected to to two soil water potential range treatments of -.01 to -.05 and -.06 to -0.1 MPa measured with tensiometers. Each treatment replicated 20 times was arranged in a randomized complete block design. Plants were harvested on 30 Nov. 1989. Weights of shoots and roots were recorded. The treatment -.0l to -.05 showed a significantly higher shoot:root ratio (1.07) than -.06 to -0.1 (0.76). This higher shoot:root ratio was due to higher shoot weight in response to -.0l to -.05 MPa. Root weights did not differ between treatments.

208 (PS 10)
OVI POSITIONAL ANTIXENOSIS-BASED HOST RESISTANCE TO THE PEAR PSYLLA IN PYRUS GERMPLASM OF EAST EUROPEAN ORIGIN
Richard L. Bell, USDA-ARS, Appalachian Fruit Research Station, 45 Wiltshire Road, Kearneysville, WV 25430-9802.

A collection of 60 genotypes-of pear (Pyrus sp.) from East Europe were assayed for ovipositional antixenosis in no-choice cage tests. Five single plant replicates of each genotype, 'Bartlett' (P. communis L.), a susceptible and NY10352 (P. ussuriensis x P. communis BC_1 hybrid)' as a resistant control, were stripped to the 6 youngest, but fully expanded leaves, and enclosed in single-plant cages. Four mating pairs of summer-morph adult pear psylla were introduced into each cage. The number of eggs laid on each plant was counted after 5 days. Egg hatch was determined 7 days later, and leaf area was measured. Twelve genotypes, 8 of which are P. communis, were found to be highly resistant to oviposition. These same genotypes had previously been found to exhibit high levels of nymphal feeding antixenosis and antibiosis. The results will be discussed in light of ovipositional cues and host acceptance-related behavior of the pear psylla.

209 (PS 9)
TIME OF INITIATION OF BRUSHING AFFECTS HEIGHT AND DAMAGE OF VEGETABLE TRANSPLANTS
Joyce G. Latimer and Paul A. Thomas*, Dept. of Horticulture, Georgia Experiment Station, Griffin, GA 30223 and Dept. of Extension Horticulture, University of Georgia, Athens, GA 30206

'Sunny' tomato, 'Marengo' pepper, 'Early Dawn' broccoli, and 'Conquest' cabbage seedlings were brushed (1.5 min, twice daily) beginning at the cotyledonary or each successive true-leaf stage and continuing until harvest (4 weeks). Tomato stem length of brushed plants was 43 to 16% less than that of untreated plants with plants treated at the earlier developmental stages exhibiting the greatest response. Very little damage was observed on treated tomato plants, regardless of stage of treatment. Stem length of brushed pepper was 24 to 14% less than that of untreated plants with younger plants being more responsive but exhibiting more damage. Broccoli and cabbage plants exhibited extensive damage and, neglecting damaged plants, brushing did not control plant height. Results of ongoing cultivar response trials in research and grower greenhouses will also be presented. Research supported by the Georgia Commercial Flower Growers Association.

210 (PS 10)
USE OF MOLECULAR MARKERS TO ANALYZE QUANTITATIVE TRAIT LOCI IN APPLE
Darlene M. Hagens * and Norman F. Weeden, NYSAES, Cornell University, Department of Horticultural Sciences, Geneva, New York 14456

Segregating morphological traits were analyzed in families from the crosses Rome Beauty x White Angel and Rome Beauty x Robusta-5 during a two year study. Characteristics studied include bearing habit, precocity of flowering, persistent calyx, fruit and bark color. Correlations between these traits and over 100 segregating molecular markers (isozyme and DNA) are being investigated to elucidate the major genes involved in these characters.

211 (PS 9)
SEQUENTIAL VEGETABLE CROPPING UNDER VARIOUS TILLAGE SYSTEMS
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Three cropping sequences and three tillage systems were evaluated for increasing returns on small farms under reduced tillage. The sequences were spring 'Packman' broccoli followed by 'Sunny' tomatoes, spring broccoli/tomatoes/fall broccoli, and tomatoes/fall broccoli. Each sequence was grown conventionally tilled with no winter cover, conventionally tilled with a wheat winter cover and no-till transplanted directly into killed wheat. The study was conducted at Knoxville, TN (elev. 251m, Greeneville, TN (elev. 400m) and Crossville, TN (elev. 549m) during 1989 and 1990. Experiments were arranged in a strip plot design with sequences stripped across tillage treatments. No. 1 tomato yield was reduced in no-till at Greeneville (1989). Percentage of No. 1 tomatoes was not affected by tillage but the tomato-broccoli system produced a greater percentage at Greeneville (1990). Percentage of cull fruit was greater in Knoxville (1990) for conventional/no cover. A tomato-broccoli sequence produced more cull fruit at Knoxville (1990) and Greeneville (1989). Broccoli head size and subsequent yield and value was generally greater at most environments in conventionally tilled plots. Sequence generally had little affect on broccoli production.

212 (PS 10)
THE GRAPHICAL DISPLAY OF GENOTYPE X ENVIRONMENT INTERACTIONS
George C. J. Fernandez*, Department of Agricultural Economics, University of Nevada, Reno NV 89557-0107

Significant genotype (G) x environment (E) interaction (GEI) results from the changes in the magnitude of differences between G in different E - quantitative or non-crossover interaction or changes in

the relative ranking of the G - qualitative or crossover interaction. Baker used the conventional joint regression analysis on three simulated data sets namely i) Random effect model ii) Multiplicative model, and iii) Yield-disease model and concluded that the joint regression analysis failed to differentiate between the crossover and non-crossover interaction. Baker detected crossover interaction which involved comparisons of all possible pairs of G in all possible pairs of E. The objectives of this study were to investigate the effectiveness of the three graphical methods i) Box et al. 's transformable nonadditivity diagnostic plot, ii) Emerson and Hoaglin's nonadditivity diagnostic plot, and iii) Gabriel's bi-plot in detecting cross-over interaction in GEI. Baker's three simulated data sets would be analyzed by these three graphical techniques and their effectiveness in detecting cross-over interactions will be discussed.

213 (PS 9)

ADOPTION OF IMPROVED WATER QUALITY MANAGEMENT PRACTICES FOR HORTICULTURAL PRODUCTION USING A WATERSHED DEMONSTRATION PROJECT

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The Lake Manatee Watershed Demonstration Project was established in 1990 through the interagency cooperation of the Cooperative Extension Service, SCS and the ASCS as part of the nationwide USDA Water Quality Program Plan. Its primary long-term goal is to encourage voluntary adoption of agricultural management practices which minimize nutrient loading of Lake Manatee, a source of drinking water for a population of more than 250,000. Agricultural activities in the watershed include citrus, fresh market vegetables and cattle production. The objectives of this project are to be achieved by demonstration, education, and implementation of management practices which minimize adverse water quality impacts on the watershed. The initial stage of the project, using cooperating growers, has been designed to characterize the impact that present management practices have on nutrient loading and to develop best management practice recommendations. This paper will present all aspects of the Project including development, implementation, and evaluation.

214 (PS 10)

CORRELATION OF RESISTANCE TO THREE *ERWINIA* SPECIES IN DIPLOID POTATOES

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In 1989 eight clones from a diploid hybrid population consisting of *Solanum tuberosum* subspp. *phureja* and *stenotomum* (p/s), were inoculated with *Erwinia carotovora* subsp. *atroseptica* (Eca), *Erwinia carotovora* subsp. *carotovora* (Ecc) and *Erwinia* chrysanthemi (Ech). In 1990 eight different p/s clones were inoculated with two isolates of each of the three *Ervinia* spp.. Tubers were inoculated with 10 µl of a 5.5 × 10^6 CFU/ml bacterial suspension and incubated at 20°C for 86 hrs (Eca), 25°C for 86 hrs (Ecc) and 25°C for 72 hrs (Ech). The maximum width of the rotten area was measured as a degree of resistance to *Erwinia soft* rot. Significant positive correlations of resistance lo Eca, Ecc and Ech were observed, indicating that screening for resistance to *Erwinia* soft rot can be accomplished by using either of the three spp..

215 (PS 9)

A RETURN-RISK ANALYSIS OF MICROIRRIGATION AS AN IMPROVED VEGETABLE MANAGEMENT PRACTICE

J.W. Prevatt*, C.D. Stanley, P.R. Gilreath, and G.A. Clark, G.C.R.E.C., Univ. of Florida, Bradenton, Florida 34203.

The primary objective of this study was to examine the effect of utilizing a microirrigation practice on vegetable returns and risk. A Target MOTAD model was formulated to determine the return-risk relationships of producing fresh vegetables based on southwest Florida yield, market price and cost data. The model objective was to maximize the expected return from the production of fresh vegetable enterprises subject to a given minimum level of risk associated with a predetermined target level of return. Eight combinations of multiple-cropped vegetable enterprises were evaluated using the semi-closed seepage and microirrigated scenarios. Three target return levels were evaluated for each production scenario resulting in six risk-efficient frontiers. Examination of the production mix revealed that a larger number of multiple-cropped vegetable enterprises entered the optimal solution at the minimum levels of risk. Conversely, associated with higher levels of risk was only one multiple-cropped vegetable enterprise.

216 (PS 10)

INFLUENCE OF PLANT ARCHITECTURE ON WHITE MOLD, YIELD, AND SEED SIZE IN GREAT NORTHERN BEANS

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Erect and open plant architecture in Phaseolus vulgaris reduces white mold (WM) (Sclerotinia sclerotiorum), but its relationship with yield has received only limited attention. We investigated the influence of plant architecture on yield and seed size in the presence and absence of WM in Great Northern (GN) cultivars and NE breeding lines. A split-plot design was used with protected (3 weekly sprays of benomyl 0.9 Kg ha^{-1} after flowering) and unprotected main plots and GN entries as sub-plots in a WM nursery, Scottsbluff, NE, (1989-90). Canopy density and erectness were rated. Severe WM and reduced yields occurred on susceptible entries with dense prostrate plant habits in the unprotected plots. Low or no WM and average to high yields were observed in entries in the protected plots. Some entries produced high yields in both protected and unprotected plots indicating that lines can be developed to perform well under both conditions. Beryl had similar yields to NE 85-43 (released as Starlight in 1990) under both treatments but had smaller seed size, less upright architecture and more WM than the latter in the unprotected plots.

217 (PS 9)

ASSESSMENT OF PEST MANAGEMENT ALTERNATIVES IN ORGANIC AND CONVENTIONAL VEGETABLE PRODUCTION IN ILLINOIS.

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Fresh vegetable production is very specialized, requiring high input levels including energy and water. Growers need information on *alternative* production practices, including their economics, before implementing any changes. A mail survey was conducted to describe production practices of Illinois fresh market vegetable growers, and to identify their perceived pest management problems. The majority of respondents produced vegetables on *20* acres or less. Few of the organic growers in the survey were certified by organizations such as the Organic *Crop* Improvement Association (OCIA). Pest identification, especially of insects, tended to be poor. Crop rotation, IPM, disease resistant varieties and tillage were important pest management practices for organic growers. These practices were less important for conventional growers.

218 (PS 10)

DEVELOPMENT OF NOVEL AND HIGH QUALITY LINES OF CUCURBITA MAXIMA AND CUCURBITA MOSCHATA SQUASH

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Cucurbita maxima small hubbard type IS-88-12 was derived by selfing (S_6) plants with orange (O) and green (G) mottled (M) fruit derived from an outcross population of a Sioux Indian landrace (IS). Lines with solid O and solid G fruit were stable. M line IS-88-12 was the most stable of the M lines. It is hypothesized that 2 major dominant genes determined the M trait with dominant O suppressing the development of green color while dominant M blocks the expression of O in some areas causing the M fruit pattern. The fruit weight (2.8 2.9 Kg) and maturity of IS-88-12 is comparable to Improved Green Hubbard but yield of the former was greater. This dual purpose squash has execellent baking quality and decorative appearance. A near-oblate early maturing small C. moschata line BN PM l-88-8 with butternut (BN) fruit qualities and skin color, and free of the crockneck rogue was derived from selfing (S_6) of a near-oblate OP (BN) S_4 line derived from a cross of 2 true breeding crooknecks BN CR-67-l-7 (NE) x yellow Cushaw. Segregation for crookneck, straightneck and neckless fruit were observed in the F_2 indicating that different genes controlled the crookneck fruit. BN PM-88-8 is ideal formicrowave cooking. Release Of both lines is planned.

219 (PS 9)

PLANT AGE AT CATFACE INDUCTION DETERMINES SEVERITY OF THE DISORDER

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In a preliminary experiment, tomatoes were induced to catface by a temperature treatment of 2 weeks at 16/10C (day/night), starting at the 6-leaf stage. Fruits of the second and third, but not the first

cluster showed catface symptoms. If catfacing induction could be further delayed by growing transplants in a non-inducing environment until most flower primordia have been initiated, plants might escape the disorder. In 2 field trials, plants were greenhouse-grown for 33, 47, or 61 days, and induced to catface by a GA_3 foliar spray (15 $ul \cdot 1^{-1}$) at transplanting. Catfacing was significantly increased by GA, sprays (23 vs 11% of all fruits in 1989, 22 vs 8% in 1990). In both years, there was a highly significant interaction between plant age and catfacing incidence, with high levels for young and medium-aged, but lower levels for old GA-treated transplants. Marketable yields were highest for youngest and medium-aged plants in 1989 and 1990, respectively. Old plants were checked in growth after transplanting and produced lowest yields in both years. Avoiding catfacing by use of old transplants thus has doubtful practical value.

220 (PS 10)
SQUASH LEAF CURL RESISTANCE IN CROSSES OF CULTIVATED AND WILD *CUCURBITA*
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In 1985, parents, F_1, F_2, and backcross (BC) generations from crosses of *C. ecuadorensis* Cutler and Whitaker (PI 540895) and *C. lundelliana* Bailey (PI 540896 and PI 540898) with *C. maxima* Duch. ex Lam. 'Pink Banana' were evaluated for reaction to SLC in naturally infected field tests at Brawley, Calif. and Ciudad Obregón, Sonora, México. Tests were planted on 21 Aug. (Brawley) and 23 Sept. (Obregón), and evaluated 43 and 57 days, respectively, after planting. SLC symptom expression was evaluated on a 1 (symptomless) to 9 (dead) scale. Significant differences in mean symptom severity were found among the parents and their F_1, F_2, and BC families. Significance level *(P)* of the differences varied with the character evaluated (older vs. terminal leaves) and between the two tests. Part of the variation between the tests could be confounded with genetic differences with the two *C. lundelliana* accessions used in the crosses (PI 540898 at Brawley vs. PI 540896 at Obregón). These results suggest that C. *lundelliana* Bailey is a better source of SLC resistance for *C. maxima* than *C. ecuadorensis.*

221 (PS 9)
AUTOMATED INSPECTION OF FRUITS AND VEGETABLES
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Research is described on the development of an automated inspection system which uses digital images and artificial intelligence techniques. Procedures have been developed for evaluating size, shape, and color of apples, potatoes, and mushrooms. Current emphasis is being placed on developing algorithms for detection of surface defects. A major effort will also be expended toward the development of an overall "quality" score for automated inspection of fruit and vegetables. The automated results are compared with those obtained using conventional manual inspection methods. Apples, potatoes, and mushrooms are the primary crops being inspected although the algorithms and techniques are applicable to many different fruits and vegetables. Color and monochromatic image processing components in "MS-DOS" and "Macintosh" computers are being used in this study.

222 (PS 10)
REACTIONS OF SPINACH ACCESSIONS TO A NEW RACE (RACE 4) OF DOWNY MILDEW
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Over 700 spinach plant accessions from six countries were screened for resistance to race 4 of downy mildew (Peronospora farinosa (Fr.) Fr. f. sp. spinaciae Byford). The predominate species examined was Spinacia oleracea, however, accessions of S. turkestanica and S. tetrandra were also tested. Twenty seedlings were inoculated in each of two replications and St. Helens was included as the susceptible control in each test. Plants were inoculated when the cotyledons were expanded and the first set of true leaves were 2 cm in length. After inoculation, plants were incubated in a dew chamber at 15 C for 48 h, followed by incubation in a growth chamber for 4 to 6 days at 15-22 C with a 12-h light/dark cycle. Plants were then returned to the dew chamber for 8-12 h at 15 C to induce sporulation. Disease incidence (DI) was recorded as the percentage of cotyledons or true leaves exhibiting evidence of sporulation. Over 98% percent of the accessions tested were susceptible to Race 4 (DI >85%). Thirteen accessions exhibited some resistance (DI £85%) with four of these accessions exhibiting a higher level of resistance (DI £50%).

223 (PS 9)
ALTERNATIVE FRESH MARKET TOMATO PRODUCTION SYSTEMS: INFLUENCE ON CROP PERFORMANCE
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This study evaluated the influence of three fresh market tomato production systems on crop performance. Systems differed in input intensity (cost of materials, labor and management) and pest control strategy. The high infrastructure/synthetic chemical (HC) system used more intensive inputs (eg. staking, plastic mulch, trickle irrigation, pest scouting) and synthetic and biological materials to control pests. The high infrastructure/biological materials (HB) system also used intensive inputs including the incorporation of compost to provide N fertility and alter soil properties while using only biological materials to control pests. The low infrastructure/synthetic chemical (LC) system used less intensive inputs and synthetic chemicals to control pests. Evidence presented here indicates that the combination of straw mulch and organic soil amendments resulted in more rapid transplant growth, earlier yield, a 2-fold decrease in crop water use, a 9-fold decrease in physiological disorders, a 67% increase in yield, and other responses. The effects of staking, pesticide usage and timing of fertility will also be discussed.

224 (PS 10)
BULB-TO-BULB VARIATION FOR SEVERAL QUALITY CHARACTERISTICS IN ONIONS
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Historically, quality evaluation on onions have been performed with 5 bulb samples regardless of the potential genetic variation expressed by selected cultivars. To determine whether potential cultivar specific variation is important in determining sample size for enzymatic pyruvic acid development, nonstructural water-soluble carbohydrate concentration, and total sulfur percentage, 9 cultivars and 1 mass population were evaluated for bulb-to-bulb variation. Entries ranged from F_1 hybrids to open pollinated cultivars. Stepwise regression analysis was used to determine optimum sample sizes for individual cultivars. The effects on cultivar improvement is discussed.

225 (PS 9)
EARLY FRUITING OF TOMATO TRANSPLANTS GROWN IN STACKED PVC PIPE SECTIONS
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Tomato cultivars 'Burpeeana Early', 'Better Boy' and 'Sunny' were started in 10 × 10 cm (diam × ht) sections of PVC pipe in the greenhouse. As plants grew, bottom leaves were removed and commercial potting media was added. Two additional pipe sections were taped to the top of the original section making a total container size of 10 × 30 cm. These transplants were compared in field plots with conventional transplants grown in peat pots (5 × 5 × 5 cm). The PVC sections were removed before transplanting; plants grown in PVC sections had adventitious roots on 20 to 25 cm of the lower stem. PVC-grown transplants had a 6-fold increase in early (6 June through 21 June) fruit number and yield compared to transplants grown in peat pots. Late yield (23 July through 6 Aug) was higher from transplants grown in peat pots. Midseason (25 June through 19 July) and total yield and mean fruit size were not affected by transplant type. Total yields of cultivars were not significantly different but midseason and late yields were highest for 'Burpeeana Early' and 'Better Boy', respectively.

226 (PS 10)
INTROGRESSION OF ALLIUM CEPA WITH ALLIUM FISTULOSUM THROUGH HYBRIDIZATION
U.S. Gupta*, S. Pan and L.C. Ewart, Department of Horticulture, Michigan State University, East Lansing, MI 48824-1325

Allium fistulosum (bunching onion) has been recognized as an excellent source of disease and insect resistance. The major problem with A. fistulosum gene introgression into the common onion (Allium cepa) has been sterility of the F_1 and backcross progenies. No evidence of generations higher than backcross 3 is available in the literature. This research was undertaken to see if further advances could be made in the transfer of A. fistulosum genetic materials into A. cepa. Currently the interspecific material is in the backcross 5 generation, and it freely crosses with the A. cepa germplasm. Plant morphology resembles A. cepa, with little if any external observable characteristics to A. fistulosum. The cytological and moleculo-biological (DNA probes using PCR) studies along with disease (Fusarium and pink root) screening results will be presented.

227 (PS 9)
TOMATO TILLAGE METHODS AND WATER QUALITY
C. A. Mullins*, R. A. Straw, G. V. Wilson, and D. L. Coffey, Department of Plant and Soil Science, University of Tennessee, Plateau Experiment Station, Rt. 9, Box 363, Crossville, TN 38555

Staked tomatoes grew equally well in field plots measuring 4 by 11 m in 1990 using conventional and no-tillage culture. Nitrogen fertilizer levels of 0, 112 and 336 kg/ha had little effect on productivity and fruit quality. An overhead irrigation system supplied simulated rainfall for 4 runoff events during the growing season and runoff water from each plot was channeled through a flume for measuring the amount of runoff and for collecting samples for analysis. Water runoff and sedimentation were greater from tilled than from no-tilled plots. In some cases, plots that had not been tilled had runoff sooner that conventionally tilled plots, but runoff leveled off quickly. This is likely due to hydrophobicity of the organic layer until saturated which is dependent on initial soil moisture conditions.

228 (PS 9)
TOMATO SPACING AND CULTIVAR STUDIES
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Plants of 'Mountain Pride', 'Corona', and 'Empire'; 3 large fruited tomato cultivars with vigorous plant growth characteristics were field grown and staked in rows spaced 180 cm apart. In-row spacings of 46, 61, and 76 cm were evaluated for each cultivar. Row spacing had little effect on crop productivity or fruit quality. Empire fruit were largest and had the most catfacing and least blossom end rot while Mountain Pride fruit had the least cracking of the 3 cultivars in the trial. Interactions among spacings and cultivars were minimal.

229 (PS 11)
GROWTH OF 'V-14 GLORY' POINSETTIA WITH 50 TO 300 MG/L NITROGEN FERTIGATION AND 0 to 0.4 LEACHING FRACTION
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Single-pinched Euphorbia pulcherrima 'V-14 Glory' in 15-cm plastic pots received constant fertigation with 50, 100, 200, or 300 mg /L nitrogen from 20N-4.4P-16.6K with a leaching fraction (LF) of 0,0.2, or 0.4. Plants received 25 irrigations during the 13 week greenhouse study. With a LF of 0.2 at study's end, leachate electrical conductivity (EC) ranged from 0.3 dS/m at 50mg/L N to 6 dS/m with 300mg/L N. With a LF of 0.4 at study's end, leachate EC was 4 dS/m with 300 mg/L N. Plants were 11% taller with 50 and 100 mg/L N than at higher N rates. Plants with 50 mg/L had the smallest bract area at all LFs, compared to higher N rates, and the lowest leaf area at 0 LF. There were similar trends for fresh and dry masses of leaves and bracts. Electrical conductivity of a saturated medium extract (EC,) from the top third of the pot at harvest increased from 0.8 dS/m at 50 mg/L N to 9 dS/m at 300 mg/L N. EC, was greater in the upper third of the container and least in the middle third.

230 (PS 10)
EVALUATION OF A FRESH-MARKET TOMATO BREEDING LINE WITH BRACHYTIC AND PROSTRATE GROWTH HABITS
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Staked tomatoes produce high yields of large, blemish free fruit because fruit and foliage are held up off the ground. Production costs, however, are among the highest of any vegetable crop. The combination of brachytic (br gene) and prostrate growth characters is being investigated as a means of developing a compact plant habit which is resistant to lodging and supports the fruit above the soil without staking. In 1990, NC 13G-1, an advanced tomato line with combined brachytic and prostrate growth habits, was compared to a normal growth habit determinate cultivar, Mountain Spring. Plants were grown without pruning or staking on black plastic-covered beds with drip irrigation. NC 13G-1 was grown in single and double rows with varied in-row spacings. 'Mountain Spring' was grown in single rows with an in-row spacing of 61 cm. NC 13G-1 in double rows had higher early and total season yields of non-graded and marketable grade fruit than 'Mountain Spring' or NC 13G-1 in single rows. The incidence of early season ground scar and fruit rot was much higher for 'Mountain Spring' than for NC 13G-1. This new plant type with its ability to hold the fruit above the soil and its adaptability to high plant populations has potential for use in a low cost, stakeless fresh market tomato production system.

231 (PS 11)
CIRCADIAN TEMPERATURE EFFECTS ON NUTRIENT CONTENT OF. POINSETTIA LEAVES
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Foliar tissue samples were collected at anthesis from poinsettia plants grown with 16 day/night (DT/NT) temperature combinations and a 10hr photoperiod. Tissue content of Al, B, Zn, Cu, and Mn were not correlated with growing temperature. N and P (%DM) decreased as average temperature increased (R^2= .603 and .564 respectively). K (%DM) increased as average temperature increased (R^2= .748). Iron content of the leaves decreased as night temperature increased (R^2= .594) and Ca and Mg tissue content decreased as DIF (DT-NT) increased (R^2= .441, and .466 respectively).

232 (PS 10)
PRODUCTION OF SOMATIC HYBRIDS BETWEEN *LYCOPERSICON HIRSUTUM* AND *L. ESCULENTUM.*
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Unilateral incompatibility has limited the direction of crossing between *L. esculentum* and *L. hirsutum* ; the latter can only serve as the pollen parent. In an attempt to introduce the *L. hirsutum* cytoplasm into *L. esculentum* , thirty-three somatic hybrid plants have been regenerated following four separate fusions between leaf protoplasts of *L. hirsutum* PI 126445 and etiolated hypocotyl protoplasts of *L. esculentum* ('OH7870', 'OH832', and 'OH8245'). A 33% PEG solution supplemented with 10% DMSO was used as the fusogen. Selection of fusion products was based on treatment of *L. hirsutum* protoplasts with 1 mM iodoacetic acid and non-regenerability of the *L. esculentum* genotypes. Hybridity was initially confirmed by intermediate morphology, including leaf shape, type of trichomes, flower shape, stigma placement, and fruit size and color. Isozyme analysis for GOT, PGM, and 6-PDH verified hybridity. Six of the hybrids produced viable seed upon selfing. At least some of the hybrids contained chloroplast DNA from *L. hirsutum* , indicating that the wild species cytoplasm may be present in these plants.

233 (PS 11)
POINSETTIA STOCK PLANT CULTURE WITH NUTRIENT WATER RECIRCULATION
Chi Won Lee*, Enrico Noli, Kenneth L. Goldsberry, and Douglas A. Hopper.
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The feasibility of growing poinsettia stock plants with ebb and flow, drip, and trough water recirculation systems was investigated. Poinsettia cvs. Annette Hegg Dark Red, Celebrate, Lilo and V-14 Glory were grown in 4 different commercial peat-lite and rockwool mixes for 4 months. Plant heights, number of harvested cuttings per plant and total biomass production were affected only by cultivars not by watering system or growing media. The total volumes of nutrient water consumed per 15 cm pot for 4 months were 10.3, 10.7 and 11.4 liters, respectively, for ebb and flow, drip and trough systems. The pattern of mineral salt accumulation in the growing media was characterized.

234 (PS 10)
GENETIC AND ANATOMICAL ANALYSIS OF A WILTY MUTANT OF TOMATO
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A unique mutation discovered in tomato (Lycopersicon esculentum, cv. Large Plum) causes extensive wilting under normal environmental conditions. The mutation is inherited as **a** single dominant gene. Mutant plants have less developed root systems (as determined by dry weight comparisons) than normal plants. However, reciprocal grafts between wilty and normal plants indicated that wilting is related to factors in

the scion, not the stock. An anatomical characterization of the wilty mutant was undertaken to establish possible structural bases for loss of turgor. Standard optical microscopy and scanning electron microscopy revealed clear differences in leaf surface and cross-sectional anatomy between wilty and normal plants. F_2 populations have been used to establish which of the anatomical features correlate with the wilty phenotype.

235 (PS 11)
EFFECTS OF GROWTH CHAMBER MICROCLIMATES ON TRANSPIRATION OF POINSETTIA
Mark A. Rose*, John W. White, and Brian R. Maxson, Department of Horticulture, The Pennsylvania State University, University Park, PA 16802.

Water management in greenhouse floricultural crops may be improved by manipulating the microclimate to control transpiration rates. The influence of important microclimatic variables on whole-plant transpiration was evaluated in a growth chamber before full-scale greenhouse studies will be conducted.

Whole-plant water relations in *Euphorbia Pulcherrima* 'V-14 Glory' were monitored during combinations of light, air temperature, air moisture, and air velocity to develop a preliminary model for use in a greenhouse environmental control computer. Dynamax stem-flow gauges were used to measure sap flow.

Simple linear and non-linear regressions were computed to predict the effects of individual microclimatic variables on transpiration rates. Light had the strongest correlation (r^2=0.948); its predictive equation was $y = 51.9\ (1.02 - 0.867\ \exp(-0.00854\ x))$ where y was whole-plant transpiration rate in $g \cdot hr^{-1}$ and x was PPF in $mmoles \cdot hr^{-1}$. Multiple regression analysis was used to compute predictive equations, evaluate the relative influence of each microclimatic variable, and plot surfaces for transpiration in various microclimatic settings. The software model developed in this research will be used to evaluate the separate and integrated effects of microclimatic variables on transpiration of poinsettia crops in the greenhouse.

236 (PS 10)
PLASTID TRANSMISSION IN SOMATIC HYBRIDS OF *LYCOPERSICON ESCULENTUM* AND *SOLANUM LYCOPERSICOIDES*
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Fusion of leaf protoplasts from tomato with suspension-derived protoplasts of *Solanum lycopersicoides* and the biased transmission of plastids in a large population of somatic hybrid plants has been reported. In order to understand factors determining the fate of plastid transmission, we carried out cell fusions of *Lycopersicon esculentum cv.* Sub-Arctic Maxi and *Solunum lycopersicoides:* 1) in the reciprocal direction to that conducted before, mesophyll + suspension, 2) mesophyll + mesophyll, and 3) suspension + suspension. Plastid number in either leaf or suspension cells of tomato and *S. lycopersicoides* has been determined. Mesophyll and suspension cells which are used for protoplast isolation contain relatively similar numbers of plastids. However, large variances and C.V's of plastid number were detected in both protoplasts of leaf tissues and suspension cells. Hybrid calluses at 100-300 mg stage have been verified as nuclear hybrids using PGM and GOT isozyme markers. Restriction fragment length polymorphisms (RFLP's) are being employed to determine the transmission of plastid genomes in somatic hybrid individuals. The relationship between plastid transmission in somatic hybrids and an initial input of organelles or nucleo-plastid incompatibility will be discussed.

237 (PS 11)
GROWTH OF CHRYSANTHEMUM AT LOW, SUSTAINED NUTRIENT LEVELS IN A COMMERCIAL-STYLE MEDIUM.
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These experiments demonstrated that in a medium of 1 sphagnum peat: 1 perlite, plant growth which met commercial expectations resulted when low, relatively steady concentrations of nutrients were applied. Nutrient solution was mechanically applied at rates of 0.5, 1, 4, and 20 mM N (NO_3 + NH_4) to *Chrysanthemum* × *morifolium* Ramat. 'Sunny Mandalay' plants 7 times per day in Experiment 1 and 14 times per day in Experiment 2. These plants were compared to 20 mM N hand-watered controls. In Experiment 1, growth of the 4 mM N plants nearly equalled that of the 20 mM plants; in Experiment 2, growth of the 4 mM plants was equal to the 20 mM plants, and the 0.5 and 1 mM N plants nearly equalled the 20 mM plants. In both experiments, tissue N and K levels decreased over the 4 mechanically fertilized treatments as applied nutrient concentration decreased. In Experiment 2, the magnitude of this decrease for N and K tissue concentrations was reduced to 56% and 38%, respectively, of that found in Experiment 1. The percent water of mechanically fertilized plants in Experiment 1 decreased as applied nutrient concentration decreased, but did not decrease significantly in Experiment 2. These three different trends indicated that steady-state nutrition was more closely achieved in Experiment 2, and thus the capacity for normal plant growth at low soil solution nutrient concentrations in a solid medium was established.

238 (PS 10)
MINIATURE CRISPHEAD LETTUCE FROM A CROSS BETWEEN A GENETIC DWARF AND A NORMAL CRISPHEAD
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A new miniature crisphead lettuce was developed for commercial and home garden use from crosses between dwarf mutants *(dwf1, dwf2,* and *dwf3)* and the crisphead cvs. Salinas and Empire. The dwarfs were induced by ethylmethane sulfonate mutagenesis of an early flowering (Ef) line (81-1251-D-20M) which has rapid cycling genes *(Ef1 Ef2)* used in lettuce breeding to reduce generation time. Dwarf mutants had small, dark green leaves and reduced stems compared to normal Ef plants and responded to applied GA3 by exhibiting a normal phenotype. Purification and GC-MS analysis of certain dwarf plant extracts showed early 13-hydroxy gibberellins were substantially diminished (10 to 50% of normal). Crosses with commercial crisphead cultivars were then made and F_2 plants selected for non-Ef (late flowering) and miniature conformation. Several phenotypes were isolated displaying differences in leaf shape and margin as well as anthocyanin expression.

239 (PS 11)
PHYSIOLOGICAL RESPONSES OF *Chrysanthemum morifolium* Ramat. TO WATER DEFICIT
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This study intended to determine the water requirement of *Chrysanthemum morifolium* Ramat. for various growth functions relating to ultimate yield. 'Bright Golden Anne' plants were vegetatively- grown under conventional glasshouse container culture for 7 weeks prior to initiating the experiments. Water was then withheld from the plants and leaf net photosynthesis, expansion growth, stomata1 conductance, and water status were measured on the first fully-expanded leaves 4 times daily over a period of 4 days. Although leaf net photosynthesis significantly increased during early stages of deprivation, it subsequently declined dramatically as water deficit developed *(specifically, after noon on the second day).* Net photosynthesis is assumed to have responded to the decline in stomatal conductance paralleling increasing tissue water stress. Intercellular CO_2, however, failed to significantly respond to water deprivation. Photosynthesis, expansion, and stomatal conductivity also mirrored the changes in leaf water status on a diurnal basis. Overall leaf area declined significantly with water deprivation *(correlation, R_2 = 0.85)* and resulting decrease in osmotic potential. Although *Chrysanthemum morifolium* Ramat. proved relatively sensitive lo water deprivation, plants recovered from as much as 7 days water deprivation. However, the longer the stress, the more negative the effect on whole plant growth and survival.

240 (PS 10)
PROGRESS IN MAPPING THE ASPARAGUS GENOME BY MEANS OF RFLP AND RAPD MARKERS
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Recently we started a research program to construct a molecular genetic map of *Asparagus officinalis* by analyzing RFLPs and PCR polymorphisms among the progeny of sexual crosses. DNAs used in RFLP and PCR analysis from 15 parent lines, 7 sexual crosses and their progenies were isolated. RFLP probes were developed from cloned cDNA from "supermale" (YY) and female (XX) mature flower mRNA. Cloned DNA fragments from 10 characterized genes and 42 cloned maize DNA fragments designated either UMC or BNL are also being used. These probes are also being used to determine the genetic variation among *Asparagus* species. The RAPD assay (PCR) based on amplification of DNA segments with a random primer was also used. Nine out of 24 random primers screened in PCR were found to show genotype specific polymorphism. These polymorphic DNA segments were amplified and resolved by electrophoresis, excised from the gel, and reamplified using the same primer. The reamplified DNAs were labeled with ^{32}P which are being used as probes in RFLPs. Two random primers showed specific polymorphisms between A. *officinalis* and A. *densiflorus* 'Sprengeri' that may provide selection markers for somatic fusion products between A. *officinalis* and *A. densiflorus.*

241 (PS 11)
IN VITRO PHOSPHATE NUTRITION OF *ALSTROEMERIA*
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Explants of *Alstroemeria* were established on modified Murishige & Skoog medium with P added as KH_2PO_4 at 0, 0.01, 0.05, 0.25, 1.25 or 2.5 mM. Cultures were transferred to fresh media every 4 weeks. Five explants were harvested from each P treatment after 3, 5, 7, 9 and 11 weeks in culture. Explants were separated into rhizome and shoot(s), weighed, dried and wet-ashed in HNO_3. Phosphorus content of the ash was determined colorimetrically.

Explants supplied 1.25 or 2.5 mM P produced significantly more shoots and growing points, and greater fresh weight of rhizomes and shoots than those supplied lower P concentrations. Relative accumulation rates for shoot P in the highest P treatments were about 0.3 $week^{-1}$, compared to 0.05 to 0.15 $week^{-1}$ in the lower P treatments. Tissue P levels greater than 7 µmol g fwt^{-1} evidently are required for maximum in vitro growth of *Alstroemeria*. Allometric analysis of fresh weight and total P distribution between rhizomes and shoots indicated that the two highest P treatments partitioned a greater proportion of fresh weight and total P to shoots than lower P treatments.

242 (PS 10)

ISOZYME VARIATION AND GENETICS IN *ASPARAGUS OFFICINALIS*

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We have used isozyme techniques (SGE) to assess variation and begin construction of a genetic map of the *Asparagus officinalis* genome. Isozyme extraction buffers, electrophoretic buffer systems, and isozyme stability during storage were evaluated. Isozyme expression under different environmental conditions was also examined. Thirty-four enzymes were evaluated for their usefulness as genetic markers in *A. officinalis.* Of these 34, 13 had sufficient activity and resolution on the gels for isozyme analysis. Of the 13 enzyme systems resolved, polymorphisms were observed in aconitase, endopeptidase, malate dehydrogenase, phosphoglucomutase, and shikimate dehydrogenase. Segregation of putative alleles is presented for ACON, END, MDH, PGM and SKDH isozymes. Co-segregation data showed linkage between a SKDH locus and a PGM locus. The isozyme analysis also included *Asparagus densiflorus* 'Sprengeri' and revealed that aspartate aminotransaminase, endopeptidase, and triosephosphate isomerase would be potentially useful for verification of cell fusion products between the two species.

243 (PS 11)

RELATIONSHIP OF BRONZE SPECKLE OF MARIGOLD TO IRON DTPA AND MANGANESE EDTA IN PEAT-BASED MEDIA

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Marigolds *(Tagetes erecta)* in commercial production may develop a specific physiological disorder of the leaves characterized by a mottled pattern of interveinal chlorosis and/or bronze speckling and downward curling of leaves, called Bronze Speckle (authors' nomenclature). Previous work by the authors indicated that the disorder was inducible with high concentrations (5 - 20 ppm) of Fe DTPA applied to peat-based media. Objectives of this experiment were to determine the effects of increasing concentrations of Fe DTPA with Mn EDTA concentrations held constant on Occurrence of the disorder. Two African marigold cultivars, 'Voyager' and 'First Lady', were grown in Metromix 360 (Grace/Sierra, Inc.) under controlled environmental conditions. Iron DTPA was supplied at concentrations of 1, 5, 15 or 20 ppm and Mn EDTA at 0.5 ppm through a regular liquid fertilizer program using a modified Hoagland's solution. By harvest, symptoms had developed in both cultivars receiving 5, 15, or 20 ppm Fe DTPA and increased in severity with increasing treatment level. No symptoms developed in plants treated with 1 ppm Fe DTPA. Iron and Mn concentrations in media leachates increased over time in all treatment groups and for both cultivars. Media leachate pH decreased from 5.8 to 4.7 over time in all treatment groups and for both cultivars. Fe and Mn concentrations in symptom and non-symptom tissue will be discussed.

244 (PS 10)

CROSS PROTECTION EFFECTS OF POTATO VIRUS Y (PVY) CAPSID PROTEIN IN TRANSGENIC TOBACCO (NICOTIANA TABACCUM).

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Potato virus Y (PVY), which is an important viral pathogen of tobacco, occurs in nature as a complex mixture of strains. We have examined the sequence variation among cp sequences of four virulent pathogenic strains, 'Chilean', 'Hungarian', 'MN', and 'NN', and one strain, 'Potato US', which produces only mild symptoms in tobacco. The purpose of this work is to determine the variation among CP sequences of these five strains in en attempt to find a correlation between CP structure and disease response in tobacco. Further, we wish to produce transgenic tobacco lines with each of the variant CP types. These transgenic plants will be used to test the extent to which a single capsid sequence can provide CP-mediated protection against the donor virus, and against other viruses of this group. Ultimately, we will produce transgenic tobacco lines with broad resistance to all of the test strains.

245 (PS 11)

MICRONUTRIENT TOXICITY IN FRENCH MARIGOLD TAGETES PATULA L.

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French marigold (Tagetes patula L.) cv. Orange Boy grown in peatlite mix was fertilized for 5 weeks with nutrient solutions containing 0.25, 0.5, 1, 2, 3, 4, 5, and 6 mM of boron (B), copper (Cu), iron (Fe), manganese (Mn), molybdenum, (Mo) and zinc (Zn). The control solution contained 20, 0.5, 10, 10, 0.5, and 4 uM, respectively, of B, Cu, Fe, Mn, Mo, and Zn. The threshold micronutrient concentrations that induced visible foliar toxicity symptoms were 0.5 mM B, 4 mM Cu, 4 mM Fe, 2 mM Mn, 1 mM Mo and 5 mM Zn. Dry matter yield was reduced when micronutrient concentrations exceeded 0.5, 3, 3, 6, 0.5, and 5 mM, respectively, of B, Cu, Fe, Mn, Mo, and Zn in the fertilizer solution. Leaf chlorophyll contents decreased when the nutrient solution concentrations of Cu, Fe, and Mn were greater than 0.5 mM, 5 mM, and 2 mM, respectively. Visual toxicity symptoms of the 6 micronutrients were characterized.

246 (PS 10)

CRYOPRESERVATION USING VITRIFICATION: AN EXAMINATION WITH DIVERSITY

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The application of large concentrations of certain cryoprotectants followed by fairly rapid cooling (i.e. vitrification) is an alternative method for cryopreservation of plant germplasm, particularly for clonal lines. Details of vitrification procedures-vary considerably among reports. Here two vitrification techniques were applied to shoot tips excised from several species whose germplasm is often maintained as clones (Genera: Dianthus, Solanum, Mentha, Arachis, Carica, Impatiens, Ipomoea, Phytolacca, Malus, Prunus, Vitis). Vitrification methods gave survival in some lines which showed no survival with two-step cooling methods; however some species were not preserved by either method. Percentages of survival after liquid nitrogen exposure varied among clones and species but were generally in the range that could be useful for germplasm preservation.

247 (PS 11)

EVALUATION, COMPARISON, AND TESTING OF MEDIA TYPES AND THEIR EFFECTS ON PRODUCTION OF HYBRID TEA ROSE 'ROYALTY'

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Literature on inert media and their effect on cut flower production disagrees on the benefits (or lack thereof) of these media. An experiment lo evaluate inert media was conducted to examine this question. Five media (rockwool, Idealite, Oasis, Peatwool, and CSU soil mix) for use in continuous cut rose production were initially analyzed for common characteristics: EC, pH, bulk density, and air, water and total pore space. Bulk densities ranged from 22 kg/m^3 (Oasis) to 830 kg/m^3 (Idealite). Initial 2 water:1 media samples showed that pH ranged from 3.7(Oasis) to 7.7 (Idealite); EC levels were 0.00 (Idealite, rockwool), 0.22 (CSU soil mix), 0.50 (Oasis) and 0.66 (Peatwool) mmhos/cm. Prior to planting, leachate and 2:1 samples from surface drip irrigation were collected; EC and pH were tested over seven days. Comparisons of the two samples were made to ascertain the relationship between sampling techniques for the "inert" media as compared to traditional techniques used for analysis of soil or soilless mixes. Rockwool and Idealite were found to raise leachate and media sample pH compared to the irrigation water, whereas, Oasis lowered both leachate and media sample pH. Leaf tissue samples were also collected at termination to establish relationships between tissue samples and media sampling techniques.

Continuing studies evaluated effects of the media on production using standard harvesting techniques. Rose production and quality were recorded for each treatment. Production was evaluated on a stems per time and fresh weight per time basis. Quality was evaluated on industry standards for stem length, stem diameter and flower quality.

248 (PS 10)

SUB-CLONAL VARIATION IN POTATO: I. ISOZYME PHENOTYPE POLYMORPHISM VISUALIZATION USING POLYACRYLAMIDE GEL ELECTROPHORESIS

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Polyacrylamide gel electrophoresis of leaf and tuber samples was used to study and characterize sub-clonal variation in potato *(Solanum tuberosum* L.) cultivars, Norgold Russet and Russet Norkotah. Twelve enzyme systems, including some representing the committed steps of major biochemical pathways, were analyzed. Both intercultivar and intracultivar variation in isozyme phenotype were observed, providing reliable phenotype polymorphism to

distinguish between Norgold Russet and Norgold Russet "M". Differences in banding patterns were found in some of the enzyme systems in both leaf and tuber samples. The systems that showed the most different and reproducible phenotypes were esterase, phosphoglucose isomerase, 6-phosphogluconate dehydrogenase, glucose 6-phosphate dehydrogenase, peroxidase, and malate dehydrogenase. The other enzyme systems showed no polymorphism or irregular staining in either leaf or tuber samples. The use of 8% polyacrilamide gels provided the necessary resolution to visualize these phenotypes, which has not been possible with starch gels.

249 (PS 11)
MUNICIPAL YARD WASTE COMPOST AS A POTTING MIX COMPONENT FOR DIEFFENBACHIA PRODUCTION
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Dieffenbachia 'Triumph' was grown for 12 weeks in the following mixes: a) peat:pine bark:sand (2:2:1); b) peat:coarse municipal yard waste compost (MYWC):sand (2:2:1); c) coarse MYWC:pine bark:sand (2:2:1); d) coarse MYWC:sand (4:l); e) coarse MYWC (100%); f) coarse MYWC:Metro 300 (1:1); g) Metro 300 (100%); h) fine MYWC:Metro 300 (1:1); i) fine MYWC (100%); j) fine MYWC:sand (4:1); k) fine MYWC:pine bark:sand (2:2:1); l) peat:fine MYWC:sand (2:2:1); and m) Vergro Klay Mix A. Number of leaves, leaf area and fresh and dry leaf and stem weights were determined at experiment termination. It was concluded that coarse and fine MYWC could be substituted for pine park in a peat:pine bark:sand mix. Plants grown in mixes containing fine MYWC were heavier and had larger leaf areas than plants grown in mixes containing coarse MYWC. Best plant growth occurred in Vergro Klay Mix A.

250 (PS 10)
COMPARISON OF METHODS OF DETERMINING STARCH CONTENT IN SWEET POTATOES
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Starch content is an important component of quality in sweet potatoes. We compared several methods of determining starch content with the intent of identifying a rapid, accurate, inexpensive method useful for screening large populations and appropriate for researchers with limited resources. Methods compared included measurement of % dry matter (DM) and alcohol insoluble solids (AIS), a hexokinase:glucose-6-phosphate linked assay (HG6P) for glucose content, and phenol-sulfuric (PS) determination of total carbohydrates. Preliminary results show AIS, HG6P, and PS results are linearly related to each other ($r \geq 0.940$). Relationships among results and time and cost estimates of each method are included.

251 (PS 11)
ZERO RUN-OFF AND THE RELATIONSHIP OF GROWING MEDIA TO WATER REQUIREMENTS OF NEW GUINEA IMPATIENS
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Because of environmental concerns, we must strive toward zero run-off (no leachate) in greenhouse crop production. These studies were performed to examine the effects of different types of growing media on rate of watering, and rates of run-off when growing Impatiens.

Water use rates and growth responses of Impatiens, New Guinea, hybrida. in 15 cm. pots were compared for five different growing media: Sunshine 11; Metro 510; Baccto Grower's Mix; Baccto Rockwool-40; and a mix containing Rockwool and Bacctite (granulated reed-sedge peat). Water was added as needed on 5 to 14 day intervals at five rates: 18, 36, 54, 72 and 90 percent of media volume. Plant growth, use rates and run-off were measured gravimetrically. Quantity of water absorbed, and percentage of leachate were recorded for each media at each watering and compared to crop growth responses. Statistical models of plant responses were developed.

Growth responses were significantly higher in media that contained Rockwool than in the other blends. Rates of growth were greatest when watering rates were above 20 percent of media volume. Increasing watering above 36 percent of container capacity had decreasing effects on height, number of lateral branches, or total plant mass. As little as 3.0 liters of water par 15 cm. pot produced marketable plants in twelve weeks with no run-off. It was clear that the amount and frequency of water applied in the production of New Guinea Impatiens can be greatly reduce. Careful selection of growing media and judicious application of water are important to reducing run-off.

252 (PS 10)
SUSCEPTIBILITY OF POTATO CULTIVARS TO INTERNAL HEAT NECROSIS ACROSS YEAR, LOCATIONS, AND HARVESTS
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Internal heat necrosis (IHN) is a physiological disorder that affects potatoes. Year, location, harvest date, and tuber size were studied to develop an IHN screening technique. In 1989 and 1990, ten potato varieties were grown at two NC locations with normal season (90-100 days) and late (115-120 days) harvests at each location. At each harvest yield data were taken, tubers were divided into three size classes (1= 48-64mm, 2= 65-83mm, 3= <83mm), and 20 tubers were evaluated for IHN within each size class. More IHN was observed when tubers were sampled in size class 2 versus 1; there were not enough tubers in size class 3 to sample. 'Atlantic' had the most severe IHN, B9792-158 was intermediate, and NC004-1 had the least. Location did not differ in IHN observed, but Plymouth was a superior location due to higher yields and tuber quality. Time of harvest was not significant. Depending on the year the amount of IHN observed varied considerably. The development of a consistent greenhouse screening technique may prove to be more valuable to breeding programs than a field screen.

253 (PS 10)
PHYLOGENY OF SELECTED *IPOMOEA* SPECIES BASED ON ISOZYME AND MORPHOLOGY CHARACTERIZATION
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Eight populations including *Ipomoea batatas* and *I. trifida* species were assayed at six polymorphic enzyme loci. Differences in allele frequencies among populations allowed distinction of the two species and among levels of ploidy. Principal component and cluster analyses using isozyme and morphological data were performed. Results from isozyme characterization in general supported the results from morphological classification. Cluster analysis from isozyme assays indicated that the hexaploid species *I. trifida* is not a different species than *I. batatas* but may be a wild type. Significant deviations of genotypic frequencies from Hardy-Weinberg equilibrium in some of the loci were detected and were possibly due to effects of natural selection; this fact was reflected in the level of homozygosity observed among populations for the loci in disequilibrium.

254 (PS 10)
TURF MANAGEMENT EFFECTS ON GENETIC STRUCTURE AND ADAPTATION OF GOLF COURSE *POA ANNUA* POPULATIONS
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Golf course *poa annua* populations located along a gradient of different intensities of turf irrigation and mowing practices were studied for characteristics of seed dormancy and seed bank, effects of light conditions and growth regulators on dry weight partitioning, and genetic differentiation and adaptation of life history traits. A large genetic component of variation of various vegetative and reproductive traits indicates rapid genetic differentiation has been taking place among the populations at the micro-ecological level. Plants from dry and low-maintenance conditions show annual characteristics, whereas plants from wet and high-maintenance conditions show perennial characteristics. Effects of light and growth regulator treatments indicate different responses between annual and perennial biotypes. This information is of value for *Poa annua* control and management.

255 (PS 11)
ORGANIC MATTER INCORPORATION AND IRRIGATION RATES FOR BEDDING PLANTS
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The effect of organic matter addition and irrigation rates on the growth of bedding plants was found to vary with species. Marigold and sweet alyssum were field-grown with or without added peat moss under normal or 50 percent reduced irrigation.

Regardless of organic matter treatment, marigolds with reduced irrigation were shorter than those with normal irrigation. Under normal irrigation, adding organic matter had no effect on height. Under reduced irrigation, incorporating organic matter was beneficial to marigolds: plants in these plots were 10% taller than plants under reduced irrigation without added organic matter.

Sweet alyssum, a relatively drought-tolerant plant, was wider under reduced than under normal irrigation. It did not benefit from added organic matter: plants grown with added organic matter were 17% narrower than those without added organic matter, regardless of irrigation level. Blanket recommendations to add organic matter to conserve water should be avoided.

256 (PS 10)
BACTERIAL WILT (XANTHOMONAS PELARGONII) RESISTANCE IN PELARGONIUMS

Shifeng Pan, Uma S. Gupta and Lowell C. Ewart, Department of Horticulture, Michigan State University, East Lansing, MI 48824-1325

Twenty one Pelargonium species, cultivars and F1 hybrid plants were screened for bacterial wilt (Xanthomonas pelargonii) resistance. P. Odorratissimum, P. cordifolium, P. cucullatum, P. grandiflorum, P. peltatum x P. cucullatum, P. grandiflorum x P. domesticum cv 'Tiny Tot', P. x domesticum cv 'Tiny Tot' x P. × domesticum cv 'earliana', P. betulinum x P. cordifolium, P. grandiflorum x P. cucullatum, P. grandiflorum x P. betulinum, P. cucullatum x P. cordifolium and P. scabrum x P. seritrilotum showed high resistance to the disease. A hybrid resulting from the cross of P. x hotorum 'inbred white' and P. grandiflorum, a proposed ancestral species of P. x domesticum, showed great tolearance. The seed parent 'inbred white' was highly susceptible to this disease. This strongly suggests that the resistant gene(s) was transferred to the P. x hortorum from P. grandiflorum. The statistical results indicated that there was no significant difference (a=0.05) between observations taken at 4.5 days and 71 days after inoculation. There were significant differences, however, between observations at 21 days and 4.5 days, and 21 days and 71 days.

257 (PS 10)
CYTOLOGY AND CROSSABILITY STUDIES IN PELARGONIUMS

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Cytology studies were conducted to determine the chromosome numbers of thirty eight Pelargonium species, cultivars and inbred lines collected from different locations. Chromosome numbers for thirteen of those species and cultivars have not been previously reported. A new chromosome number of 2n=8 for Pelargonium species (P. elongatum) was found. One hundred and eighty-two interspecific crosses were performed among those species, cultivars and inbred lines to determine crossing campatibility. Thirty eight combinations produced variable seeds, and nineteen of them showed partial seed development. One hybrid plant was produced from an inbred P. x hortorum 'inbred white' crossed with P. grandiflorum, one of the suggested ancestral P. x domesticum group. P. peltatum was found to be a bridge species crossing with P. cordifolium, another proposed P. x domesticum ancestral species and the P. x hortorum group. The chromosome number and the crossability study results will be presented and discussed.

258 (PS 10)
GENETIC DIVERSITY AMONG *FUCHSIA* SPECIES AND CULTIVARS

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Genetic diversity among *Fuchsia* sp. was evaluated using isozyme analysis. Twenty-two enzyme systems on 5 gel/buffers were tested for 17 *Fuchsia* species and 40 cultivars. Five enzymes systems had suitable resolution for use in isozyme analysis (PGI, DIA, PGM, MDH, GOT). Four other systems (ACO, EST, ACP, IDH) showed promises results but need to be modified to improve resolution to facilitate use in isozyme analysis.

A high degree of isozyme polymorphism among species was observed for the 9 isozyme systems mentioned above. This was not surprising given the abundance of morphological characters exhibiting polymorphism among the species examined. The level of isozyme polymorphism among cultivars was low, despite having high morphological diversity for horticultural traits. A higher degree of polymorphism was seen for cultivars with parentages that included species, such as *F. triphylla* or *F. encliandra*, rather than to the typical parentage of *Fuchsia x hybrida (F. magellanica x F. fulgens)*.

The large degree of polymorphism among species suggests that they provide a rich source of new genes for cultivar improvement and that isozymes may be useful in marker-assisted selection.

259 (PS 11)
A QUICK METHOD FOR MEASURING PHYSICAL PROPERTIES IN HORTICULTURAL SUBSTRATES

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The determination of air and water holding capacities of horticultural substrates has been plagued by errors in measurement. The amount of air and water held at container capacity is influenced by the substrate and container height. Container capacity (CC) can be established through specific measurement. Air space (TP-CC) is usually poorly determined because of errors in total porosity measurement. Total porosity can be measured with great accuracy at 0 kPa tension on a pressure plate apparatus, but is costly in equipment and time. Using a modified method of extraction and a new apparatus, using standard aluminum soil sampling cylinders, total porosity was measured with an 85% reduction in time and no decrease in accuracy. Also, container capacity and air space can be determined, but are specific to the container used (7.6 cm dia. X 7.6 cm h). The values of total porosity are not specific to container size and therefore can be used with more conventional methods of determining container capacity. A 1.5 MPa pressure plate extractor is used to determine unavailable water (UW) content in 48 hours. UW is also unaffected by container size. Total porosity, container capacity and air space can be accurately determined in approximately 26 hours, with unavailable water in an additional 24 hours.

260 (PS 10)
DETECTION OF TAXOL IN IMMATURE *TAXUS MEDIA* AND *TAXUS CUSPIDATA* STEMS.

Enaksha R. Wickremesinhe* and R.N. Arteca, Department of Horticulture, The Pennsylvania State University, University Park, PA 16802.

Taxol is an antitumor compound found in *Taxus* plants. This experiment was conducted to evaluate the taxol levels in *Taxus media cv.* hicksii and *T. cuspidata* cv. capitata at various stages of maturity. Immature (green) and mature (brown) stems were harvested from two well established trees at The Pennsylvania State University, University Park campus. Samples were freeze-dried, ground in a UD mill and extracted in methanol. The methanol extract was concentrated *in vacuo* and partitioned against 1:l methylenedichloride (MC) and water. The MC fraction was dried *in vacuo*, resuspended in methanol and analyzed by HPLC. A Dynamax-60 A 8 mm phenyl column (4.6 mm X 250 mm) with a Waters 600E HPLC system connected to a U6K injector and a 484 tunable absorbance detector was used. Taxol was eluted within 14 minutes using an isocratic mixture of water, methanol and acetonitrile (39:20:43). We found that the immature stems of *T. media* had 0.015% taxol compared to 0.004% in mature stems and immature stems of *T. cuspidata* had 0.003% taxol as compared to 0.001% in the mature stems expressed on a dry weight basis.

261 (PS 10)
ESTABLISHMENT OF ROOT CULTURES FROM CEPHALOTAXUS HARRINGTONIA CALLUS

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Cephalotaxus harringtonia plants produce alkaloid compounds possessing antitumor properties, the major one being homoharringtonine. The purpose of this study was to produce roots from callus cultures developed earlier. Fast growing callus cultures were placed on MS basal salt medium with B-5 vitamins, 2% sucrose, 10 µM kinetin, 0.45 µM 2,4-D and 0.2% Gelrite. Upon subculture onto basal medium without hormones, we observed organogenesis of both shoots and roots. Roots were excised and established on basal medium without hormones. By subculturing two 2-inch root tips containing numerous visible laterals in liquid medium we were able to harvest 30 g of roots/250 ml flask after 3 weeks and 50 g/250 ml flask after 6 weeks. A 20-fold increase in fresh weight was achieved within 3 weeks when 15 grams of roots were initially seeded into a 3 liter air-sparged bioreactor. However, most of these roots appeared to be fleshy/swollen while root cultures established from half inch root tips grew slower but were normal in appearance. We arc currently in the process of establishing growth characteristics for these roots and assaying roots for the presence of these alkaloids.

262 (PS 12)
THE EFFECTS OF WOUNDING TULIP BULBS ON ETHYLENE EVOLUTION AND PLANT GROWTH.

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Tulip bulbs (12/up cm) of 'Apeldoorn' and 'Oxford' were used. The effects of wounding on ethylene production and subsequent plant growth and flowering were studies. After 3, 6, 9, and 12 weeks of dry storage at 2 C, the scales of 30 bulbs were cut 4 times at 90 degree angles just before planting. Uncut bulbs of each cultivar were used as the controls. The bulbs were planted and forced in a greenhouse at 13-15 C. The length of the internodes, flower size, and date of flowering were recorded. On the day of each planting date, 15 intact and 15 cut bulbs were used to measure the rate of ethylene production using a gas chromatograph. Samples were taken daily for 5 days. Initial results of bulbs precooled for 0, 3 and 6 weeks show significant increases in ethylene production after wounding. These and other results will be discussed.

263 (PS 11)

EFFECTS OF COMPACTION ON SUBSTRATE CO_2 IN A SUBIRRIGATION SYSTEM

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Greenhouse substrates are designed to allow maximum aeration. Substrate water holding capacity can be increased by media compaction.

Six inch standard pots, fitted with gas tight openings for removing gas samples, were filled with Metromix 350 and Peatwool at 2 different compaction rates. Half the pots were planted with rooted cuttings of Poinsettia pulcherrima 'Glory' and half were left fallow. Air samples were taken at both wet and dry soil moisture conditions at early, mid point and at the end of the cropping cycle. In general, wet substrates had higher CO_2 than drier substrates and more compacted substrates had higher CO_2 than less compacted.

CO_2 decreased with time in all treatments. The highest CO_2 levels occurred in wet heavily compacted Peatwool with a plant and the lowest occurred in dry Metromix with no plant.

264 (PS 12)

INTERACTION OF COLD STORAGE AND LONG DAYS ON EASTER LILIES

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Easter lily bulbs (Lilium longiflorum) were exposed to 0, 1, 2, 3, 4, 5, or 6 weeks cold; 0, 1, 2, 3, 4, 5 or 6 weeks long days (LD) or cold followed by LD in the following combinations: 0/6 (weeks cold/weeks LD), 1/5, 2/4, 3/3, 4/2, 5/1, or 6/0. Increasing weeks of cold decreased leaf number and days to flower from start of greenhouse forcing, but increased percentage of plants flowering. However, total time from potting to flowering of bulbs treated with cold/LD combinations lengthened as weeks of cold increased. Long days alone did not substitute equally for cold as the majority of plants exposed to LD did not flower. At least one to two weeks of cold were required for LD to effectively cause flower initiation. Depending on the year, 100% of the plants flowered when treated with three to six weeks of cold alone or with any combination of cold and LD including at least one week of cold. Average date of emergence tended to decrease as bulbs were exposed to greater amounts of cold but was not influence by LD. Plant quality was reduced by exposure of the bulbs to cold. Experiment was repeated for three consecutive years.

265 (PS 11)

ABNORMAL ROOT MORPHOLOGY OF CATHARANTHUS ROSEUS GROWN IN SOLUTION CULTURE

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Rose periwinkle (C. roseus 'Little Linda'), a common bedding plant, grown in Hoagland solution #1 with Fe-EDTA at 5 mg/L Fe had normal shoot morphology, but abnormal root morphology. The primary root was twisted and lateral roots were extremely stunted with dichotomous branching. Over a dozen other bedding and foliage plant species had normal root morphology when grown in an identical solution, and cuttings from periwinkle with abnormal roots produced normal roots when rooted in 2 mM $CaCl_2$. When these rooted cuttings were grown in Fe free Hoagland solution #1, root morphology was normal, indicating that the Fe-EDTA caused the problem. Seedlings were then grown in solution for 30 days with Fe supplied as Fe-EDTA (both 5 mg/L and 1 mg/L Fe), Fe-DPTA (5 mg/L and 1 mg/L Fe), Fe-EDDHA (2.75 mg/L and 0.55 mg/L Fe) or Fe_2O_3 (1 g/L). Solution pH for all were in a normal range of 4.8 - 5.6 Only the seedlings grown with Fe_2O_3, Fe-EDTA (5 mg/L Fe) and Fe-DTPA (5 mg/L Fe) developed abnormal root structure. All others had normal roots.

266 (PS 12)

RESPIRATORY RESPONSE OF HYBRID LILY BULBS TO POST-VERNALIZATION LIGHT TREATMENTS.

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Hybrid lily bulbs, cvs. Enchantment and Jamboree, were harvested from the greenhouse following shoot senescence, graded by weight, and vernalized under controlled conditions; 3 weeks at 2 C for Enchantment, 4 weeks at 5 C for Jamboree. Following initial dark vernalization, bulbs were exposed to daily light/dark cycles (18/6 hr) at temperatures of 5/2 C (4 weeks for Enchantment) or 7/3 C (6 weeks for Jamboree). During the daily light cycle bulbs were exposed to PAR levels of either 220, 2, or 0 u mol·m^{-2}.sec^{-1} photosynthetic (PS), photoperiodic (PP) or dark (DK) treatments respectively. Bulb respiration was determined at weekly intervals following vernalization, by measuring CO_2 in a closed system with an infra-red gas analyzer. Respiration was measured under both light and dark conditions. Respiration was higher in the light than in the dark for bulbs in all treatments. In both the light and the dark, respiration was highest for PS treated bulbs followed by PP and than DK treated bulbs. Initial respiratory rates in the light (averaged for all treatments) were 0.695 and 0.719 u mol CO_2.g^{-1} fresh wt.hr^{-1} for Enchantment and Jamboree respectively. The respiratory response over time differed between cultivars. For Enchantment initial respiration declined 40% after 2 weeks and an additional 10% after 4 weeks. Whereas Jamboree bulb respiration declined at a constant rate over the 6 week period (also 50%).

267 (PS 11)

WATER ECONOMY OF GERALDTON WAX

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The water economy of Geraldton wax was studied by measurement of daily water use using calibrated heat balance stem flow gauges. The rate and accumulated xylem sap flow was recorded for the trunk, primary and secondary branches and partially shaded lower eastern and sun-lit upper western branches. The daily course of xylem sap flow was strongly influenced by the orientation of the leaf area to irradiance and the intensity of irradiance. Sap flow in both primary (^{F}max = 86.1 g h^{-1}) and secondary (^{F}max= 61.9 g h^{-1}) branches was closely matched when normalized on a unit leaf area basis. Defoliation of the secondary branch reduced its water use by 78% and resulted in preferential water use by the primary branch. It is likely that shedding of leaves under water stress, a common phenomenon in Geraldton wax, has similar effects. The water use of the east facing branch (1.20 Kg d^{-1} m^{-2} of leaf area) was lower than that of west branch (1.53 Kg d^{-1} m^{-2} of leaf area) and the difference was prominent during the afternoon when the eastern branch was shaded (E 22% < W). The hydraulic conductance of the west branch to liquid flow was 3.56 x 10^{-14} m s^{-1} Pa^{-1} which was higher than values reported for some other woody species.

268 (PS 12)

COMPARISON OF JUVENILITY IN TWO GENERA OF THE ASTERACEAE

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Chrysanthemum x superbum, *Coreopsis lanceolata*, and *Coreopsis grandiflora* are LD flowering perennial plants. The end of juvenility could be defined as the minimum expanded leaf number required for fastest flowering once placed in LD. This research was conducted to compare juvenility and flowering requirements in dwarf and standard cultivars of these species. Plants were maintained under SD and transferred to LD upon reaching true leaf stages beginning with 0 (cotyledons only) and progressing at 2 or 3 leaf intervals to the 24 leaf stage. *Coreopsis* 'Sunray' and *Chrysanthemum* 'G. Marconi' were relatively unresponsive to LD whereas LD induced flowering in 70-100% of the plants in each leaf number treatment in *Coreopsis* 'Early Sunrise'. Plants transferred at the 15 leaf stage required the least number of LD to reach anthesis. LD promoted complete flowering in *Chrysanthemum x superbum* 'Snow Lady' plants and 90% of the SD control plants flowered as well. SD control plants from the other 3 cultivars remained vegetative. Effects of vernalization will also be presented.

269 (PS 11)

REDUCING NITROGEN LEACHING FROM CONTAINERIZED GREENHOUSE CROPS: INCREASING THE EFFECTIVENESS OF CONTROLLED-RELEASE FERTILIZER APPLICATIONS

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Marigold *(Tagetes erecta* L., 'First Lady') plants growing in 0.5-liter pots were fertilized with water-soluble 20N-4.3P-16.6K (WS) or 3 types of controlled-release 14N-6.2P-11.6K (CR). In all treatments plants received 560 mg N pot^{-1} and were irrigated with the same volume of water over the course of the experiment. Leachate was analyzed for NO_3-N and NH_4-N. A single application of Osmocote (3-4 month release) at planting reduced N leaching to 64% of WS while making 2 smaller applications reduced N leaching to 33% of WS. A split of 3 applications of Nutricote Type 40 (40 day release) reduced N leaching to 51% of WS. Greater reductions in N leaching were achieved with Nutricote Type 100 (100 day release) but dry weight was reduced significantly. With all CR N leaching was greatest in the 30 day period following planting; 57-96% of the total was leached depending on CR type and application method. A second experiment shows how this pattern might be changed.

270 (PS 12)
FLORAL INITIATION IN THE LONG-DAY PLANT *Rudbeckia hirta*
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A study was undertaken to determine the rate of floral initiation in *Rudbeckia hirta. R. hirta* plants were grown to maturity, 14-16 leaves, under short days (SD). Paired controls were established by placing half of the plants under long days (LD) with the remainder left under SD. Beginning at the start of LD (day 0), five plants were harvested daily from each photoperiod group for twenty days. Harvested meristems were fixed in 2% paraformaldehyde - 2.5% glutaraldehyde in 0.1 M sodium cacodylate buffer (pH 7.0) for 24 hrs, dehydrated in an ethanol series, embedded in paraffin and sectioned at 8 µm. Serial sections were stained with Methyl-green Pyronin, with adjacent sections treated with RNase for nucleic acid comparison. All events of floral initiation were identified, The results of limited inductive photoperiod indicate that 16-18 LD were required for flowering.

271 (PS 11)
EFFECTS OF DIFFERENT APPLICATION METHODS, SOURCES AND LEVELS OF CONTROLLED-RELEASE FERTILIZATION ON ASTER (ASTER X FRIKARTI 'MONCH').
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Application method of controlled release fertilizers on containerized asters did not consistently increase plant growth or dry weight. Within controlled release fertilizer sources, larger, heavier and higher quality plants with more secondary shoots resulted from Osmocote 14N-6.2P-11.7K, 3-4 month than the average of Osmocote 18N-2.6P-10K, 8-9 month and Osmocote 17N-1.6P-8.3K, 8-9 month plus micronutrients. Plant growth and dry weight increased with increasing levels of Osmocote 14N-6.2P-11.7K in topdress and incorporated application treatments.

272 (PS 12)
JUVENILITY AND PHOTOPERIODIC RESPONSE OF *RUDBECKIA HIRTA* FROM DIFFERENT LATITUDES OF ORIGIN.
Diane D. Beckwith and Robert E. Lyons*, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061-0327.

Rudbeckia hirta is a self-sowing annual or tender perennial which is a popular component of commercial meadow mixes. Successful performance of this wildflower may be dependent upon the geographic location of the seed source. *R.* hirta seed collected from seven latitudes, ranging from 30 10'N to 45 10'N, was germinated and subsequently exposed to inductive long day conditions at different leaf numbers to determine juvenile phase length. Two clones had a juvenile phase of up to 24 leaves, others were juvenile up to 18 leaves. Speed of flowering, stem and scape lengths, leaf number and ray floret number were measured at first flower. Latitude of origin had a significant effect on all parameters measured except leaf number. The number of days to first flower increased with latitude of origin. The responses of the 30 10'N clone differed significantly from all other clones, except in leaf number.

273 (PS 11)
SPLIT-INTERVAL IRRIGATION: WATER EFFLUENT AND AGERATUM GROWTH
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Water collection modules were used to compare split-interval irrigation with conventional irrigation using container-grown Ageratum houstonianum 'Blue Puffs'. Container leachate and runoff effluent volumes were measured to correlate water quantity with irrigation treatment. Container leachate and runoff effluent volumes were reduced with split-interval irrigation compared to conventional irrigation. As the number of episodes per cycle of split-interval irrigation increased the volume of runoff and container effluent decreased. Growth indices and root distribution of ageratum were similar with equal volumes of water applied, regardless of the number of episodes per cycle.

274 (PS 12)
EFFECT OF NIGHT-TIME HUMIDITY AND FERTILITY LEVEL ON PHYSIOLOGICAL DISORDERS OF POINSETTIA.
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Poinsettia, *Euphorbia pulcherrima* Willd. cvs Lilo, V-14 Glory and Annette Hegg Dark Red (AHDR) were grown in a greenhouse under low, high or ambient night-time humidity regimes. Humidity treatments were imposed daily (1700-0800 hrs) beginning with the onset of short days and continuing through final bract expansion. Poinsettias were fertilized with either (all in mg/liter) 245N-46P-160K or 490N-92P-320K. Relative humidity, plant canopy and root zone temperature, and PAR levels were monitored. Necrotic transitional bracts, necrotic bracts, and bracts with bilateral spots, on both the axillary shoots and the main axis, were counted and recorded. Night-time humidity in the high, low and ambient humidity regimes averaged 86, 56 and 64, respectively. Significant night-time humidity x cultivar, and humidity x cultivar x fertility interactions were observed with respect to transitional bract necrosis on axillary shoots. The highest incidence of axillary shoot-transitional bract necrosis occurred in the low humidity x high fertility regime on V-14 Glory. Transitional bract necrosis occurred significantly less frequently on V-14 Glory in response to low fertility and high night-time humidity. On the main axis, necrotic bracts occurred most on the Lilo cultivar, under low or ambient humidity x high fertility conditions. Bracts with bilateral spots were most prevalent on AHDR produced under the low fertility regime.

275 (PS 11)
EFFECT OF LEACHATE FRACTION ON THE DYNAMICS OF THE SOIL NITRATE-N PROFILE UNDERLYING A GREENHOUSE CROP.
Richard J. McAvoy, Department of Plant Science, University of Connecticut, Storrs, CT 06269-4067.

Poinsettia stock plants were produced on top of bottomless $1m^3$ soil filled boxes which *were* recessed into the greenhouse floor. Plants were irrigated with a 280 mg/liter N solution on a constant basis to produce a leachate fraction (LF) of either 10 or 50 percent. Soil core samples were removed at 15cm increments to a depth of 90cm from replicated treatment boxes at two week intervals. Leachate samples were collected from randomly selected pots following each irrigation and the volume recorded. The number and dry weight of poinsettia cuttings produced was recorded twice during the twelve week study. Soil, leachate, plant tissue and potting medium samples were analyzed for nitrate-N (NO_3-N) content. After 6 weeks NO_3-N levels were significantly higher at both the 0-15cm and 15-30cm depths of the 50% LF treatment than the 10% LF treatment. The increase in $N0_3$-N at the 30-45cm depth after 10 weeks was significantly greater in response to the 50% LF treatment than the 10% LF treatment. NO_3-N accumulation in the 45-90cm depth did not significantly differ between treatment groups during the study. After 6 weeks the NO_3-N level in the 0-15cm depth of the 50% LF soil was 2.5 times higher than the 10% LF soil. A similar response was observed after 8 weeks in the 15-30cm depth range. Poinsettia cutting production did not significantly differ between treatment groups.

276 (PS 12)
FLORAL INDUCTION IN SISYRINCHIUM BERMUDIANA L.
Glenn L. Roberts*, Masaru J. Tsujita and Jean Gerrath, Dept. of Horticulture, University of Guelph, Guelph, Ontario, N1G 2W1, Canada.

Sisyrinchium bermudiana L. plants were grown in growth chambers under 10 hour short-day regimes. Plants were removed at periodic intervals to provide inductive cycles of 2, 3, 6, 8, 12, 14 and 16 weeks. Flowering (taken at the time of visible bud) was initiated best on plants receiving 10 or more weeks of short days. Scanning electron microscopy of the shoot apices at weekly intervals confirmed that the transition from vegetative to floral occurs at the 10 week short-day inductive cycle. It was also determined that stamens and tepals develop first as common stamen-tepal primordia which bifurcate to form outer tepals and stamens opposite.

277 (PS 11)
RECIRCULATING FLOOD/MAT SUBIRRIGATION SYSTEM FOR PLUG PRODUCTION
Jack W. Buxton* and Donna Switzer, Department of Horticulture and Landscape Architecture, University of Kentucky, Lexington, KY 40546, U.S.A.

A recirculating flood/mat subirrigation system was evaluated for plug production. Plug trays (cells 2.0 cm × 2.0 cm × 3.2 cm deep) were placed on capillary mats in water tight benches designed to contain water to a maximum depth of 1.25 cm during flooding. The capillary mats extended from the bench over the 1.25 cm bench lip **a** distance of 0, 5, 10, 15, 20, or 25 cm. After flooding most of the free water in the bench was syphoned back into the reservoir through the water distribution line. The water in the plug medium and capillary mat was syphoned through the capillary mat back into the reservoir. The amount of water remaining in the plug medium decreased as the pad length below the bench increased. After 5 hrs. trays on mats extending 20 or

25 cm below the bench contained 40% less water than trays on mats not extending below the bench and 24% less water than on mats extending 5 cm below the bench. Preliminary results indicate marigold seedlings irrigated 4 times daily were larger if the mat extended over the bench a minimum of 15 cm; whereas those irrigated 2 times daily were not affected by the length of the mat. Seedlings irrigated 4 times daily with the mat extending at least 15 cm below bench level were larger than seedlings on any mat length irrigated 2 times daily. The flood/mat irrigation system is potentially capable of providing an adequate amount of water and aeration within-the plug container during germination and seedling growth.

278 (PS 12)

GERMINATION, STORAGE LIFE AND ENDOGENOUS POLYAMINE LEVELS IN PURPLE CONEFLOWER (Echinacea purpurea) SEED FOLLOWING OSMOTIC PRIMING.

Sharon T. Kester, Nining Wartidiningshi, and Robert L. Geneve, Dept. of Horticulture, University of Kentucky, Lexington KY 40546

Rapid, uniform germination of purple coneflower seeds has been achieved following osmotic priming in an aerated PEG solution (-10 bars) for seeds held at 25°C for 5 days. Putrescine, Spermine, Spermidine (1 mM); GA_3 or ethephon (100 µM) were added to the priming solution to evaluate their effect on germination after storage at ambient (25°C). 5°C or at accelerated aging (30°C) conditions. Following 14 days in storage at 30°C, germination dropped to £ 22% for all primed seed lots regardless of treatment. This compared to 88% for the unprimed control seeds stored at the same temperature. Within the first 90 days of storage at ambient temperature, germination of all primed seed lots declined rapidly (£ 40%) compared to acceptable germination (80%) in unprimed seeds. However, seeds stored at 5°C maintained high germination percents (between 70-80%) for the control and primed seed lots. Endogenous polyamine levels, determined by HPLC, did not increase during the priming process. Putrescine added to the priming solution increased the extractable polyamine titer, but did not substantially improve germination following seed storage.

279 (PS 13)

COMMERCIAL FLORICULTURE EXTENSION PUBLICATIONS IN THE U.S. - 1991

Robert G. Anderson*
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A list of the commercial floriculture publications available from each state's cooperative extension service was compiled. This list was prepared under the auspices of the ASHS Extension Advisory Committee and will be available for distribution. The list includes extension publications, newsletters, association publications, association newsletters, videotapes, computer programs, etc. appropriate for continuing education programs in commercial floriculture.

280 (PS 12)

MODELING DAHLIA 'ROYAL DAHLIETTA YELLOW' TEMPERATURE DEPENDENT DEVELOPMENT RATE

Jens J. Brondum* and Royal D. Heins, Department of Horticulture, Michigan State University, East Lansing, MI 48824-1325

Dahlia "Royal Dahlietta Yellow" plants were grown in controlled temperature chambers under 25 different day and night temperature environments ranging from 10°C to 30°C. The day length was 12 hours with an average PPF level of 300 micromol m^{-2} s^{-1} at canopy level. Leaf unfolding rate, shoot elongation and flower development rate were determined and models developed. Leaf unfolding rate increased as temperature increased up to 25°C. Stem elongation increased as the difference between day and night temperature increased. Flower initiation was delayed at high (30°C) temperature and flower development rate increased as temperature increased from 10°C to 25°C. Plants are currently being grown under greenhouse conditions to provide data for validating the models.

281 (PS 13)

POPULARIZING POMOLOGY

Brenda Olcott-Reid* and William Reid, Dept. of Horticulture, University of Arkansas, Fayetteville, AR 72701 and Pecan Experiment Field, Kansas State University, Chetopa, KS 67336-0247.

Fruit gardening; immensely popular until the previous half century, is once again reviving. Home fruit growers need specific how-to information tailored to their conditions, not just general guidelines or a condensed version of recommendations for commercial growers. Fruit gardeners especially need advice on choosing types of fruit best suited to their climate and site, selecting cultivars and rootstocks that resist serious pests and weather problems in their area, timely training and caring for fruit plants to keep them healthy, and recognizing pests and controlling them ecologically on a small scale.

This presentation illustrates the development of such information for a national magazine audience. Research and Extension reports from many regions must be analyzed and applied to home fruit growing. Detailed charts of cultivars' fruit quality, disease resistance and other attributes enable home growers to make wise choices before planting. Maps of regional cultivar adaptations or pest distributions, line drawings oftraining and pruning techniques, photos of cultural practices and pests all add visual appeal and enhance reader understanding. Photos or plans of fruit plants in a landscape further entice homeowners to plant fruit.

282 (PS 12)

MODEL DEVELOPMENT FOR TIME TO FLOWER OF SCHLUMBERGERA TRUNCATA

Nathan E. Lange*, Jens J. Brondum and Royal D. Heins, Department of Horticulture, Michigan State University, East Lansing, MI 48824-1325

Induced Schlumbergera truncata plants of 3 cultivars ('Madisto,' 'Dark Marie,' and 'Camilla') were placed in 12C, 16C, 20C, and 24C greenhouse sections when flower buds reached 2 mm in length, Flower bud lengths were measured every 3 days until buds reached approximately 40 cm in length after which they were measured daily until anthesis. The exact date and time was recorded for each measurement. Average air temperature in each greenhouse section was recorded every 2 hours. The average air temperature was determined from the time of each measurement to the recorded anthesis date. Flower bud length was modeled as a function of days to flower (DTF) and average air temperature (T) in the following form: $length\text{-}Ae^{-(b_o+b_1*T)*DTF}$. In this model, *A* represented the final flower bud length at flower and b_o and b_1 were growth rate constants relating growth rate to temperature in the experimental range. Separate models were initially developed for each cultivar. The variation between the predicted times to flower among the cultivar models was determined for buds 2.5 mm in length over a temperature range of 14C to 24C. Differences in days to flower were less than three days in all cases and generally less than 2 days. Therefore, all data were combined to develop one prediction model. The final model parameters were $A = 66.32$, $b_o = -0.0606$, and $b_1 = 0.00806$.

283 (PS 13)

UNCOMMON FRUITS WITH HORTICULTURAL POTENTIAL

Lee Reich, Plumtree Nursery and Research Farm, 387 Springtown Road, New Paltz, NY 12561

A study was conducted on the horticultural potential of a number of uncommon fruit species. Many were found to show promise, some for commercial cultivation, others for growing in backyards. Particularly outstanding in both respects were Actinidia arguta, A. kolomikta, Asimina triloba, Cornus mas, Diospyros virginiana, and Prunus tomentosa. To commercial grower, these species offer an opportunity to diversify with an exotic fruit that may demand premium prices. Some of the species also exhibit a high degree of cold-hardiness and, at present, can be grown with little or no pesticide applications. Future research will be directed to breeding and elucidating cultural requirements. Current horticultural limitations and virtues of each of the above species will be presented.

284 (PS 12)

COOLER NIGHT TEMPERATURES DO NOT COMPENSATE FOR HIGH -TEMPERATURE- INDUCED LATERAL BUD ATROPHY IN CHRYSANTHEMUM

James E. Brown-Faust* and Royal D. Heins, Department of Horticulture, Michigan State University, East Lansing, MI 48824-1325

Dendranthema grandiflora 'Powerhouse' plants were pinched to 5 nodes and grown in growth chambers at 35 C day temperature and 14, 17.3, 21, 23.8, or 27°C night temperature to determine if night temperature increased lateral shoot development on plants exposed to high day temperatures. Vegetative cuttings from two successive flushes of lateral shoots were removed and evaluated for lateral shoot development after rooting and subsequent apex removal. Lateral shoot development was also determined on a third flush of shoots developing on the original plant. Night temperature did not have a horticulturally significant effect on the number of cuttings removed from plants during each flush, nor on the number of lateral shoots which developed on the cuttings. The percentage of nodes which developed a lateral shoot for each of the three flushes of cuttings was 80%, 68%, and 12%, respectively. We conclude that cool night temperatures are ineffective in increasing the number of lateral shoots which will develop on plants grown under high (35°C) day temperatures.

285 (PS 13)
THE UTAH FRUIT PEST MANAGEMENT PROGRAM AS A COMPUTER INFORMATION BASE
Anthony H. Hatch*, Diane Alston, Sherman V. Thomson and Steven Dewey, Utah State University Extension Service, 100 East Center L600, Provo, UT 84606

The introduction of personal computers and new software has provided us with another tool through which information can be disseminated to extension service clientele. updating or upgrading the information in information bases can be done rapidly and easily distributed. The Utah Fruit Pest Management Program is distributed to county agents , agribusinesses, and individuals with computers. County agents or agribusiness personnel can use the information base to provide their clients printed biological descriptions and illustrations of pests and the proper control procedures to follow. The client can be provided only the information sought without having to buy a bulletin that contains other pest information not of interest to the client. Our information base will be available as a hands-on demonstration.

286 (PS 12)
ROSE *(ROSA HYBRIDA* L.) DEVELOPMENT UNDER AMBIENT AND REDUCED SOLAR IRRADIANCE
Douglas A. Hopper * and Steven E. Woerner, Department of Horticulture, Colorado State University, Fort Collins, CO 80523

Established plants of *Rosa hybrida* L. 'Royalty' and 'Red Success' were hard pinched 20 March 1990 to time production for a Mother's Day crop. Plants were grown in four identical greenhouses covered with fiberglass reinforced plastic (FRP) panels. Two greenhouses received ambient solar radiation while two additional sections received 50% reduction in solar irradiance due to use of a shading thermal blanket. Temperature set points were 20C/17C day/night in all houses; control was provided by a Hewlett-Packard 9920 computer system. At flowering, harvested blooms were measured for node (leaf) number, stem diameter, stem length, and fresh weights of stem, leaves, and flower bud. Time to visible bud, to first bud color, and to flowering from pinch were recorded.

Significant differences ($P \leq .05$) in stem length occurred between cultivars. Fresh weights of stem and leaves differed ($P \leq .05$) between cultivars; stem and flower bud fresh weights differed ($P \leq .05$) between solar radiance levels. 'Red Success' development rate was slower than 'Royalty' for visible buds (8 days), first bud color (5 days), and flowering (6 days). Solar irradiance had no significant effect on development for both cultivars ($\leq$1 day difference in flowering time). Although 'Red Success' flowering stems were both longer and heavier, increased development time counteracts the tendency towards higher quality.

287 (PS 13)
DEMONSTRATING THE BENEFITS OF THINNING NATIVE PECAN GROVES WITH A COMPUTER SIMULATION MODEL.
William Reid*, Pecan Experiment Field, Kansas State University, P.O. Box 247, Chetopa, KS 67336-0247.

Tree thinning is a basic but often overlooked part of managing native pecan groves. In addition, the importance of selecting the proper trees to thin has not been adequately stressed. Growers often select trees to remove at random without the benefit of tree performance records. Significant yield and nut quality improvements per acre can be made by preserving superior trees. To demonstrate yield responses to both random and selective tree thinning, a computer simulation was developed. The simulation model was constructed by integrating three stochastic model components. Given an initial tree density, the first component creates a native pecan grove of various tree diameters and nut production potentials. The grove is then thinned at random and selectively. The second module simulates tree growth and yield responses to thinning. The final component creates annual weather conditions that set in motion the irregular bearing pattern commonly observed in pecan groves. The simulation prints out and graphs 10 years of pecan yield data following thinning. The simulation is based on long term yield data from native pecan trees in Kansas and data reported in the literature. This simulation could become an important extension aid in demonstrating the importance of selective thinning.

288 (PS 12)
INFLUENCE OF IRRADIANCE AND FERTILITY ON PLUG-GROWN GERANIUM SEEDLINGS.
M.P. Kaczperski* and A.M. Armitage, Department of Horticulture, University of Georgia, Athens, GA 30602

The effects of different irradiance levels and fertility regimes were examined for *Pelargonium* × *hortorum* 'Scarlet Elite'. Seeds were germinated in plug trays and placed in growth chambers maintained at 23C and 24 hour photoperiod. Treatments were arranged in a factorial design consisting of three irradiances of 100, 250 or 400 µmol $s^{-1}m^{-2}$ from metal halide lamps and three fertility levels from half-, full-, or double-concentration of Modified Hoagland's solution. Seedlings were evaluated weekly for 3 weeks and then potted in 10 cm pots and grown to flower in a greenhouse. Irradiance had a greater effect on seedling growth than fertility level. Seedlings grown under high irradiance were shorter and produced less dry weight and leaf area than those grown under lower irradiances. Greatest dry weight and leaf area were produced by seedlings grown at 250 µmol $s^{-1}m^{-2}$. Seedlings grown at the lowest fertility regime produced greater leaf area than those at higher fertility levels. When grown to flower, seedlings subjected to irradiance of 250 µmol $s^{-1}m^{-2}$ and low fertility flowered first. Seedlings subjected to the highest irradiance and fertility level were poor quality at time of transplant and flowering was delayed by up to 12 days.

289 (PS 13)
THE SPANISH FRUIT GERMPLASM NETWORK
R. Socias i Company, Unidad de Fruticultura SIA - DGA (INIA). Apartado 727, 50080 Zaragoza, Spain

The Instituto Nacional de Investigaciones Agrarias (INIA) has initiated in 1990 a Fruit Germplasm Project. The diversity of climates in Spain has made recommendable to scatter the different basic collections in different places, taking as a starting point the collections already existing at the different regional research centers across Spain. The species included in the Project are: almond, apple, apricot, banana, cherimoya, cherry, grape, hazelnut, mango, olive, peach, pear, prune and walnut. Details on these collections, their curators and the locations will be presented on the poster.

290 (PS 12)
CIRCADIAN TEMPERATURE EFFECTS ON PLANT CHLOROPHYLL CONTENT.
John E. Erwin*, Robert D. Berghage, and Royal D. Heins, Department of Horticulture, University of Minnesota, St. Paul, Minnesota, 55108, New Mexico State University, Agronomy and Horticulture Department, Las Cruces, New Mexico, 88003, and Department of Horticulture, Michigan State University, East Lansing, Michigan, 48824.

Dendranthema grandiflora 'Bright Golden Anne', *Fuchsia x hybrida* 'Dollar Princess', and *Pelargonium hortorum* 'Red Elite' plants were grown under 16 different day/night temperature (DT/NT) regimes with a 9 hr photoperiod. Chlorophyll a and b were extracted and measured spectrophotometrically. Both total chlorophyll and the chlorophyll a/h ratio were affected by the relationship between DT and NT and the average daily temperature. Total chlorophyll per unit area and per gram dry weight increased as DT increased and as NT decreased, i.e. as the difference (DIF) between day and night temperature (day temp. - night temp.) increased. The chlorophyll a/b ratio calculated on a per unit area and per gram dry weight basis increased as DT decreased and NT increased, i.e. as DIF decreased. Both total chlorophyll and the chlorophyll a/h ratio also decreased as the average daily temperature which plants were grown under increased.

291 (PS 12)
DIURNAL VARIATIONS IN TEMPERATURE AFFECT CELLULAR ELONGATION BUT NOT DIVISION.
John E. Erwin*, Peter Velguth, and Royal D. Heins, Department of Horticultural Science, University of Minnesota! St. Paul, MN, 55108, and Department of Horticulture, Michigan State University, East Lansing, MI, *48824.*

Lilium longiflorum 'Nellie White' plants were forced under 12 different day/night temperature (DT/NT) regimes in 1986 and 16 DT/NT regimes in 1987 with temperatures ranging from 15 to 30C. Measurements were made on stem parenchyma and epidermal cell length and width from plants grown during 1986. Cell volume and vertical cell number per internode were calculated from this information. Leaf epidermal cell length and stomatal frequency were measured on plants grown in 1987. Parenchyma and epidermal cell length from both stem and leaf tissue increased linearly as the difference (DIF) between day and night temperature (day temp. - night temp increased. Parenchyma cell length increased from 95 to 295 µm as DIF increased from -15 to 10C. Cell width was unaffected by the DT/NT regime The DT/NT regime also had no significant effect on cell number per internode. Cell volume increased linearly as DIF increased. The increase in cell volume associated with an increase in DIF was a result of the relations between cell length and DIF since there was no relationship between cell width and DIF. The DT/NT regime had no effect on stomatal frequency.

252 (PS 12)
RELATIONSHIP OF PROTEIN, STARCH, AND LIPID CONTENT WITH GERMINATION AND SEEDLING VIGOR IN IMBIBED DENSITY-SEPARATED PRIMULA SEED
M. Khademi*, D. S. Koranski, and J. M. Peterson, Department of Horticulture, Iowa State University, Ames, IA 50011

Seeds of Primula 'Dukaat Helderrose' were imbibed for 48 hr at 18C and separated into density classes of 1.08, 1.10, 1.12, 1.14, 1.16, and >1.16 g cc^{-1} using Maltrin 600 solution. Seeds were rinsed with distilled water and air dried at 22C for 48 hr. Tests for germination, seedling vigor, and soluble/insoluble protein, starch, and lipid content were conducted. Soluble and insoluble proteins were subjected to SDS-PAGE. NMR spectroscopy was used for lipid analysis. Seeds of higher densities (>1.14) showed higher percentage of germination and good seedlings compared to those of lower densities. Soluble protein and starch

content increased with density while the insoluble protein remained unchanged. Distinct groups of protein with estimated MW of 50, 33, and 25 kd were present in the protein profile of unseparated imbibed seeds. These proteins were found to be most abundant at densities of 1.16 g cc^{-1} and greater. Presence of an additional protein of 14 kd was noted in the insoluble protein profile.

293 (PS 13)

GERMPLASM COLLECTION USING PUBLIC CONTESTS - THE *ASIMINA TRILOBA* EXAMPLE

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The pawpaw *Asimina triloba* (L.) Dunal) is the largest fruit native to the United States. The genus *Asimina is* the only temperate climate representative of the tropical family Annonaceae, famous for fruits such as custard apple *(Annona reticulata),* cherimoya *(A. cherimola),* sweet-sop *(A. squamosa),* and others. There is a need to collect pawpaw germplasm for genetic improvement programs. A nationwide contest was conducted, patterned on the American Genetic Association "Where Are the Best Pawpaws" contest held in 1916. Over 430 fruit from 16 states were submitted despite the poor pawpaw crop over much of the country caused by a late cold spring. The largest fruit weighed over 400 g. Approximately 300 inquiries from 25 states and 2 foreign countries also resulted from this contest. Similar contests may be useful for the collection of germplasm of other minor fruit.

294 (PS 12)

CHEMICAL ROOT PRUNING AND ROOT REGENERATION

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Rooted, bed-grown cuttings of *Viburnum plicatum tomentosum 'Mariesii'* were used to evaluate effects of $CuOH_2$ on root pruning and root regeneration. Interior walls of containers were painted with 0, 50, 100, 250 and 500gm $CuOH_2$/liter white exterior acrylic latex paint. Plants were grown 5 months in a pine bark medium in these containers, plus a control (0 paint, 0 $CuOH_2$). All $CuOH_2$ levels reduced the number of roots which continued to grow (deflected roots) after contacting container walls. Control and paint only treatments had 112 and 87 deflected roots/plant, and 50gm $CuOH_2$- 61, 100gm $CuOH_2$- 15, 250gm $CuOH_2$- 12, and 500gm $CuOH_2$-9 respectively. Chemical analysis of serial root sections showed copper conc. were highest in root tips with conc. rapidly decreasing proximally. After transplanting from treated containers, 100% root regeneration occured within 2 days in the control; 88% in 4 days for paint only; 92% in 4 days for 50gm $CuOH_2$; 98% in 4 days for 100gm $CuOH_2$; 76% in 4 days for 250gm $CuOH_2$; and 92% in 6 days for 500gm $CuOH_2$. After 32 days plants in the 100gm $CuOH_2$ treatment reached the same level of root growth as the control plants. A statistical root growth curve was constructed based on individual treatment data.

295 (PS 13)

CONSERVATION OF TEMPERATE FRUIT, NUT, AND GRAPE GERMPLASM

Kathleen S. Rigert, USDA, ARS, NCGR-Davis, University of California, Davis, CA 95616-8607

The National Clonal Germplasm Repository (NCGR) at Davis was established in 1982 and is one of ten facilities in the National Plant Germplasm System charged with the preservation of clonally propagated crops. The Davis repository is responsible for the maintenance, evaluation, and distribution of wild and related species of Vitis (grape), Prunus (stonefruit), Juglans (walnut), Pistacia (pistachio nut), Olea (olive), Ficus (fig), Actinidia (kiwifruit), Diospyros (persimmon), Punica (pomegranate), and Morus (mulberry). The stonefruit collection is maintained as small trees in insect-proof screenhouses; the other collections are maintained as whole trees or vines at a 70 acre (32 ha) field facility. Complementing germplasm maintenance functions, repository research activities support the implementation of long term preservation techniques for backup collection development, the evaluation and characterization of collection materials, and the maintenance of disease-free material. To obtain collection materials for your work or for information on cooperative research and evaluation projects, please contact the author at the address above.

296 (PS 12)

PHOTOSYNTHESIS, WATER RELATIONS, AND CARBOHYDRATE ANALYSIS OF ECTOMYCORRHIZAL PINUS TAEDA L. SEEDLINGS.

Sven E. Svenson,* FLREC, University of Florida, Fort Lauderdale, FL 33314, and Fred T. Davies, Jr., Department of Horticultural Sciences, Texas A&M University, College Station, TX 77843.

Seedlings of Pinus taeda inoculated with Pisolithus tinctorius (Pt) or noninoculated were acclimitized in a growth chamber for 30 d before exposure to water deficits. Half of the seedlings from both ectomycorrhizal treatments were subjected to a gradually developing water deficit of 0.05 MPa (predawn needle water potential) per day for 38 days. Net photosynthesis (Pn) declined as water deficit severity increased. Compared to seedlings watered daily, osmotic potentials at full turgor and at turgor loss were lower in seedlings given 38 days of water deficit. Pinitol, fructose and glucose were higher, and myo-inositol was lower, in seedlings subjected to water deficits. Pt-inoculated seedlings had higher Pn at peak water deficits, lower osmotic potentials at full turgor and at turgor loss, and lower myo-inositol compared to noninoculated seedlings.

297 (PS 13)

STRATEGIES FOR SHORT AND LONG-TERM RECRUITING IN HORTICULTURE

Elizabeth A. Sluzis*, Valencia Libby, George Whiting and Stephanie Cohen, Department of Landscape Architecture and Horticulture, Temple University, Ambler, Pa. 19002-3994.

Although many programs nationwide have had continually declining horticulture enrollments, our programs have increased. The Department of Landscape Architecture and Horticulture at Temple University has developed effective recruiting techniques using a variety of methods. Several different methods of reaching potential students are used, including brochures, presentation of programs at middle and high schools, a movable visual display highlighting learning and careers in horticulture and design, ads in trade journals, regional newspapers and on the University radio station and excellent exposure to the public with award-winning exhibits in the nationally renowned Philadelphia Flower Show. An ongoing Lecture Series showcasing well-known horticulturists and landscape architects is open to the public. This, plus continuing education courses, serves the community and our program as well. Enrollment has been slowly increasing due to our extra efforts over the last ten years.

298 (PS 12)

EFFECTS OF ROOT OXYGEN DEPRIVATION ON GROWTH AND DEVELOPMENT OF KENTUCKY COFFEETREE SEEDLINGS

C.C. Fu and C.J. Starbuck*, Department of Horticulture, University of Missouri, Columbia, MO 65211.

Greenhouse studies were conducted to determine effects of root oxygen deprivation on root and shoot growth of Kentucky coffeetree (Gymnocladus dioicus L.) seedlings. Leaf surface area, shoot dry weight and root dry weight of trees cultured in water with <2 ppm [O_2] were significantly lower than of those grown in water with >6 ppm [O_2]. Trees grown in water with >6 ppm O_2 also exhibited greater taproot elongation than those grown in water with <6 ppm [O_2]. The thresholds of [O_2] for lateral root development on root segments 6-9 and >9 cm from the base of the cotyledon (including the root tip) were 2 and 4 ppm, respectively. Significant lateral root development did not occur in water with < 6 ppm [O_2].

293 (PS 13)

AN INTEGRATED PEST MANAGEMENT EXTENSION PROGRAM FOR NURSERY PRODUCERS IN SOUTH CAROLINA

J.T. Moody* and M.C. Halbrooks, Department of Horticulture, Clemson University, Clemson, SC 29634-0375

The ornamental horticulture industry in South Carolina has expanded significantly over the last decade. Today, concerns regarding environmental and public health, and stricter regulations of pesticide use, are creating incentives for growers to evaluate alternative methods of pest control. Nursery producers currently use an array of chemicals in an attempt to control pests including insects, weeds, and diseases. Integrated pest management (IPM) provides an opportunity to reduce chemical reliance. The overall objective of this extension program is to collect and collate information relevant to the implementation of an IPM program. The first year, 1989 - 90, surveys were developed to determine: how receptive and knowledgeable growers were about IPM; to ascertain current methods

of pesticide application and scouting; and to identify potential cooperators in the program. Ten nurseries representing 858 acres were selected to he scouted bi-weekly during the first season. Types of data collected included: key pest species; pest-plant relationships; grower action responses to pest problems; types and frequency of pesticide use. The second year, 1990 - 91, will involve implementation of IPM strategies such as: cultural methods; use of horticultural oils, soaps, and lower risk pesticides; and spot treatment applications to help maintain pest populations below economically damaging levels.

300 (PS 12)
INFLUENCE OF LIGHT INTENSITY ON LEAF PHYSIOLOGY AND PLANT GROWTH CHARACTERISTICS OF PHOTINIA X FRASERI

Jeffrey G. Norcini*, Peter C. Andersen, and Gary W. Knox, University of Florida/IFAS, AREC, Monticello, FL, 32344

Leaf physiology and plant growth of Photinia x fraseri Dress were assessed when grown under 100% sun or polyethylene shade with a light transmittance of 69, 47, or 29% sun. Plants in 29% sun usually had the lowest rates of net CO2 assimilation rate (A); consistent differences in A did not occur among the other three treatments. Net CO2 assimilation rate was most dependent upon photosynthetic photon flux (PPF; R2=0.60) whereas stomatal conductance to water vapor was primarily influenced by vapor pressure deficit (R2=0.69). Light saturated A was achieved at » 1400 µmol m-2 s-1 for 100% sun-grown plants. Under 29% sun, plants had a lower light compensation point and a higher A at PPF < 800 µmol m-2 s-1; however, plants under 100% sun manifested higher A at PPF > 1400 µmol m-2 s-1. Total growth was best in 100% sun in terms of total leaf area, number of leaves, and dry wt (total, stem, leaf, and root), even though plants from all treatments were about the same size by the end of the experiment. Plants in all treatments had acceptable growth habit (upright and well-branched), however plants grown in 29% sun were too sparsley foliated to he considered marketable.

301 (PS 13)
ENVIRONMENTAL LANDSCAPE MANAGEMENT

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Environmental Landscape Management (ELM) is an extension education program developed to promote resource conservation and environmental protection through appropriate landscape design and maintenance practices. Use of ELM practices by Florida home owners and landscape professionals will conserve energy and water, recycle yard wastes, and reduce inputs of fertilizers and pesticides. Site analysis and appropriate landscape design and plant selection are inherent components of ELM. Guidelines for ELM integrate irrigation, fertilization, pest control, recycling of yard wastes and other cultural practices to result in a holistic approach to landscape management.

Five videos, 3 slide sets, 20 newspaper releases, and a 45-page booklet, The Florida Environmental Landscape Guide, have been produced to support ELM. This information also will be available on CD-ROM in each county extension office.

302 (PS 12)
ANALYSIS OF TREE GROWTH RESPONSES TO THEIR ENVIRONMENT.

Steven C. Wiest*, David L. Hensley, James Robbins, Charles E. Long and John C. Pair, Kansas State Univ., Dept. Horticulture, Manhattan, KS 66506

Height and girth growth of Crataegus crus-galli var. inermis, Fraxinus excelsior 'Kimberly', Pistacia chinensis, Pyrus calleryana 'Aristocrat', and Quercus shumardi was measured vernally at 6 diverse locations in Kansas from 1984 to 1988. Correlation of growth with various environmental parameters was made using polynomial, Fourier and power series, logarithmic and exponential regression. Results suggest that F. excelsior and P. chinensis were less sensitive to precipitation during the growing season than were other species. Additionally, growth of most species was inversely correlated to the highest minimum air temperature during the winter prior to the growing season. We believe that this portion of an ongoing comprehensive study, related to identifying trees compatible with harsh environments, will, upon further development, allow the prediction of species which will do well in a known micrometeorological environ.

303 (PS 13)
USING WILLOW CUTTINGS AS AN EASY AND INEXPENSIVE MEANS OF DEMONSTRATING GRAFTING TECHNIQUES.

Gerald L. Klingaman, Plant Science 314, University of Arkansas, Fayetteville, AR 72701

Teaching the art of grafting to new undergraduate horticulture students is an important part of propagation training. Students often lack the experience necessary in grafting to successfully graft traditional nursery rootstocks. Expertise in grafting can only be achieved through repetition; however, ever-shrinking budgets for teaching supplies seriously limit the amount of material available for classroom use. A simple, widely available, inexpensive and successful plant to use in demonstrating the principles of grafting is any of the various *Salix sp.* used as ornamental plants. Scions may be grafted together using various grafting procedures, grafting tapes and/or waxes or callus inducing treatments. Callus formation on unrooted scions will occur in 2 weeks at room temperature. The grafts may then be rooted as hardwood cuttings. Achieving a high percentage success is important in encouraging any aspect of student training. Success rates for this plant approach 100% even for inexperienced students.

304 (PS 14)
PURIFICATION AND SOME PROPERTIES OF ALPHA-AMYLASE OF PEAR FRUIT

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Alpha-amylase was purified from freeze-dried pear fruit by extraction at pH 7.40 with Tris, Acetate and Imidazole buffer followed by differential ammonium sulfate precipitation and desalting column. The specific activity of the enzyme was increased 5.68 fold during purification. The optimum pH was 5.64 in Acetate buffer. The difference in the time course of alpha-amylase was observed between freeze-dried and fresh samples.

305 (PS 13)
CONCEPTS OF AN ACADEMIC COURSE IN PUBLIC GARDENS DEVELOPMENT AND MANAGEMENT

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New public gardens are being created at an unprecedented rate across the U.S. and older gardens are expanding and entering new areas of responsibility. A special topics course was developed and taught to make students aware of the potential job opportunities in this field, and to provide knowledge and skills which would benefit graduates in working in a public garden and in servicing such gardens professionally as an outside consultant. The course covers such topics as creating a mission statement, design and master planning concepts, plant collections, records, labelling, interpretation, administration, fund raising, plant introduction programs, conservation issues, etc. Practical work experience in the NCSU Arboretum and field trips to assorted public gardens were offered. Details of course content and the teaching manual development for the course will be on the poster display at the ASHS meeting.

306 (PS 14)
TOTAL LIPID AND FATTY ACID CONTENT OF POLLEN FROM SEVERAL SPECIES

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Hydration of various pollens over saturated salt solutions demonstrated that pecan (Carya illinoensis) pollen equilibrated at a lower moisture content than any of the other pollens tested. Other experiments conducted with Fourier Transform infrared spectroscopy indicated this might be a result of a high lipid content. We are extracting pollen lipids to determine the bulk lipid content and the individual fatty acids making up this component of Pinus ponderosa, Piceapungens, Corylus avellana, Typha latifolia, Phoenix dactylifera, Zea mays, and Carya illinoensis. Preliminary results indicate that bulk lipid content of pecan pollen may be as high as 12-16%. We are also extracting the lipids from different pecan varieties to determine if lipid content varies among them to any great extent.

307 (PS 13)

MARKET GARDENING RESEARCH AND DEVELOPMENT IN THE GAMBIA

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Vegetable gardening in The Gambia provides an important supplemental income for women farmers who grow tomato, onion, cabbage and other vegetables for sale on the local market, to restaurants and for export to Europe. Government and international agencies provide research and technical support, while non-governmental organizations (NGO's) provide production capital (such as wells) and marketing support. Production problems include pest management and the labor intensity of hand irrigation and harvesting. Growers cite low prices as their greatest constraint. Small local canning facilities may help alleviate market gluts and extend marketing and consumption opportunities beyond the fresh market production season.

308 (PS 14)

OVULE PERFORATION: A NEW TECHNIQUE TO INCREASE GROWTH OF IMMATURE PEACH *(Prunus persica* L. Batsch) EMBRYOS IN VITRO

Alberto C.O. Pinto*, Suzanne M.D. Rogers and David H. Byrne
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Peach (P51-2) embryos (4 mm) were cultured in vermiculite support (VS) to evaluate growth in perforated and non perforated ovules. Monnier, and SH media containing 120 g/l sucrose and no hormones or IAA (0.25 mg/l or 0.50 mg/l) both with kinetin (0.01 mg/l) were tested. In another study, 'Goldprince' embryos (4 mm) were cultured in perforated ovules or in endosperm nurse tissue. The media used were Monnier, SH or SH + glutamine (400 mg/l), each with 120 g/l sucrose in VS system. The highest embryo lengths were obtained by ovule perforation treatments, regardless the media used. Embryos of P51-2 cultured in ovule perforation with Monnier and hormones (0.5 mg/l IAA + 0.01 mg/l kinetin) were twice as long as the best non perforation treatment. SH + glutamine (400 mg/l) was not effective for promoting growth of 'Goldprince' embryos with either ovule perforation or endosperm nurse. Ovule perforation may be an effective method for promoting growth of immature (< 5 mm) peach embryos.

309 (PS 13)

PRECODEPA: A MULTI-COUNTRY DEVELOPMENT PROGRAM TO IMPROVE THE RESEARCH-EXTENSION INTERFACE FOR POTATO PRODUCTION IN THE TROPICS

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PRECODEPA was formed with the purpose of coordinating research and extension to improve small-farm potato production. The program involves 9 countries in North, Central America and the Caribbean with the cooperation of the International Potato Center (CIP). Research and extension work was planed based on identified bottlenecks. Work was coordinated when similar bottlenecks were identified in different regions and/or countries. The project strategies emphasized the following: training of personnel to coordinate the work between extension and research; development of integrated pest management (IPM) practices; technology generation and validation trials on farmers' fields, and market development for commercialization purposes. The success of this unique program should serve as a model for similar agricultural projects in the future.

310 (PS 14)

CONSTRUCTION OF A cDNA LIBRARY FROM APPLE FRUIT TISSUE

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The construction of cDNA libraries from apple fruits is complicated by the low abundance of RNA and large amounts of contaminating polysaccharides. To overcome these problems, we extracted 400 grams of apple 'York Imperial' fruit tissue in Tris-guanidine isothiocyanate buffer, and purified the RNA by sedimentation through cesium chloride cushions. We purified mRNA from the total RNA using oligo-dt cellulose followed by ethanol precipitation. The procedure yielded 1.3 mg of total RNA and 24 µg of polyA mRNA from the initial 400 g of tissue extracted.

The synthesis of cDNA from the polyA mRNA was accomplished using the Amersham cDNA Synthesis Plus System. We monitored both first and second strand synthesis by setting up duplicate reactions (5mg mRNA/rxn) and measuring the incorporation of (^{32}P)dCTP into cDNA. The cDNA was inserted into a λ gtll phage expression vector. The phage were grown on an E. *coli* Y 1090 host strain in the presence of IPTG and X-gal. The resulting library had 160,000 phage with 81% recombinants. The library is presently being screened for cDNA clones to ACC synthase and calmodulin. These findings will also be discussed.

This work was supported by the Pennsylvania Department of Agriculture contract no. 448145.

311 (PS 13)

EDUCATIONAL TELEVISION NETWORK: AN EFFECTIVE, DELIVERY SYSTEM FOR HOME HORTICULTURE INFORMATION

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"Backyard Farmer" is a Cooperative Extension Service (CES) television programs which air one night a week on the Nebraska Educational Television Network (ETV). This one-hour program which airs throughout the lawn and gardening season from approximately April 1 to September 1 each year. For 39 years a live call-in format has provided the setting in which a panel responds to viewers' questions on the air. The panelists are Extension specialists in horticulture, entomology, plant pathology and agronomy.

Feedback from the target audiences was desired to evaluate the effectiveness of these two programs. The primary questions being raised were: 1. Is "Backyard Farmer" a viable program which Cooperative Extension should continue? 2. If so, how can Extension better work within the given structure and with the available resources? 3. If so, are there changes or adaptations needed in the program?

In July 1985, telephone interviews were conducted with a random sample of Nebraska households to evaluate the viewers' reactions lo both the format and the content of the program. In 1990, a follow-up to this survey was made.

A summary & interpretation of the findings will be shown.

312 (PS 14)

INTRODUCTION AND EXPRESSION OF GUS AND NPTII GENES IN PECAN SOMATIC EMBRYOS

J. Austin Burns*[1], Dayton Wilde[2], Hazel Y. Wetzstein[1], and Scott A. Merkle[2], Department of Horticulture[1] or School of Forest Resources[2], University of Georgia, Athens, GA 30602.

Highly repetitive somatic embryos and callus of pecan, *Carya illinoensis*, (Wetzstein et al. 1989) were exposed to kanamycin selection medium and assayed for the suppression of secondary embryogenesis. Concentrations of kanamycin which yielded suppression were defined. The developmental condition of the cotyledons was found to play a critical role in the selectivity of the system. Callus and somatic embryo cotyledons were bombarded with DNA-coated tungsten particles in the DuPont Biolistic™ PDS-1000. The foreign DNA (pBI121.1) contained a CaMV35s promoter upstream of the GUS (β -glucuronidase) gene and a 5[1] nos driven NPtII (neomycin-phosphotransferase II) gene for kanamycin selection. Cotyledons were cultured on selection medium for several months post bombardment. GUS expression was present but variable among secondary embryos produced on medium containing kanamycin.

313 (PS 13)

UNDERGRADUATE STUDENTS EXPOSURE TO HISTORICAL HORTICULTURE

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A survey was distributed to the Horticulture Club faculty advisors at the ASHS member institutions in the U.S. The objective of the survey was to access the appreciation undergraduate horticulture students have for historical figures in horticulture. Ten departments responded to the survey with a total of 133 students participating. The majority of students (62%) were juniors or seniors. Students were asked to recognize, recall or associate individuals with their significant horticultural contributions. Fifteen historical figures were selected with a bias for 7 individuals having a high potential for recognition, 7 having a low potential for recognition and one control individual having no association with horticulture. Responses to the survey followed the expected bias with a greater number of students recognizing individuals from the 'high potential for recognition' group. However, a majority of students (> 50%) recognized only two individuals, Gregor Mendel and Carl Linneaus. The ability of students to recognize Liberty Hyde Bailey was surprisingly low (≤ 30%). The results from this survey indicated that students can have an interest and ability to identify historical figures involved in Horticulture, however, their exposure to these individuals through current course work is limited.

314 (PS 14)
EFFECTS OF SOMATIC EMBRYO MORPHOLOGY ON CONVERSION INTO PEANUT PLANTLETS
Charleen M. Baker* and Hazel Y. Wetzstein, Department of Horticulture, Plant Science Building, University of Georgia, Athens, GA 30602

Somatic embryos were initiated from immature peanut cotyledons (Arachis hypogaea cv. AT127) on a modified MS medium with either 5, 10, 20 or 40 mg/l 2,4-D. Two months after initiation of the cultures, embryos were categorized into 6 developmental classes based on single vs fused embryos, well-defined vs distorted axis and well-defined vs no apex. Embryos were placed on a hormone free medium for conversion into plants. Data were taken for nongerminated (no root production), germinated (root production) and converted (leaflets and roots) embryos. Embryo class did not influence percent of nongerminated embryos. Embryos with the poorest apex development had the best germination percentages, but the poorest conversion into plants. Single embryos converted to form plants with one shoot whereas fused embryos formed branched plants. Plants have been transferred to the greenhouse for further observations.

315 (PS 14)
PEG EFFECTS ON GROWTH AND WATER LOSS OF MICROPROPAGATED GRAPE
Imed Dami* and Harrison Hughes, Department of Horticulture, Colorado State University, Fort Collins, CO 80523

Polyethylene glycol (PEG, MW 8000) was used to induce water stress in grape cv. Valiant in vitro. Use of PEG at 2, 4, and 6% (w/v) during rooting in vitro reduced growth and slowed rooting. At the 2% level plantlets recovered and made satisfactory growth. Water loss as measured by air drying of detached leaves was used to compare control (no PEG) and the 2% PEG treatment. After 1 hr, over 80% of leaf moisture was lost in the control which was double that of the PEG treatment. After 4 hrs, approximately 99% moisture was lost in the control as compared to 78% in the PEG treatment. Relative cuticular wax levels between the 2 treatments are currently being evaluated.

316 (PS 14)
LEAF ANATOMY OF MICROPROPAGATED GRAPE AFFECTED BY REDUCED WATER POTENTIAL
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Grape cv. Valiant was micropropagated in an MS medium with and without 2% (W/V) of polyethylene glycol (PEG, MW 8000). Leaf anatomy of control (in vitro, no PEG), treated (in vitro, PEG), field grown and greenhouse grown plants were compared under light microscopy. Cell size, palisade layer formation, relative intercellular air space and apparent chloroplast number varied between the leaves of control and PEG treated (high osmoticum) plantlets. These leaf characteristics in the high osmoticum medium appeared more similar to the leaves of the greenhouse and field grown plants. Leaves from control plantlets contained cells of larger size, lacked normal palisade layer formation, greater intercellular pore spaces and fewer chloroplasts. Leaves of PEG treated plantlets had smaller cells, a more defined palisade layer, reduced intercellular pore spaces and greater number of chloroplasts. Leaves of greenhouse and field grown plants had small cells, a well-defined palisade layer, least intercellular pore space and greatest number of chloroplasts. These results demonstrate that a high osmoticum medium may be used to induce more normal leaf development.

317 (PS 13)
AN INEXPENSIVE TEACHING LABORATORY EXERCISE TO INDUCE CARBON DIOXIDE DEFICIENCY IN PLANTS
David R. Hershey, Department of Horticulture, University of Maryland, College Park, MD 20742-5611

A common teaching exercise involves solution culture of plants to induce nutrient deficiencies. However, CO_2 deficiency is rarely demonstrated in such exercises although it can be more easily induced than many of the micronutrient deficiencies since purification of nutrient solutions is not required. A simple CO_2 deficiency apparatus is built with six, 2-liter soda bottles; two, 1-liter soda bottles; aquarium tubing; Z-hole, number three rubber stoppers; calcium hydroxide; an air pump; a twist tie; electrical tape; aluminum foil; plastic straws; an aquarium valve; and a complete nutrient solution. Air, scrubbed of CO_2 by bubbling through two bottles of calcium hydroxide solution, is pumped into nutrient solution contained in a solution culture system built from the two, 1-liter soda bottles. The solution culture system is sealed inside a 2-liter soda bottle using electrical tape and twist-tie wire. Tolmiea menziesii and Brassica rapa (Wisconsin Fast plants) grown in such a CO_2 deficient system grew poorly or died while plants thrived in a system with water replacing the calcium hydroxide solution.

DETERMINATION OF OPTIMUM INOCULATION LEVELS OF MELOIDOGYNE INCOGNITA FOR TOMATO AND PEACH UNDER IN VITRO CULTURE CONDITIONS
G. Hashmi* and L. Krusberg, University of Maryland, College Park, MD 20742, and R. Huettel and F. Hammerschlag, USDA/ARS, PSI, Beltsville, MD 20705

In order to either develop genetically modified plants or to select somaclonal variants with root-knot nematode (Meloidogyne incognita) tolerance or resistance under in vitro conditions, optimum nematode inoculum levels should be known. Penetration of second stage juveniles (J2s) of M. incognita in tomato (Lycopersicon esculentum) root explants and in vitro-propagated peach [Prunus persica (L.) Batsch] plantlets were compared at five levels of inoculum (25, 50, 75, 100 and 200 J2s for tomato and 50, 100, 200, 500 and 1000 J2s for peach). In tomato, the greatest percentage of root penetration was 30% at the 75 J2 level, whereas in peach, the maximum penetration was only 8% at the 200 J2 level. This significant difference ($P<0.05$) in penetration rate of M. incognita (at all concentration levels) into these two hosts indicates that optimum nematode levels for in vitro screening need to be determined on a species to species basis.

319 (PS 13)
USING INDEPTH COURSES AS A TEACHING TOOL IN EXTENSION
Wesley L. Kline* and Shirley T. Kline, USAID/Honduras/ARDO, APO Miami, FL 34022

The use of indepth short courses has been used in New York to increase technical and managerial expertise of growers, agribusiness personnel, consultants and extension agents. The short courses, Indepth Management Program for Vegetables Storages, Soil Fertility, and Basic Greenhouse Production, were designed around two to five days of instruction. University faculty, extension specialists, industry experts and experienced growers have been used as presenters. The use of growers from another region lended credibility to the course. Hands on experience and a notebook of reference materials reinforced lecture presentation.

Matching participants' level of expertise to the level of instruction has been a major challenge. Detailed course description help to alleviate the problem of overwhelming some and boring others. The use of advisory groups to decide course offerings and content addresses industry needs.

Indepth courses must be offered during times of low labor and managerial demands, scheduling around traditional vacations, school holidays, and other meetings. Courses should be scheduled early in the meeting season to avoid participants becoming tired of too many meetings. Three sessions is the maximum for consistent attendance in our experience.

320 (PS 14)
PHENOTYPIC STABILITY OF BACTERIAL LEAF SPOT RESISTANCE IN PEACH REGENERANTS UNDER GREENHOUSE AND FIELD CONDITIONS
F.A. Hammerschlag*, USDA/ARS, Beltsville, MD 20705 and D. Ritchie and D. Werner, Dept. of Plant Pathology and Dept. of Horticultural Science, North Carolina State University, Raleigh, NC 27695-7609

Phenotypic stability of bacterial leaf spot (Xanthomonas campestris pv. pruni) resistance in peach regenerants derived from toxin-selected and unselected cell cultures was investigated. A detached-leaf bioassay was used to evaluate the original regenerants rescreened after two or more years in the greenhouse and to evaluate plants following a two-year tissue culture propagation cycle. Leaf defoliation (over a two year period) from regenerants under field conditions was also evaluated. Both greenhouse and field studies indicated that although leaf spot resistance was retained in some regenerants, resistance was only transient in nature in other regenerants. This research provides additional evidence that selection at the cellular level and/or screening regenerants at the whole plant level for bacterial spot resistance is a feasible approach to obtaining much needed useful variation.

321 (PS 13)
PROJECT LEAP: A CONCEPTUALLY BASED BIOLOGICAL SCIENCES CURRICULUM FOR ELEMENTARY GRADES K-6
Donald A.Rakow* and James M. Affolter, Department of Floriculture and Ornamental Horticulture. 20 Plant Science Building, Cornell University, Ithaca, NY 14853.

Cornell Plantations with National Science Foundation funding and in conjunction with academic resources of Cornell University, has developed a K-6th grade level curriculum for the biological sciences. Based on the theory of conceptual change learning, the curriculum challenges students to identify their initial conceptual framework regarding

particular phenomena, engages them in guided explorations, then allows them to refine their earlier misconceptions. Through the use of concept mapping, students also learn about the interrelationship of plants and animals in the natural environment. This presentation will focus on: the organization of the curriculum, its relation to a state mandated syllabus, and materials for teacher training.

322 (PS 14)

GENE EXPRESSION IN PECAN SOMATIC EMBRYOS

Amnon Levi*, Hazel Y. Wetzstein, Department of Horticulture, Plant Science Building, University of Georgia, Athens, GA 30602 and Glen A. Galau, Department of Botany, University of Georgia, Athens, GA 30602.

Repetitive somatic embryogenic lines of pecan *(Carya illinoensis)* were obtained and subcultured on basal WPM, following a one week induction of zygotic embryo tissue on modified WPM with 6 mg/L NAA. Gene expression of somatic embryos has been studied and compared with that occurring in zygotic embryos. Somatic embryos simultaneously expressed mRNA classes that are specific to each of the zygotic embryo cotyledon (Cot), maturation (Mat), and post abscission stages (Late embryogenesis, Lea). Somatic embryos exhibiting such multiple, nonregulated gene expression patterns have a low germination rate. Treatments found to enhance embryo germination (cold and desiccation) may be effective in part, by modifying gene expression patterns. Some of the Cot and Mat mRNA classes decreased following such treatments, while Lea mRNAs were not effected. Cold and desiccation treatments appear to coordinate gene expression in pecan somatic embryos, which might be associated with embryo germination.

RETAINING MASTER GARDENER VOLUNTEERS

Larry Stouse* and Charles Marr, Department of Horticulture, Kansas State University, Manhattan, KS 66506

Master Gardener volunteers in Johnson County, Kansas assist in the Extension educational programs for the 300,000 residents of this southwestern Kansas City suburban area. The Johnson County Master Gardener program, started in 1980, has excellent retention of volunteers with over 35% of the volunteers still active from the original classes over a decade ago. Retaining volunteers offers advantages of increased knowledge of volunteers with experience, "advertising" the program in the community to recruit new volunteers, and serving as mentors for new volunteers. Retention is encouraged by emphasizing that volunteer hours are an opportunity for further learning rather than a "payback" for training received. An advisory board and committee structure encourages ownership of the program by volunteers. A structured advanced training program is offered and an emphasis is placed on establishing a variety of quality volunteer opportunities. Abilities and skill levels of new volunteers in areas such as woodworking, photography, arts, speaking, or similar skills are immediately assessed and put to use in addition to horticultural abilities and knowledge. A "mentor" program encourages blending of new class members with advanced volunteers in activities and discussions of activities and projects. Applicants for new class volunteers are screened with class size held to 20-25 participants.

324 (PS 14)

SOMATIC EMBRYOGENESIS AND PLANT REGENERATION FROM IMMATURE COTYLEDONS OF WATERMELON

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Cotyledon explants from immature embryos of Allsweet, Crimson Sweet, Jubilee II, Minilee and the breeding line FLA587 Gate were plated on MS medium with 3% sucrose, B5 vitamins and 0.7% T.C. agar, containing test concentrations of the plant growth regulators (PGR) 2,4-D (10, 20 and 40µM) and either 0.5µM BA or 0.5 µM thidiazuron (TDZ), and incubated in the dark for 3 weeks. Controls consisted of MS medium without PGRs. Somatic embryos, some with well developed cotyledons and hypocotyls, were observed on cotyledon explants of Allsweet, Crimson Sweet, FLA587 Gate and Minilee 3 to 4 weeks after transfer to MS medium without PGRs. Somatic embryos were most frequently observed on cotyledons from medium with 0.5µM TDZ and 10 or 20µM 2,4-D. Somatic embryos germinated on MS medium without PGRs and the resulting plantlets were transferred to Magenta boxes that contained autoclaved ProMix. The whole procedure, from explant initiation to transfer to soil, required approximately 15 weeks.

325 (PS 13)

DEVELOPING MULTIMEDIA EDUCATIONAL SOFTWARE

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Recent advances in computer software now enable non-computer programmers to design and develop interactive multimedia educational programs. "Authorware", a sophisticated software package facilitates program development through the use of object oriented programming (moving icons). These modules can include color photos, live action video, animation, audio, and text. Combined with other database programs, one can access large quantities of information. A pilot project has been developed which integrates scanned color photos of perennials with a description of their attributes. Based upon user defined parameters, the data base is searched. All plants meeting the requirements are listed and presented on the computer screen. Ease of use and visual quality of the presentation combine to create user-friendly and exciting computer applications for non-computer literate individuals.

326 (PS 14)

SEMIPERMEABLE COVERS ENHANCE STOMATAL FUNCTION AND PHOTOSYNTHESIS OF IN VITRO-CULTURED TOBACCO.

Farida Safadi*, Jack Morgan and Harrison Hughes, Department of Horticulture, Colorado State University and Crops Research Laboratory, USDA-ARS Fort Collins, CO 80523

Semipermeable caps (SPC; Suncap closure, Sigma) for tissue culture jars were compared with the plastic B-caps (Magenta) relative to the following factors: leaf surface conductance response to (1) high and low RH (2) low and high CO_2, (3) darkness; CO_2 content of the jars; photosynthetic capacity. Leaf surface conductance of plantlets covered with SPC showed lower conductance at 30%, 50%, and 70% humidity levels and a faster response to high and low CO_2 content and darkness thus indicating enhanced stomata1 function. The CO_2 content of vessels with SPC was consistently lower after a period of darkness and higher after a period of light. This is indicative of better gas exchange. Photosynthetic ability of the plantlets from vessels with SPC was higher than that of the plantlets from the B-Cap covered jars. The decreased conductance and improved photosynthesis may enhance acclimatization of plantlets to ex vitro conditions.

327 (PS 13)

CLAUDE MONET AND HIS GARDEN: HOW FLOWERS INFLUENCED IMPRESSIONIST PAINTING

Laura Paine* and Helen C. Harrison, Department of Horticulture, University of Wisconsin, Madison, WI 53706.

Throughout history, art has reflected the values and relationships of the culture from which it springs. Among European artists, until quite recently, the natural world has been little more than a backdrop in painting styles whose purpose was to portray societal values. In the mid-nineteenth century, however, the exclusive use of religious and philosophical themes gave. way to a completely different approach to painting. The Impressionist Movement focused on portraying our natural surroundings and the beauty of the ordinary features of everyday life. The Impressionist artist painted outdoors (this was a revolutionary ides at that time), using color and light to quickly capture a moment in time, rather than meticulously reconstructing a scene in the studio. Natural themes were the essence of this painting style. Claude Monet is considered by many to be the father of the Impressionist Movement. And it was the garden that gave this artist his greatest inspiration. Monet's garden at Giverny, where he lived the last 43 years of his life has been restored and is now a French National Monument. Today, we can visit the garden that inspired so many of his paintings and gave rise to the unique style that became the standard for Impressionism. Two years before his death, Monet reflected on the influence of the garden on his life and his work: "I perhaps owe having become a painter to flowers" (Claude Monet, 1924. In Joyes, C. Monet at Giverny, p. 36. Mathews Miller Dunbar, London. 1975.)

328 (PS 14)

SEX SHIFT AMONG REGENERATED SPINACH PLANTS

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Leaf-derived spinach *(Spinacia oleracea* L.) callus was initiated on MS medium containing 2 mg L^{-1} kinetin and 0.5 mg L^{-1} 2,4-D in darkness at 20± 3C. Male and female plants served as a source of explants. Callus differentiation was induced on a medium containing 2 mg L^{-1} kinetin, 0.01 mg L^{-1} 2,4-D, and 1 mg L^{-1} G A_3. Regenerated shoots were transferred onto a hormone-free medium solidified with 8 g L^{-1} Phytagel for root induction. The shoot cultures were exposed to a

long-day photoperiod (13 h) for flower induction. The sex of the regenerated plants was determined by flower morphology. Most regenerated plants exhibited sex corresponding to their respective explant donors; a proportion, however, were monoecious. Sex shift of regenerated plants could be useful in performing inter-regenerate crossing; thus, obtaining seeds from selected plants, regardless of their sex, is rendered possible.

329 (PS 15)

CHARACTERISTICS OF Prunus serotina FLOWER BUDS

Sorkel Kadir* and E. L. Proebsting, WSU-Prosser, WA 99350

Prunus serotina is a member of sub-genus Padus, which includes *Prunus padus* and *Prunus virginiana.* The subgenus is characterized by large racemose inflorescences that have been reported to freeze without deep supercooling. DTA results showed that the flower buds produced two exotherms, high temperature exotherms (HTE_x) and low temperature exotherms (LTE_x). The inflorescences deep supercool as LTE_x were produced from intact and detached inflorescences. *Prunus serotina* dormant inflorescences freeze as a unit and not as individual florets. Our preliminary results showed that XV were restricted to the base of the dormant flower buds and did not run the length of the inflorescence in contrast to *Prunus padus* and *Prunus virginiana.* The absence of XV elements within the inflorescence apparently prevented the spread of ice into the bud, thus facilitated deep supercooling. Dormant buds stored at -7°C resulted in the disappearance of both high and low temperature exotherms, while buds stored at +3°C exhibited HTE_x (-7.8 to -10.4 °C) and LTE_x (-23 to -25°C).

330 (PS 14)

DIRECT ADVENTITIOUS SHOOTS FROM LEAF SEGMENTS OF DENDRANTHEMA GRANDIFLORA TZVELEV.

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Leaf midrib segments (ca. 5 x 5 mm) of five cultivars of Dendranthema grandiflora were cultured on MS medium supplemented with either 0, 0.01, 0.1, 1.0 or 10.0 µM BA, 2iP, kinetin or TDZ and 11.5 µM IAA. 'Iridon' and 'Hekla' produced the greatest number of directly formed shoots from the margin of explants on medium containing BA and IAA. On this medium root and callus formation were suppressed. 'Rave' produced few shoots and 'Adorn' and 'Goldmine' were not responsive to any treatment. The greatest number of shoots from 'Iridon' explants could be induced with a BA and IAA treatment for either 14 or 17 days followed by transfer to MS lacking growth regulators. The position of the explant within the leaf did not significantly influence the number of shoots formed. Nearly 100% of the shoots rooted in basal medium. Cefotaxime (100 µg/ml) did not significantly influence the number of shoots formed; however, shoots produced on kanamycin (>12.5 µg/ml) medium were white. Leaf segments co-incubated with Agrobacterium tumefaciens formed copious amounts of callus.

331 (PS 15)

SEASONAL PATTERNS OF COLD HARDINESS AND POLYPEPTIDES IN BARK AND XYLEM OF GENETICALLY RELATED (SIBLING) DECIDUOUS AND EVERGREEN PEACH TREES.

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Deciduous fruit trees undergo endo-dormancy during fall at which time they also attain maximum cold hardiness (CH). Because these two processes occur simultaneously it is difficult to study them independently. We have been able to overcome this limitation with the use of genetically related (sibling) deciduous and evergreen peach trees. Using this system we conducted a time course study to characterize the seasonal fluctuations in CH and proteins in bark and xylem tissues. Cold hardiness (LT_{50}) was assessed using electrolyte leakage method. Polypeptides were separated using SDS-PAGE. The data indicated that 1) CH of bark increased from -5°C (in August) to -49°C (in January) and from -3°C to -22°C for deciduous and evergreen trees, respectively. In January, under favorable conditions, evergreen trees were actively growing. 2) CH of xylem successively increased from -11°C to -36°C in deciduous trees and from -7°C to -16°C (in November) in evergreen trees and then plateaued. 3) LT_{50} of xylem in both genotypes closely approximated the mid-point of low temperature exotherms determined by differential thermal analysis. 4) As CH increased several qualitative and quantitative differences in polypeptides were noted between two genotypes. These changes during cold acclimation will be compared with those during de-acclimation.

332 (PS 14)

IN VITRO GERMINATION AND DEVELOPMENT OF SHOWY LADY SLIPPER ORCHID (CYPREPEDIUM REGINAE Walt.) SEEDS.

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Green pods of the C. reginae orchid were collected from a bog near Ithaca, NY. Pods were surface sterilized, and seeds were plated on agar media. The 8 germination treatments were arrange in a complete 3 way factorial consisting of 2 basal media (fish emulsion, FE vs. yeast extract, YE), 2 media pHs (4.8, 6.8), and 2 temperature regimes (constant 24 C vs. 6 wks. at 5 C prior to transfer to 24 C). Sequential stages of development included embryo enlargement and rupture of the testa (1), root elongation (2), leaf primordium development (3) and finally rhizoid development with or without protocorm greening (4). After 4 months post sowing, germination (stage 1 or beyond) was 56% and 0% on FE at pH 4.8 and 6.8 respectively, and 45% and 78% on YE at pH 4.8 and 6.8 respectively. Protocorm development from unchilled seeds after 4 months was greatest on YE at the lower pH, with 14% reaching stage 3 or 4, as contrasted to only 5% reaching stage 2 (none beyond), for the other germinated treatments. Chilled seeds had higher germination for all treatments but no development beyond stage 1 at 4 months post sowing.

333 (PS 15)

INTERACTIONS BETWEEN PEACH AND TALL FESCUE ROOTS

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The objective of these greenhouse studies was to determine what soil water conditions are necessary to promote peach root growth in monoculture or in association with tall fescue. In split root systems, peach roots were unaffected by tall fescue when two conditions were met: a) the soil moisture was continually maintained at field capacity and b) when at least 50% of the peach root system resides in moist soil devoid of grass roots. Peach root initiation and growth are inhibited by water stress developed at the peach root surface in the presence of tall fescue roots. Peach roots growing in soil at field capacity devoid of grass roots can transport water to peach roots in regions where the soil water potential is less than field capacity. Through this mechanism of water transfer the peach tree can support root growth in the presence of sod when at least 50% of the root system resides in soil without grass roots.

334 (PS 14)

IN VITRO MICROPROPAGATION OF SELECTED CULTIVARS OF HOSTA

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Calli were initiated from immature inflorescences of selected cultivars of Hosta in the light on Hosta initiation medium (Carolina Biological Supply Company, 1986). Three cultivars, Francee, Birchwood Park's Gold, and Wide Brim Sum & Substance, produced microshoots. The calli were compact and green in color. The highest percentage of callus formation occurred with the Francee cultivar. Nakaiana, Golden Edger, Golden Scepter, Obscura, Sum & Substance, and Shade Fanfare produced only calli. The calli were transferred to modified Murashige and Skoog salts. The media containing 5 × 5 factorial combinations of NAA and BA (0.0, 0.1, 0.5, 1.0, or 2.0 mg/l). The results show that media with NAA at 1.0 and 2.0 mg/l in combination with BA from 0.5 to 2.0 mg/l produced the highest number of microshoots per explant.

335 (PS 15)

BUDBREAK AND PHYTOTOXICITY IN 'REDHAVEN' PEACHES INDUCED BY HYDROGEN CYANAMIDE AT DIFFERENT DORMANCY STAGES.

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Most of the rest-breaking chemical treatments are effective at concentrations near the lethal point. Treatments could delay or damage rather than accelerate bud development depending on concentration and application date. We evaluated the response of 'Redhaven' peach trees to several concentrations of hydrogen cyanamide at different dormancy stages with respect to budbreak and phytotoxicity.

H_2CN_2 (0.031, 0.062, 0.125, 0.25, 0.5, and l.0M) were applied to container-grown 'Redhaven' peach trees growing under natural conditions every 2 wks. After treatment trees were placed in a warm, long day (16 hr. photoperiod) greenhouse with supplemental light. The extent of budbreak, stem dieback, aborted and live buds were recorded. H_2CN_2 broke dormancy 8 to 12 days after application. In early stages and after termination of dormancy peach trees were more sensitive to H_2CN_2. Overall, concentrations from 0.062 to 0.25M were best for overcoming dormancy. Optimum concentration varied depending on the physiological stage of the plant.

336 (PS 14)

IN VITRO PRODUCTION OF ARTEMISININ FROM *ARTEMISIA ANNUA* L.

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Shoot proliferation of Artemisia annua L. was achieved in modified Murashige and Skoog medium supplemented with 1 .0 mg/liter 6-benzylamino purine (BA). Shoots removed from culture and dipped in 0.3% indolebutyric acid, rooted and acclimated to in vivo conditions using mist. Artemisinin was produced in vitro and ranged from 0.4 to 0.7 mg/g dry weight. Of four growth regulators tested (BA, kinetin, butanedioic-2,2-dimethylhydrazide, or chlormequat chloride), only BA at 1 .0 mg/liter and kinetin at 10.0 mg/liter increased yield of artemisinin in vitro but this effect was due to an increase in dry matter production which overcame a decrease in artemisinin content.

337 (PS 15)

THE TIMING OF PRUNING OF PEACH TREES ON FRUIT YIELD AND QUALITY, COLD HARDINESS, CARBOHYDRATE STATUS, AND ON THE INCIDENCE OF *CYTOSPORA* CANKER

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Fruit yield and quality measurements were taken from 10 year-old 'Newhaven' peach trees pruned at prebloom (preb), full-bloom (fb), and 2, 4, 6, and 8 weeks following fb. Trees were hand-pruned with dormant type thinning and heading cuts. Fruit weight and circumference tended to decrease from fb onwards, while fruit were firmer at fb+4 and fb+6 than at preb. Firmer peaches were also measured at fb+6 than at fb. Fruit color was measured on a tri-stimulus color scale. Value (L) indicated that lighter fruit occurred with pruning at preb, fb, and fb+4 weeks, while fruit were darker at fb+2, fb+6 and fb+8 weeks. Hue (a) indicated that trees being pruned at preb had redder fruit than those pruned at fb+2 or fb+8 weeks. Redder fruit were also measured at fb+6 than at fb+8 weeks. Chroma (b) indicated that peaches from trees pruned at fb+4 had the highest degree of yellow, while fruit from tree pruning at fb were more yellow than at fb+2, fb+6 and fb+8 weeks. Also being investigated are the pruning timing effects on cold hardiness and carbohydrate status of one year-old stems, and *on Cytospora* canker incidence at the pruning cuts.

338 (PS 14)

PLANT TISSUE CULTURE MEDIUM pH AS INFLUENCED BY INORGANIC MEDIUM FORMULATION, CARBOHYDRATE, SOLIDIFYING AGENT, AND ACTIVATED CHARCOAL

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Four carbohydrates (suc, glu, fru, mal) were tested against 6 inorganic basal media [MS, White, B5, Nitsch & Nitsch, Schenk & Hildebrandt, and Woody Plant Medium (WP)] for their influence on post-autoclave pH. For all basal media, post-autoclave pH values were highest for the sucrose-containing media and progressively lower for maltose, glucose and fructose-containing media, respectively. MS + suc and WP + suc treatments decreased 0.2 pH units from initial values following autoclaving. Eleven solidifying agents [Difco Bacto and Noble agar, Gibco Phytagar, CBS TC agar, Oxoid #1 agar, Sigma Agar and Purified agar, Res. Organics k-carrageenan (0.8%), Sigma Agargel and Rés. Organics Caragar (0.4%), and Merck Gelrite (0.2%)] were added to MS + 0.1M suc medium. Post-autoclave pH values were significantly higher (0.06 to 0.24 units) than liquid MS + suc control (final pH 5.61) for all solidifying agents, except Sigma Purified agar, which was 0.05 pH units lower. Neutralized and acid-washed activated charcoal were compared in liquid and agar MS + 0.1M suc media. If added after pH adjustment, charcoal additions were found to raise post-autoclave pH up to 0.7 units from controls. If added prior to pH adjustment, both charcoals raised post-autoclave pH of liquid media. In agar media, neutralized charcoal raised and acid-washed charcoal lowered post-autoclave pH. Since medium pH may affect morphogenesis and/or growth, these data lead us to recommend that post-autoclave pH should be determined and necessary adjustments made prior to autoclaving in subsequent medium preparations to have them more accurately reflect published values.

339 (PS 15)

EFFECT OF ROOTSTOCK WATER STRESS ON APPLE GRAFT SUCCESS.

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Virus-free clones of Malus sylvestris were subjected to pre- and post-graft water stress, using an on-demand intermittant drip irrigation system to maintain media water potentials at a minimum of -5, -9, -18, or -25 kPa. The 'MMMIII' rootstocks were potted into 9-liter containers in a 3 sand : 1 peat media, and chip-bud grafted with 'Golden Delicious' scion buds, and forced after 30 days. Media and air temperatures, relative humidity, and media water potentials were monitored constantly, and leaf area and xylem potentials (pre-dawn and daytime) were determined at grafting and at forcing.

Bud survival tended to decrease progressively with increased water stress of the rootstock. Leaf size at forcing was dependent on treatment levels, but did not correlate with bud survival. Growth of surviving buds was significantly less at -5 than at lower potentials.

Investigation on the effect of pre-grafting stress of the scion donor plant is in progress.

340 (PS 14)

IN VITRO ORGANOGENESIS OF 'BEAUREGARD' SWEETPOTATO

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Methodology is presented for organogenesis of 'Beauregard sweetpotato, a cultivar released in 1987 that is rapidly increasing in commercial use in the U.S. Regeneration of 'Beauregard' sweetpotato plantlets was obtained when complete leaves and 10 mm internode explants were cultured in liquid and solid media respectively over a period of 8 weeks. Leaves in liquid Murashige and Skoog medium containing 2 mg/l of IAA placed on a shaker under dark conditions produced white callus at the cut end of the petiole and roots underneath the callus in 4 weeks. Leaves were subsequently transferred to MS medium containing 500 mg/l of Chlorocholine chloride (CCC) and 0, 1, 5 and 10 mg/l of BAP for 4 more weeks. Shoots were regenerated from callus using 1 mg/l of BAP.

The effect of NAA auxin and various concentrations of the cytokinin Thidiazuron on internodes was examined under 16 hr. light and 8 hr dark photoperiod using MS solid medium. Explants on 0.05 mg/l NAA alone produced roots and shoots. The most plantlets however, were regenerated using 0.05 mg/l of NAA and 0.01 mg/l Thidiazuron. Regeneration of plants from leaves and internodes may be a useful system for a clean and rapid propagation of 'Beauregard' sweetpotato.

341 (PS 15)

WIND LIMITS GROWTH OF YOUNG APPLE TREES

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Wind stress as it affects tree growth was measured 2 consecutive years on a 4 year old planting of Red Fuji apple trees under drip irrigation. A 6m high Eucalyptus windbreak grew perpendicular to both prevailing wind and orchard rows. Trunk cross sectional area decreased as distance from shelter increased, until a point 60m from the windbreak. At this point trunk area increased and reached levels similar to trees near the shelter. Corresponding wind run data from within the apple rows suggests that high windspeeds may be correlated to small trunk girth. A flow anomaly may explain the increase in growth 60m from the windbreak. Measurements of total branch growth follow a similar pattern to measurements of trunk area. Branch growth was divided into 4 quadrants parralel and perpendicular to the prevailing wind. Only at 40-50m from the windbreak was branch growth on the downwind side of the tree greater than on the upwind side. This measured wind flagging tends to confirm that the apparent change in growth in response to shelter was due to changes in wind flow. Shelter is valuable for apple trees, but even where rows are planted parallel to the prevailing wind the orchard itself provides some internal protection.

342 (PS 14)

CORRELATIONS AMONG COMPETENCIES FOR PROTOPLAST CULTURE, LEAF DISK REGENERATION AND ANTHER CULTURE *IN SOLANUM PHURELA*

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Studies among competencies for protoplast culture, leaf disk regeneration, and anther culture have been conducted on 20 F_2 generation potatoes of the cultivated diploid (2n=2x=24) species, *Solanum phureja.* The F_1 generation was obtained from a cross

between a protoplast culture incompetent but anther culture competent clone, AD3-8, and a protoplast culture competent but anther culture incompetent clone, NBP2. AD3-8 is a homozygous line obtained by chromosome doubling an anther-derived monoploid (2n = 1x = 12) whereas NBP2 is a heterozygous field selection obtained from H. DeJong, Agriculture Canada, Fredericton, NB. The F_2 generation was produced by sib-crossing two randomly selected F_1 individuals. Segregation was observed for all three tissue culture traits in the F_2 population; however, there was no apparent correlation among the traits.

343 (PS 15)

EFFECTS OF WATER STRESS ON FLOWERING IN PRUNE

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Regulated deficit irrigation in drip irrigated French prune was found to allow water savings of up to 30% without significant detrimental effects on yield or quality and with some possibly beneficial effects. Plant based measurements (predawn water potentials) were used to assess the levels of stress experienced by the trees. Water deprivation at certain growth stages was found to have an enhancing effect on flowering the following year. This effect appeared to be most pronounced when the trees were stressed during the first half of fruit growth stage II. The increase in flowering was linearly related to the previous season's stress with flower density increasing from 5 blossoms/cm limb circumference, with an average predawn water potential of -0.3 MPa, to 15 blossoms/cm limb circumference, with an average predawnwater potential of -0.7 MPa. The spring 1991 results (year 3 of study) will also be discussed.

344 (PS 14)

ESTABLISHMENT OF A RELIABLE IN VITRO TUBERIZATION SYSTEM FOR SOLANUM TUBEROSUM: DEVELOPMENTAL ANATOMY OF THE MICROTUBERS

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For this study we adapted the in vitro tuberization procedure of Bourque et al (In Vitro Cell Develop Biol 23:381-386, 1987). In this poster we will detail the procedures for a) the sterile in vitro maintenance of virus indexed stock plantlets, b) shoot multiplication, and c) the initiation of microtubers on nodal cuttings. Shoots, procedures a) and b) are grown in the light (16:8, day:night) at 23°C on a solid (procedure a) or liquid (procedure b) MS medium with 3% (w/v) sucrose. Microtubers were produced on nodal cuttings made from shoots grown in procedure b). These cuttings were placed on basal MS medium containing 10% (w/v) sucrose, 2.5 mg/l kinetin and 1 g/l chlorocholine chloride (CCC). The explants were incubated in the dark at 19°C. Initial tuber formation could be observed after 2 days and most active enlargement occurred 5 to 15 days after initiation. Under these conditions the microtubers originate directly from the axillary bud without stolen elongation. The microtuber anatomy is very similar to that of normal tubers. Microtuber growth is predominately due to enlargement of the perimedullary zone (internal phloem), which is the major site of starch storage.

345 (PS 15)

ROLE OF THE PROTOPLAST IN DEEP SUPERCOOLING OF XYLEM TISSUE

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It is believed that the cell wall plays the primary role in determining whether or not a cell will exhibit deep super-cooling. Although a minor role for the protoplast has been suggested, via freezing point depression due to concentration-of solutes, the exact role remains unclear. Experiments were undertaken to determine the effects of killing or plasmolyzing the protoplast on the freezing profile of xylem tissue of peach and dogwood as determined by differential thermal analysis (DTA). Quenching of stem tissues in LN_2 for 30 min resulted in a marked shift of the low-temperature exotherm (LTE). In contrast, killing of stem tissue in 5% gluteral- dehyde, which left the protoplast intact, resulted in a slight shift of the LTE to colder temperatures. The use of plasmolyzing salt solutions (0.6 osmol) also resulted in a marked shift of the LTE to warmer temperatures. Divalent salt solutions were more effective than monovalent salt solutions of equal osmolality. Preliminary data indicate that the protoplast plays a significant role over and above freezing point depression in determining the freezing profile of deer, supercooling tissue, and that contact of the plasmá membrane with the cell wall is essential in order to achieve maximum deep supercooling.

346 (PS L4)

EFFECTS OF ETIOLATION AND TISSUE SOURCE ON PROTOPLAST YIELD OF *IPOMOEA BATATAS* LAM.

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Tissues were obtained from *in vitro* propagated nodes of 'Beauregard and 'Jewel'. Explants were taken from light- and dark-grown shoots that were divided into segments with young (folded) leaves or older (fully expanded) leaves. These segments were separated into lamina, petiole, and internode. Tissues were digested for 14 h in an enzyme solution containing 2% Cellulysin® cellulase and 0.5% Macerase® pectinase. Protoplasts were isolated by discontinuous density gradient centrifugation. Digestion of etiolated petioles yielded the most protoplasts per g of tissue (1.28×10^6), followed by etiolated internode (1.24×10^6), and etiolated lamina (1.18×10^6). Etiolated tissue yielded more protoplasts per g (1.23×10^6) compared to light-grown tissue (0.44×10^6). There was little difference in yield between younger and older tissue. 'Beauregard' tissues yielded slightly more protoplasts per g (0.72×10^6) compared to 'Jewel' (0.62×10^6). Protoplasts cultured at a density of 1.5×10^5/ml resulted in rapid colony establishment on liquid MS medium with 2.69 µM NAA + 0.9 µM 2,4-D and either 0.57 µM thidiazuron or 2.28 µM zeatin.

347 (PS 15)

PROTECTION FROM FROST OR FREEZE WITH SPRINKLERS

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A wide range of sprinkling methodology is evolving, ranging from overtree to undertree, with recent interest focusing on intree microspinkler placement. This includes how geometry of the sprinkler placement and the droplet pattern, droplet size, water temperature, canopy shape and density seem to be interacting with conventional boundary conditions of air temperature, motion, humidity, and radiant exchange. The availability of BitNet networking facilities has expedited exchange of ideas on this subject, increasing the effectiveness of coordination that has included the exchange of personnel, equipment, and climatic conditions two decades. A review of this cooperative effort develops the current issues and how these are being investigated, including experiences with six models and how well they may be expected to predict protection over a range of meteorological conditions and crop geometries from strawberries to fruit trees.

348 (PS 14)

MEDIA AND GROWTH CONDITIONS FOR INDUCTION OF CALLUS AND ORGANOGENESIS FROM PROTOPLASTS AND EXPLANTS OF PHYSALIS PERUVIANA

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Physalis peruviana has been shown to produce withanolides, steroidal compounds having antifeedant and toxic effects against several insect species such as Heliothis zea and Spodoptera littoralis. The plant tissue culture requirements of P. peruviana were evaluated as the first step in the transfer of this insect resistance to solaneaceous crop species by protoplast fusion. Conditions for the isolation of mesophyll leaf protoplasts were defined. Media previously developed for the optimal regeneration of tomato and potato were found to select against P. Peruviana. This allows for selection against P. peruviana protoplasts in post-fusion regeneration schemes. True leaf explants were cultured on MS, SH and B5 media with NAA(0-2 mg/1)/BAP(0-4 mg/1) or NAA(0-2 mg/l)/KIN(0-4 mg/l). Optimum growth was observed on MS media with NAA/KIN. Root formation was the predominate organogenic response.

349 (PS 15)

GROWTH RESPONSES OF SELECTED GROUND COVER ROSES UNDER WATER STRESS CONDITIONS.

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Three container grown ground cover rose cultivars: Alba, Pearl and Red, were subjected to five consecutive water stress cycles. Morphological and physiological responses to water stress were measured and compared among cultivars. Leaf number, leaf area, shoot and root dry weight, root/shoot ratio, leaf area ratio, relative water content, relative growth rate, and transpiration rate were affected by water stress. Responses differed among cultivars. Although water stress had significant effects on water use efficiency, net assimilation rate, epicuticular wax content, and stomatal conductance, no significant differences were observed among cultivars. Interactions of water stress, stress cycles, and cultivars were most prominent for relative water content, transpiration rate, and stomata] conductance. Alba was considered to be the most drought resistant, Pear1 was intermediate and Red was the least resistant to drought.

350 (PS 14)
EFFICIENT REGENERATION OF CELERY PLANTS FROM SEEDLING TISSUE

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Celery is a high value crop for which genetic engineering approaches may be beneficial. In order to utilize genetic transformation it is necessary to have an efficient regeneration procedure. Although *Agrobacterium tumefaciens* mediated transformation has been reported for celery (Catlin et al. 1988), the protocol utilized an annual, non-commercial celery genotype, and required a prolonged time in tissue culture that resulted in frequent chromosomal rearrangements. To reduce these problems and establish a system for cultivated genotypes, we have developed a faster regeneration procedure using axenically grown seedling tissue of three different celery cultivars, Golden Detroit, Florida 683, and Tall Utah HK. Factors tested included: explant source tissue, genotypes, basal salts, hormone combinations, treatment of the tissue and transfer intervals. The best procedure uses 20 -40 day old hypocotyl or petiole tissue placed on solid Wright and Lacy (1988) callus-induction medium for 6-10 weeks. Embryonic callus is then transferred to hormone-free regeneration medium; differentiation occurs within 2 - 4 weeks. The time from explant to plantlet (2 - 4 months) is 1 - 2 months faster than for other systems in the literature. This protocol is now being used for A. *tumefaciens* transformation experiments using the vector pCIB10 and kanamycin selection.

351 (PS 15)
ACCLIMATION AND DEACCLIMATION OF *ROSA MULTIFLORA* THUNB. 'BURR' PLANTS TO COLD TEMPERATURE

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Rooted cuttings were transplanted into 3.9 L plastic pots and placed in a glasshouse under a minimum 12 hr photoperiod and at 18°/24°C night/day. When plants had shoots with ˜30 nodes, they were assigned randomly to growth chambers under either long days (18°/24° n/d, 14 hr photoperiod) or short days (4°/10° n/d, 10 hr photoperiod). Plants were then periodically assessed for cold hardiness. Single node segments from the middle third of each shoot were placed into vials containing water. Vials were then placed in a -2°C waterbath for 12 hours. Ice was used as a nucleator. Temperature was then lowered 2°/hr. Samples were removed at 3" increments (-5, -8, -11, -14. -17, and -20°) for % electrical conductivity (EC) determination. At each sampling temperature, tissue viability was also assessed by placing additional nodes in plastic bags with moist filter paper for one week. At this time, stem and bud survival ratings were assigned. EC was used to calculate the index of injury (I_i) and there was a significant correlation between bud and stem viability ratings and I_i. When plants were placed in the growth chamber, the temperature at which at least hall of the tissue was killed (KT) was -5°. After 3 weeks, the KT was -14° for plants exposed to short days vs. -5° for plants under long days. The KT decreased to -17° after 4 weeks of short day exposure. When plants under short days for 3 weeks were transferred to long day conditions, the killing temperature returned to -5° after 1 week.

352 (PS 14)
PRODUCTION OF EMBRYOS IN ASPARAGUS ANTHER CULTURE

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Anther culture is useful for the synthesis of doubled haploid supermale asparagus plants which are necessary for the production of all-male hybrids. Through embryogenesis 70-100 plants/100 anthers cultured were recovered. Flowers collected from the field in July, August and September, for the genotype G203, were stored at 5°C for 24 hours. Anthers with microspores at the late uninucleate stage were placed on callusing media (MS media with 500 mg/l casien hydrolysate, 800 mg/P glutamine, 2 mg/ℓ NAA, 1 mg/P BA and 5% sucrose) at 32°C in the dark for 3-4 weeks. Calli were then grown at 25°C with a 16 hour photoperiod for 3-4 weeks. Developing embryos and calli were transferred to micropropagation media (MS media with 6% sucrose 0.1 mg/ℓ NAA, 0.1 mg/P kinetin and 6.55 10^{-4} mg/ℓ ancymidol) for embryo maturation (4 weeks). Approximately 15 percent of the anthers produced embryogenic calli and each callus produced 5-20 embryos. More than 50 percent of the embryos germinated on MS media containing 1 mg/I' GA,. Preliminary cytology showed 6 of 10 plants sampled to be haploid.

353 (PS 15)
INFLUENCE OF PHOTOPERIODS ON COLD TOLERANCE AND BUD PHENOLOGY OF WHITE SPRUCE SEEDLINGS

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Sixteen-week-old whole white spruce seedlings (Picea glauca) were hardened in growth chambers under 8, 10, 12 and 14 h photoperiods for 14 d at 15°/l0°C followed by a 13 h photoperiod under declining temperatures (12°/8°, 10°/5°, 5°/2°) for 14 d for each set of D/N temperatures and finally by 35 d at 0°/0° without light. Afterwards, deacclimation conditions consisted of 14 d each at 10°/5° and 15°/10° with 15 h photoperiods. Frost tolerance of shoots and roots and phenology of apical bud were followed. Hardening of shoots was influenced by the photoperiods while hardening of roots responded only to temperature changes. Frost tolerance of shoots was higher and bud formation was accelerated with the 8 h photoperiod. After 56 d of acclimation, frost tolerance of shoots was -30°, -17°, -17°,. and -12° under 8, 10, 12, and 14h, respectively. Budbreak occurred sooner following shorter photoperiods, but no difference was observed between 8 and 10 h treatments.

354 (PS 14)
GENETIC TRANSFORMATION OF *APIOS AMERICANA* BY *AGROBACTERIUM TUMEFACIENS*

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Three wild-type strains of *A. tumefaciens* (A281, 15955, and 33970) were tested for infection on in vitro seedlings of three genotypes (LA034, LA006, and LA318) *of A. americana.* All three strains incited tumor formation on the three genotypes. Tumors incited by strains 15955 or 33970 were tested for opine production.

To optimize procedures for transformation, stem segments from the three *Apios* genotypes were inoculated with *A. tumefaciens* A281 carrying the pBi121 binary vector containing the neomycin phosphotransferase II (NPTII) and β-glucuronidase (GUS) genes. Putative transgenic tumor tissues were selected on medium containing kanamycin (50 mg/liter) and the transformations were confirmed by GUS histochemical assays. The highest transformation frequency observed was with plant genotype LA006, 3 days of co-cultivation, and 0 to 2 days of preconditioning.

355 (PS 15)
THE INFLUENCE OF RATE OF COOLING OR RATE OF WARMING ON THE COLD HARDINESS OF × CUPRESSOCYPARIS LEYLANDII, LAGERSTROEMIA, AND PHOTINIA × FRASERI

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In laboratory freeze tests, cooling and warming rates may influence the reliability of cold hardiness estimations. This study determined whether cooling rates of 2, 4, and 6 C/h or warming rates of 25, 4, and 0 C affected the killing temperatures of × Cupressocyparis leylandii (A.B. Jacks. and Dallim.) Dallim. and A.B. Jacks., Lagerstroemia L. sp., and Photinia × fraseri Dress. 'Birmingham' at four times during the year. Data suggest that new growth, especially spring growth, was killed at higher temperatures by faster rates of cooling (6 C/h) and warming (25 C) compared to slower rates. Although × Cupressocyparis leylandii showed no differences in cold hardiness at 2, 4, and 6 C/h cooling rates, higher killing temperatures occurred at25 C compared to 4 and 0 C. The killing temperature of Lagerstroemia was 3 C higher after warming at 25 C compared to 4 and 0 C. On most dates when Photinia × fraseri leaves and stems were cooled at 6 C/h or warmed at25 C, the killing temperatures were higher than those observed for slower cooling and warming rates. Cooling at 4 C/h or slower and warming at 4 C are recommended for × Cupressocyparis leylandii and Lagerstroemia. A 2 C/h cooling rate and 4 or 0 C warming rate are recommended for Photinia × fraseri leaves and stems.

356 (PS 14)
CLONING OF TWO cDNA ENCODING FOR ACC SYNTHASE FROM ETIOLATED MUNG BEANS

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Ethylene has been shown to be very important in many physiological processes. The ability to regulate ACC synthase, the rate limiting enzyme in the ethylene biosynthetic pathway has many potential uses. Hormonal treatment of etiolated mung bean hypocotyl segments has been shown to increase ethylene, ACC and ACC synthase levels. To better understand the mechanism of hormonal regulation of this important regulatory enzyme, it was necessary to clone for the gene regulating its production. In order to accomplish this etiolated mung bean segments were treated with 10 µM IAA + 3 µM BR to stimulate ACC synthase levels. Poly A˚ mRNA was extracted from hormonally treated etiolated mung bean hypocotyl segments 6 hours after treatment initiation with a yield of 10 µg/gm tissue. This mRNA was used to construct a cDNA library using the λ gtll expression vector. The library contained 4×10^{6} clones with 92% recombinants. Approximately 25,000 pfu were screened using an 890 base pair fragment from clone pUC18::pcVV4A (van der Stratten, PNAS 87:4859). Two putative ACC synthase clones (HIM4 and HIM10) were obtained. Supported by National Science Foundation Contract #DCB-89-0 5 0 5 5 .

357 (PS 14)

AN ANATOMICAL COMPARISON OF IN VITRO- AND EX VITRO-FORMED ADVENTITIOUS ROOTS OF *TRACHELOSPERMUM ASIATICUM*

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One-node cuttings of Asian jasmine were rooted *in vitro* (TC) and *ex vitro* (M). Cutting stem bases were then analyzed for: 1) sequential time differences in root primordia initiation and development and 2) differences in adventitious root xylem development and root-to-shoot xylem connections. Root primordia were first observed at day 3, and by day 7 root-to-shoot xylem connections were equally developed in TC and M treatments. Continued development and emergence of adventitious roots were observed at days 8-10. At 13 and 18 days, when viewed by SEM, TC root hairs were morphologically thicker and l/3 - l/2 the length of M root hairs. There was no apparent difference in root hair density. Reductions in root hair length could have implications for producers attempting to acclimatize TC-generated plantlets.

358 (PS 14)

PHYSIOLOGICAL COMPARISONS OF IN VITRO- AND EX VITRO-FORMED ADVENTITIOUS ROOTS OF *TRACHELOSPERMUM ASIATICUM*

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In vitro- (TC) and *ex vitro-formed* (M) 18-day old adventitious roots of Asian jasmine *(Trachelospermum asiaticum)* were compared for their ability to absorb and translocate radiolabelled phosphorus from a nutrient solution. Samples were taken at 1, 2, 4, 8, 12 and 24 hr subsequent to the initial dosage of the nutrient solution with 7.4×10^{-2} MBq liter^{-1} $KH_2{}^{32}PO_4$ at hr 0. TC roots were capable of absorbing ^{32}P, but at significantly reduced levels compared to M roots. The greatest difference was observed at hr 12, with significant differences noted at all sampling times except hr 0 and 1. These differences are hypothesized to be primarily physiological or metabolic, but not due to morphological alterations. With the exception of hr 12, no significant difference in ^{32}P translocation from root to shoot could be detected. This finding is partial evidence that the root-to-shoot vascular interface in TC-formed adventitious roots of Asian jasmine was well-developed and would not be a limiting factor in acclimatization.

Thus, while TC roots absorbed less P from a radiolabelled nutrient solution than M roots, in vitro-produced plantlets were still successfully acclimated to greenhouse conditions.

359 (PS 15)

EFFECTS OF MOISTURE STRESS CONDITIONING ON GROWTH AND METABOLISM OF LIVE OAK *(QUERCUS VIRGINL4NA* MILL.)

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Live oak *(Quercus virginiana)* is widely planted in the South by homeowners and municipal horticulturists. Periodic drought conditions impact growth of this species. Conditioning planting stock to moisture stress may enable plants to have a greater capacity to adjust under drought conditions. Field-grown, 1-yr old live oak seedlings were transplanted to a sand media, placed under greenhouse conditions and exposed to: 1) an establishment period; 2) a conditioning period where half of the seedlings were exposed to moderate drought levels; 3) a recovery period; and 4) a drought period in which water was witheld from all seedlings. Leaf water potentials, leaf area, root and shoot growth, photosynthesis, and nonstructural carbohydrates were measured at specific intervals during each period. Results indicate conditioned seedlings maintained higher rates of photosynthesis, on a per area basis, under imposed drought conditions. Influence of treatments on root/shoot ratio and carbohydrate partitioning will be discussed.

360 (PS 14)

PHOTOSYNTHESIS OF IN VITRO CULTURES OF *Fragaria ananassa* CV. SENGA SENGANA AND A CLONE OF *Betula verucosa* AS INFLUENCED BY LAMP TYPES

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Experiments were conducted to determine the influence of lamp type on photosynthesis of in vitro cultures of strawberry and birch. Cultures were exposed to 30 µmol m^{-2} s^{-1} of PAR (400-700 nm) for 8-10 weeks from the following light sources: Osram incandescent lamp 40 W (Inc), Osram warm white L 18 W / 30 (WW), Philips cool white TLD 58 W / 33 (CW), Philips red TLD 40 W / 15 (R), Philips blue TLD 18 W / 18 (B), Philips prismatic lamp SL 13 (SL), and combinations of these lamps with CW. Growth vessels for the cultures were modified so that CO_2 uptake or release by the cultures could be determined with minimal altering of the plantlet environment. Photosynthetic activity was measured with an IRGA as CO_2 consumption per dm^2 leaf area. Response curves were generated from light regimes of 0-360 µmol m^{-2} s^{-1}. In general, photosynthetic level was highest in cultures exposed to light sources with a high proponion of blue light (B and B + CW), as compared to cultures exposed to light sources with a high proportion of red light (Red and Inc).

361 (PS 15)

RESPONSES OF BOTTOMLAND AND RIPARIAN TREE SPECIES TO WATER STRESS

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Tree species that resist the effects of both flooding and drought may be well-suited for use in urban environments where both saturated and droughty soils are common. The purpose of this project is to compare the growth and water relations of tree species native to habitats with moist to flooded soils, including *Fraxinus pennsylvanica* Marsh., *Asimina triloba* L., and *Taxodium distichum* L., during exposure to a range of soil moisture levels. In a pilot study to define treatments for eliciting flood and drought stress responses in a bottomland species, potted *F. pennsylvanica* seedlings were treated for 68 days by irrigating when mean moisture tension of the medium reached 0 (flooded), -8.3, -11.2, or -20.0 kPa. All plants survived each treatment, but shoot length, dry weight of shoots, ratio of root to shoot weight, and specific leaf weight were lower for flooded plants than for those in the other regimes. Development was not significantly different among nonflooded plants, indicating that a mean soil moisture tension of less than -20.0 kPa is needed to reduce growth in seedlings of *F. pennsylvanica.*

362 (PS 14)

OSMOTIC SEED PRIMING, VIGOR TESTING, AND OPTIMUM GERMINATION TEMPERATURE OF RUDBECKIA FULGIDA

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Rudbeckia fulgida, a popular herbaceous perennial, is noted for its heat tolerance and resistance to powdery mildew. It can be difficult to germinate and displays variable germination rates. The following studies were conducted to improve germination of this species: 1). Initial germination studies defined an optimum germination temperature of approximately 30°C. 2). Seed vigor can be used to predict germination under stressful conditions and after storage. In cold vigor tests, seeds were subjected to temperatures of 5°C, 10°C, and 15°C for 2, 4, 6, or 8 days. An overall decline in germination occurred when seeds were stressed for an increasing number of days. 3). Seed priming can contribute to more rapid and uniform germination of seeds, which can increase the efficiency of production schedules for growers. Seeds were primed in various concentrations of PEG and KNO_3 to determine the best osmotic agent and osmotic potential. Germination trials were conducted. Results will be presented.

363 (PS 15)

RESPONSES OF FIVE CONTAINER-GROWN HERBACEOUS PERENNIAL SPECIES TO LABORATORY FREEZING

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The ability of plant materials to resume normal growth following exposure to cold is the ultimate criterion of viability. Therefore, controlled freezing and resumption of growth studies were conducted to determine cold tolerance of five commercially important herbaceous perennial species. Container-grown *Gaillardia* X grandiflora 'Goblin', *Physostegia virginiana* 'Summer Snow', *Salvia* X *superba* 'Stratford Blue', *Tanacetum coccineum* 'Robinsons Mix', and *Veronica repens* were subjected to temperature treatments of 0, -2, -4, -6, -8, -10, -12, -14, -16, and -18°C in a low-temperature freezcr. Temperatures were lowered from 2°C at a rate of 2°C per hour until medium in the containers stabilized at the desired temperature. Upon removal from the freezer, plants were placed in a 2°C cooler to thaw gradually. After thawing, plants were transferred to a warm greenhouse (20°C) for forcing. All test plants survived exposure to -10°C. Exposure to -12°C resulted in poor regrowth of *Physostegia, Salvia,* and Veronica, and killed *Gaillardia* and *Tanacetum.* None of these herbaceous perennial species survived exposure to -14°C and below.

364 (PS 14)
IN VITRO AXILIARY SHOOT REGENERATION IN CHINKAPIN OAK
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Surface-sterilized embryonic explants of chinkapin oak (Quercus muehlenbergii Engelm.) were cultured in woody plant medium (WPM) containing no growth regulators or supplemented with several levels of 2,4-D in combination with BA. Explants were then subcultured in half-strength WPM containing (in mg/l) 1.0 BA or kinetin and 0.1 NAA. The cultures were maintained under 46 $\mu EM^{-2}s^{-1}$ light for 16 hrs.

Explants with cotyledons cultured in WPM with no hormones for two weeks and transferred to medium containing (in mg/l) 1.0 BA and 0.1 NAA, resulted in several axillary shoots in eight weeks. Kinetin in the medium also induced multiple axillary shoots.

Explants cultured in 2.4-D based medium and subcultured into the BA based medium resulted in callus growth in some cultures. However, the callus was compact and non-morphogenic.

365 (PS 15)
REDUCING WATER LOSS FROM BARE-ROOTED NURSERY TREES AFTER HARVEST
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Desiccation during postharvest handling of bare-rooted deciduous nursery trees is thought to be responsible for poor establishment of some species upon replanting. The application of antidesiccants is one possible method of protecting plants against severe water loss during storage and establishment. Over 20 different antitransparent compounds and fruit waxes were tested on two-year-old bare-root seedlings of Washington Hawthorn *(Crataegus phaenopyrum* Med.), a desiccation sensitive species, and Norway Maple *(Acer platanoides* L.), a desiccation tolerant species. Seedlings were sprayed with the compounds and allowed to dry at room temperature for up to 48 h, during which time the plants were weighed at various intervals to determine water loss. The best treatments were applied to seedlings which were stored at 0°C for 8 weeks, and then planted out to evaluate survival. Foliar antitranspirants, such as VaporGard and Wilt-Pruf, were ineffective in reducing water loss over the 48 h period. Several different formulations of fruit waxes provided the best protection against water loss over the 48 h period and in cold storage. The application of a fruit wax to bare-rooted trees may be a viable method of reducing water loss during postharvest handling.

366 (PS 14)
SCANNING ELECTRON MICROSCOPY (SEM) OF INVITRO-GROWN MINIATURE ROSE TRANSFERRED TO GREENHOUSE CONDITIONS
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Leaf anatomy of miniature rose *(Rosa chinensis minima)* cv., Red Sunblaze, from in vitro shoot proliferation through rooting under mist and final growth in a greenhouse, was exposed by SEM. On the abaxial leaf surface, in vitro-cultured and mist-rooted plantlets exhibited raised epicuticular wax. In contrast, greenhouse-grown plantlets had a flat abaxial surface, which consisted of a dense cuticle layer with little epicuticular wax. These results suggest that the wax may have contributed to the high survival rate of ex-vitro microcuttings. Leaves from greenhouse-grown and mist-rooted plantlets possessed ellipsoid stomata of similar size. However, leaves of in vitro-cultured plantlets had circular, ovoid, and ellipsoid stomata of many different sizes. Transverse sections of leaves from the greenhouse and under mist revealed well defined palisade (rod shaped) and spongy mesophyll (tube shaped) layers as opposed to the loosely arranged palisade (spherical) layer of plants grown in vitro. The advantage of using the SEM cryofracture method relative to light microscopy of cross sections is discussed.

367 (PS 15)
GROWTH OF THREE LEGUME TREE SPECIES AT HIGH ROOT-ZONE TEMPERATURE
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Previous studies suggest that the success of *Gleditsia triacanthos inermis* Willd. as an urban street tree is due in part to its resistance to high root-zone temperature (RZT). In this experiment, growth of G. *triacanthos inermis, Maackia amurensis* Rupr. & Maxim., and *Sophora japonica* L. at high RZT was compared. Half-sib seedlings of the species were cultured together in solution. RZT was raised from ambient (23C) to 35C for either 0, 6, 12, or 24 hr day^{-1} for 42 days. Dry mass of *G. triacanthos inermis* and M. *amurensis* roots and lamina decreased as exposure to 35C increased beyond 6 hr day^{-1}, and chlorosis of lamina was prevalent in the 12 and 24 hr day^{-1} regimes. *S. japonica* seedlings at 35C for 6 hr day^{-1} had less dry mass than seedlings in the 0 hr day^{-1} treatment, but mass increased as exposure to 35C increased beyond 6 hr day^{-1}, and no foliar symptoms of heat stress were observed. These data indicate that resistance to high RZT is similar for G. *triacanthos inermis* and M. *amurensis,* and that *S. japonica* is sensitive to fluctuating RZT but is highly resistant to a constant RZT of 35C.

368 (PS 14)
QUANTITATION OF INDOLEACETIC ACID IN ROOTS OF QUERCUS RUBRA BY ELISA AND HPLC.
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Comparisons were made between ELISA and HPLC techniques for the quantitation of IAA. Samples of Quercus rubra, Red Oak, root tissue were obtained from the roots of l-3 mm diameter actively growing 5-year-old nursery plants. Combined tissue from several plants was used to ensure sample uniformity prior to extractions. Crude methanolic extracts were purified by HPLC using PRP-1 and Ro-Sil preparative columns. IAA was quantified by ion-pair HPLC with fluorescence detection. Samples for ELISA analysis were partially purified by solid phase extraction with PVPP, C-18 Sep Pak and ethyl-acetate/water partitioning. Immunoassay quantitation was by commercial kits obtained from Idetek, Inc. IAA levels by ELISA averaged 48 ng/g (fresh wt) with a standard deviation of 20.6. HPLC quantitation showed a mean of 63 ng/g (fresh wt) with a standard deviation of 9.1. Partial purification by solid phase extraction and partitioning was necessary to remove interfering substances prior to immunoassay. Quantitation by ELISA was faster and had fewer equipment problems but required greater operator skill.

369 (PS 15)
A DECISION SUPPORT SYSTEM FOR THE PROTECTION OF CROPS FROM FROST
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A computer program was developed that assists with frost protection decision making for horticultural crops. The program assists with selecting sites, choosing protection methods, determining effectiveness of protection methods, and management of a system during a frost night. The program also includes a simulation model to predict temperatures during a frost night and a climate database to determine potential frost dates for any location in the state of Pennsylvania. An automated irrigation control module that can be customized to fit a particular field is included. The program will be demonstrated at the poster.

370 (PS 16)
SHADE DURING THE FINAL SWELL INFLUENCES PEACH QUALITY
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Scaffold limbs of 'Biscoe' trees were shaded 6 to 3, 3 to 0, and 6 to 0 weeks before harvest (WBH). Four levels of incident photosynthetic photon flux density (IPPFD) were created with polypropylene shade cloth. One secondary scaffold branch per scaffold limb was girdled 6 WBH to isolate the branch from the rest of the tree. Shading 6 to 3 WBH did not influence fruit weight or quality. Fruit weight was positively related to % IPPFD for girdled, but not nongirdled branches, shaded 3 to 0 and 6 to 0 WBH. Fruit soluble solids were positively related to % IPPFD when branches were shaded 3 to 0 or 6 to 0 WBH. Firmness declined as ground color changed from green to yellow for fruit shaded 6 to 3 WBH. Shading 3 to 0 and 6 to 0 altered the relationship between ground color and fruit firmness: firmness declined and fruit abscissed, but fruit remained green.

371 (PS 15)
INFLUENCE OF THAW RATES ON THE LEVEL OF INJURY BY FREEZE-THAW STRESS IN A COLD HARDY POTATO SPECIES
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Late spring and early fall frosts often involve a cold clear night during which the plants experience relatively slow freezing rates of about 1C/h. However, such nights are usually followed by a sunny morning

which brings rapid rewarming at rates that can exceed 5C/h. To examine the influence of thaw rate on freeze-thaw injury a cold hardy, acclimating potato species, *Solanum commersonii* was frozen at 1C/h with ice nucleation at -1C and subjected to thaw rates of either 1 or 5C/h. Ion leakage was assayed as a measure of tissue damage. Two to three times greater ion leakage was observed with quick thaw compared to slow thaw primarily at critical temperatures (range where injury progresses). This ion leakage difference due to thaw rates and concomitant injury meant the difference between recovery or death to the tissue frozen to the same temperature. The critical temperature range was broadened with acclimation and with quick thaw rates. These data indicate the necessity for careful consideration of thaw protocol in freeze experiments and may indicate a possibility for mitigating frost damage by controlling thaw rates in the field.

372 (PS 16)

CHANGES IN PROTEIN PROFILES IN PEACH EMBRYOS DURING THE BREAKING OF DORMANCY BY CHILLING

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Imbibed peach seeds were held at 5C or 20C for up to 8 weeks. Germination at 20C of seeds held at 5C increased from 20% at 5 weeks to 95% at 8 weeks, but seeds held continuously at 20C remained dormant. Aqueous extracts of the cotyledons and embryonic axes were prepared weekly and subjected to SDS PAGE. Little change in protein profiles occurred in the embryonic axes, regardless of temperature, or in cotyledons of seeds held at 20C. However, concentrations of 9 polypeptides in the cotyledons had decreased after 5 weeks of chilling, and new proteins of lower molecular weight appeared. Similar changes occurred during the chilling of partially imbibed seeds that were incapable of germination, but at a slower rate. Changes in the cotyledons were not affected by removal of the embryonic axis prior to chilling. Soaking seeds in KGA_3 (500 ppm) hastened germination by 4 weeks, and germination preceded changes in protein profile. Thus the embryonic axis does not mediate the response, and the changes are associated with chilling, rather than with germination.

373 (PS 15)

THE NATURE OF SEQUENTIALLY ADDITIVE INTERACTIONS ON YIELDS

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For economic and environmental reasons, there is urgent need that the efficiency of inputs into production of horticultural crops be increased. Two types of stresses limit crop production. Type and degree of each stress present must be ascertained by diagnostic procedures for efficient crop management. Liebig-type stresses permit little or even no response to correction of other stresses until those of Liebig type are corrected first since this type limits most; these stresses can interact synergistically. When there are no remaining Liebig stresses, inputs to correct Mitscherlich-type limiting factors can give responses in direct proportion to the amount of input until the need is satisfied. Efficiency for each individual input progressively increases with use of other inputs since they are sequentially additive. Order of input to correct Mitscherlich stress is not important, and favorable economic and environmental choices can be made. Stresses of either type can be mineral nutrients, soil properties, water and pests; it is urgent that many disciplines be involved. Horticultural experiments and crops can be most successful with full "se of these concepts which will be illustrated.

374 (PS 16)

EFFECT OF THERMOPERIODIC CYCLING ON GERMINATION AND EMERGENCE OF PEACH SEEDS

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Seeds of two peach cultivars 'Johnson Elberta' and 'Halford' *(Prunus persica* L. Batsch.) were stratified at 2, 6 and 14C or cycled between 2 and 14C in 12/12, 14/10, 16/8, 18/6, 20/4, 22/2 and 23/1 hour cycles. Treatments ranged from 14 to 98 days. Emergence due to chilling occurred at lower temperatures and in shorter chilling durations than germination. Germination after cycled treatments increased with increased time at 2C. Emergence increased with increased cycling time at 2C up to the 20/4 hour cycle and then decreased.

Seedlings were harvested after seven weeks. Stem and normal leaf dry weights increased with longer stratification durations. Epinastic leaf, lateral shoot and cotyledon dry weights decreased with longer stratification durations. Normal leaf weight was greater after any cycled treatment than after constant 2C stratification. Cotyledon weight decreased with increased time at 2C in cycled treatments.

375 (PS 15)

MYCORRHIZAE AND ROOT SIGNALS IN DRYING SOIL

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Stomatal behavior is evidently under partial control of non-hydraulic signals originating in roots in response to drying soil. We thought it possible that mycorrhizal fungi may affect this root to shoot communication, firstly because these fungi can exert their own influence on host stomata1 conductance (Cs) and secondly because mycorrhizal symbiosis alters root metabolism and hence might influence biochemical responses of roots to environmental changes. Rosa hybrida plants were grown with roots divided between two pots: roots of one pot were colonized by Glomus intraradices (M), 'those of the other were left nonmycorrhizal (NM) and supplemented with phosphorus. Cs was monitored twice daily as either the mycorrhizal or nonmycorrhizal pot was allowed lo dry, with shoot water status maintained at nonstress levels by watering the other pot. Cs as percent of controls (plants with both M and NM pots watered daily) declined more rapidly when water was withheld from M roots. Ultimate reductions in Cs were similar whether M or NM roots were dried; we observed 17% reductions in M-dried plants by day 11 and 21% reductions in NM-dried plants by day 21. These declines were observed before any change was apparent in leaf water potential or relative water content. Workers investigating non-hydraulic root signals in other plant species have previously reported 0% to 75% reductions in Cs as a result of partial root system drying.

376 (PS 16)

DORMANT PEACH FLOWER BUD PROTEINS ASSOCIATED WITH CHILL UNIT ACCUMULATION OR NEGATION TEMPERATURES

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Recent work tentatively identified soluble proteins of ca. 18 and 61 kD that decrease, as well as an 81 or 89 kD protein that increases, in dormant peach flower buds late in the chilling accumulation period (Lang and Tao, 1990, HortSci. 25:1068). To examine the changes in proteins related to positive or negative chilling unit temperatures, dormant flower buds and l-year-old shoots of 'Hawthorne' peach were collected in the orchard at 200,400, and 600 chilling units. Buds were frozen immediately in liquid nitrogen and shoots were placed in dark treatments of 5.0° C (chilling promotive), 15.5 ° C (chilling neutral), or 24.5° C (chilling negative) for 200 hr, after which buds were removed and frozen. Flower buds from a second set of treated shoots were sampled 42 hr after transfer to a budbreak forcing growth chamber. Soluble proteins were extracted and analyzed by one- and two-dimensional sodium dodecyl sulfate-polyacrylamide gel electrophoresis. The relationship of promotive and negative chilling temperatures to, as well as transfer to growth conditions on, changes in peach flower bud protein profiles will be discussed.

377 (PS 15)

STRUCTURE OF EPICUTICULAR WAX IN SORGHUM MUTANTS

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Sorglium bicolor mutants for cuticular wax production provide a model system for analysis of epicuticular wax (EW) physiology, biochemistry, and genetics. Mutants produced from seed treated with the chemical mutagen, diethyl sulfate (DES) (1.0 ppm), were selected in the M2 generation and self-pollinated to produce 38 individually segregating near-isogenic mutants of 2 classes: 1) bloomless (lacking visible EW) and 2) sparse bloom (possessing little visible EW).

SEM of normal bloom abaxial leaf sheath surfaces reveal two structural EW types: 1) long filaments and 2) surface plates. Abaxial leaf blade surfaces manifest two types: 1) globular EW associated with epidermal idioblast that resemble silica cells and 2) surface plates. Structural EW is rarely present on adaxial leaf surfaces. Mutagenized plants possess altered EW morphology. Filament EW is quantitatively reduced on sparse bloom mutants, while globular EW has replaced filament EW on bloomless mutants. In addition, structural variation within mutant classes indicates that further genetic analysis is needed to characterize these DES induced mutation events. Moreover, studies of EW biosynthesis and physiological function may be enhanced by utilizing these near-isogenic mutants.

378 (PS 16)

DIURNAL SHADE EFFECTS ON GAS EXCHANGE AND GROWTH OF APPLE

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The east and west aspect of a large apple canopy receive maximum light at different periods of the day. Midday depression of net photosynthesis (Pn) may influence the time of day when intercepted light is most effective. Greenhouse grown 'Lawspur Rome'/M.111 trained to single shoots were given the following shade (73%) treatments: 1) sun all day, 2) shade in the morning (am-shade), 3) shade in the afternoon (pm-shade) and 4) shade all day. At 0, 3, 6 and 12 weeks, dry weight (DW) of leaves, shoot and roots were measured. Am-shade and pm-shade reduced total DW by 12% and shade all day by 30%. Afternoon Pn was 46% lower than morning Pn in all but am shade treatment. Pn of am shade did not increase in the afternoon when PFD was maximal. Conductance in the afternoon was 22% lower than the morning in shade and pm-shade treatments, but remained the same in sun and am-shade. Light level and leaf position influence on Pn was also measured.

379 (PS 15)

AVOCADO FRUIT TOLERANCE AND RESPONSES TO INSECTICIDAL O_2 AND CO_2 ATMOSPHERES

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Atmospheres with < 0.5% O_2 and/or ≥60% CO_2 have been shown to be insecticidal. Avocado fruit *(Persea americana* Mill., cv Hass) were exposed to air and to a modified atmosphere (MA) containing O.1-0.44% O_2 and 54-75% CO_2 at 20°C for 0 to 5 days. Fruits were evaluated every day immediately after removal from MA and after ripening in air at 20°C. MA for 2 days or more reduced the respiration rate and texture and green color losses. However, exposure of fruit to these atmospheres for more than one day resulted in exocarp and mesocarp injury after ripening in air. MA reduced the activities of alcohol dehydrogenase (ADH) and lactate dehydrogenase (LDH) and increased the activity of pyruvate decarboxylase (PDC) in the mesocarp. Exocarp PDC and ADH were reduced and that of LDH was slightly increased in MA However, MA had no effect on 4 glycolytic metabolites. We conclude that these insecticidal atmospheres can only be used in avocado, as a potential treatment for postharvest insect control, for periods of one day or less.

380 (PS 16)

APPLE FRUIT DEVELOPMENT IN NORTHERN MEXICO

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Apples grown in México are affected by delayed foliation and have to receive rest breaking treatments. There are also problems of biennial bearing. Fruit growth is affected by the dry spring and summer conditions. It is necessary to evaluate the effect of cultural practices on fruit growth and develop models for fruit size and shape. This experiment was carried our during 1990 at the Fruit Research Station Canatlán, located at 24°43'N, 104°47'W. Fruit development was evaluated on three apple cultivars: Top Red Delicious, Skyline Red Deli cious and Golden Delicious, under different management conditions in regard to rest breaking sprays and fruit thinning. Weekly measurements of fruit length and width and biweekly - measurements of fruit weight were made. Full season fruit - growth curves were calculated and adjusted by means of Growing Degree Hour calculations. The fruit development curves had a sigmoid shape and were affected by rest breaking practices and thinning. The average size was increased by proper leafing and thinning. Delayed foliation caused smaller fruit size. From these family of curves a model for fruit development is being developed.

381 (PS 15)

VALIDATION OF TWO MODELS USEFUL FOR SIMULATING DIURNAL TEMPERATURE FLUCTUATIONS.

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The validity of two models to simulate diurnal temperature fluctuations from daily maxima and minima, developed from weather records within Kansas, has been confirmed. About 10 years of historical hourly temperature data from 7 cities, ranging in latitude from San Antonio, TX to Madison, WI, were used to determine how universally applicable the models are. The results demonstrate that the two models simulate diurnal temperature fluctuations better than other models currently in common use. These models should greatly improve the prediction of events that depend upon either heat units (i.e., bud emergence or insect life cycle stage) or chilling units (i.e., vernalization or freezing intensity).

382 (PS 16)

PREHARVEST NITROGEN APPLICATION EFFECTS ON OVULE LONGEVITY AND YIELD OF 'DOYENNE DU COMICE' PEAR TREES

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'Doyenne du Cornice' pear *(Pyrus communis* L.) trees are known for low fruit set and crop in spite a high bloom density. A previous work with this cultivar showed that an application of N prior to harvest increases the availability of N reserves to the developing reproductive tissue. Mature trees were given a single foliar application of 5% or 10% urea or a soil application of ammonium nitrate (130 g actual N), 6 weeks before harvest. Ovule senescence was detected by fluorescence microscopy. Ovule longevity was extended by the N treatments. There was no effect on fruit set despite a slight increase with the 10% urea treatment. However, if corrected for trunk cross section area, fruit set shows a significant increase with an application of urea. There was no effect on flower density, crop density, fruit fresh weight, and yield efficiency.

383 (PS 15)

VOLCANIC PUMICE PROVIDES A GOOD PHYSICAL ENVIRONMENT FOR PLANT GROWTH

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Geraniums grown with a mulch of Volcanic pumice had 30% more dry weight and 31% more flowers than bare soil controls. No difference in growth or flower number was observed between geraniums mulched with volcanic pumice (red, black, or small red/black), white marble, or shredded hardwood bark. The lower geranium growth and flower number observed with bare soil corresponded to faster water loss. The bare soil treatment had a lower moisture content after 12 days without water. This difference was followed 7 days later by elevated temperatures (8.8°C higher at the soil surface and 4.9°C higher 10 cm below the surface. In contrast, the temperature 10 cm above the soil surface was 3.9°C lower for bare soil than mulch one day after watering to saturation, but no difference was observed after the soil dried out (17 days without water). In conclusion, volcanic pumice supported plant growth better than bare soil and equal to hardwood bark and white marble. The temperature and moisture holding characteristics were also better than bare soil, but the same as the other mulches tested.

384 (PS 16)

FRUIT QUALITY, MATURITY, AND STORAGE OF EIGHT ASIAN PEAR CULTIVARS GROWN IN CENTRAL WASHINGTON

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Several harvest indices and storage potential of 8 Asian pear cultivars (20th Century, Chojuro, Hosui, Kikusui, Niitaka, Seigyoku, Shinko and Shinseiki) were evaluated using fruit grown under irrigated, central Washington conditions. Shinseiki was among the first to mature and Niitaka was among the last. Chojuro and Hosui developed the highest soluble solids at harvest and Shinko was lowest. Titratable acidity at harvest was highest for 20th Century, Shinko, and Shinseiki. Seigyoku and Hosui exhibited good storage (at -0.5°C for 90 days in cardboard tray packs) characteristics while Niitaka and Shinko stored poorly (others were intermediate). None of the 8 cultivars produced a classic climacteric respiratory pattern; only negligible amounts of ethylene were produced.

385 (PS 15)

ACID RAIN AND POLLEN DEVELOPMENT

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Simulated acid rain at pH 4.5 dramatically reduces corn pollen germination growing on liquid media, primarily due to tube rupture. Acid rain at pH 3.5 inhibits germi-

nation, but does not cause tube rupture. Rupture of tubes is prevented by both low and high temperature treatments of the media. Pollen dusted on the surface of distilled water burst, but the addition of KCN to the water prevented bursting. Pollen tubes developed on media at pH 5.5 would rupture as the pH was lowered to pH 4.5 unless treated with KCN. The data suggest that pollen rupture is related to pH sensitive physiological events. Premature bursting of pollen tubes could result in failure of any particular pollen grain to participate in the reproductive process.

386 (PS 16)

RELATIONSHIP BETWEEN CHROMATICITY VALUES AND LYCOPENE CONCENTRATION IN TOMATO FRUITS

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Lycopene is the predominant carotenoid pigment in tomatoes and primarily responsible for red color. Spectrophotometric procedures for lycopene evaluation although accurate are time consuming and destructive. The objective of this study was to relate chromaticity values (L*,a*,b*) measured using a Minolta Chroma Meter CR-200b portable tristimulus calorimeter with lycopene concentrations in the pericarp of 'Celebrity', 'Mountain Delight' and 'Early Pick' tomatoes. Fruit were selected to encompass varying maturities from green to red ripe and were obtained from a commercial source. Lycopene from individual skin disks or pericarp plugs corresponding to each location of color measurement was extracted in acetone and measured spectrophotometrically at 503 nm. The L* value (a measure of lightness) or a* value (a measure of redness) was determined to be well correlated with lycopene concentration in all 3 cultivars. The linear regression of the lycopene concentration on the ratio of (a*/b*) provided the best R for all cultivars (0.75).

387 (PS 15)

CARBOHYDRATE METABOLISM IN TOBACCO CULTIVARS DURING SHIFTS IN GROWTH TEMPERATURE

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This study examined the effect of shifts in growth temperature on: 1) the partitioning of carbohydrate into starch or sucrose; and 2) the differential responses of tobacco types which differ in starch accumulation capacities. Six-week-old tobacco seedlings of Speight G28 (G28), a flue-cured cultivar, and Ky 14 (K14), a burley cultivar, were acclimated for 9 days in growth chambers to a 14 h photoperiod of 300 µmol/s-m^2 PAR at 27/22 C (day/night) and a relative humidity of between 70-80%. Temperature was then shifted to 15/10 C for 13 days and then back to 27/22 C for 8 days. At all points, sucrose, starch and protein content was higher in G28. Both cultivars demonstrated significant increases in dry matter accumulation per area, 1 day after the shift to 15/10 C. Dry matter increased steadily through day 13 in G28, but increased to day 5 and then leveled off at day 13 in K14. Nearly identical patterns of sucrose accumulation were observed in both species, with marked increases to day 5 and then a dramatic decline at day 13. Starch content increased steadily from day 1 to day 13 in G28, but leveled off in K14 after day 5. At day 8, soluble protein content increased only slightly in K14, but increased nearly 2-fold in G28. Within 1 day of the return to 27/22 C, starch and sucrose levels in both cultivars dropped 2 to 5-fold, to pre-temperature shift levels. The significance of these finding will be discussed.

388 (PS 16)

ETHYLENE EVOLUTION AND AMMONIUM ACCUMULATION OF TOMATO AS AFFECTED BY NUTRIENT DEFICIENCIES AND (AMINOOXY) ACETIC ACID APPLICATION

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Tomato plants *(Lycopersicon esculentum* Mill. 'Heinz 1350', and *neglecta-1)* were grown in greenhouse with sand culture. Modified NO_3-based Hoagland's solutions without P, K, Ca, Mg and with or without (aminooxy)acetic acid (AOA) were compared with full-strength NH,-based and NO,-based solutions. The characteristic symptoms of nutrient deficient plants were delayed by AOA application, especially Ca and Mg deficiency. K, Ca, and Mg deficiency stimulated ethylene evolution and ammonium accumulation. P-deficient plants had low ethylene evolution but high ammonium accumulation. Ethylene evolution and ammonium accumulation by tomato plants were suppressed by AOA application with nutrient deficient treatments.

389 (PS 16)

CELL WALL HYDROLYSIS IN TOMATO LOCULE GEL FORMATION

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Locule gel formation in tomato fruit is initiated during the latter stages of maturation and prior to the onset of fruit ripening. The development is characterized as a proliferation and apparent autolysis of locule material which, by the terminal phase of ripening, results in almost complete tissue liquefaction. Earlier work (ACS Symp. Series 310, pp.141-56, 1986) demonstrated that some of the changes affecting the cell wall of this tissue were similar to those occurring in pericarp tissue; however, gel tissue expresses no PG activity. Cell wall and ethanol powders (EP) were isolated from gel and pericarp and subjected to comparative *in vitro* autolysis studies. When incubated in buffer at pH 4.5, EP from gel released reducing sugars and uronic acids. when yields were corrected for nonenzymic release, net recoveries were highest in immature-green gel and steadily decreased as ripening proceeded. EP from immature and mature pericarp showed little net release, indicating that the activity of gel EP was related to the early stages of gel formation. Data on product analysis will be presented.

390 (PS 16)

GROWTH & DEVELOPMENT OF 8 MATURE GREENHOUSE TOMATO GENOTYPES AT DIFFERENT LIGHT AND NIGHT TEMPERATURE CONDITIONS

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Greenhouse tomato germplasm was evaluated for growth and flower cluster and fruit development from December to April to identify a more energy efficient genotype. Seven tomato genotypes (1 inbred, 4579, and 6 hybrids) were compared to an advanced greenhouse tomato inbred line (ICR.9) at 2 different night temperatures (17.2 C and 12.2 C) and light levels (natural light and 30% shade 2 days/week). One week after transplanting, growth and development data was collected for 12 weeks at 2 week intervals and weekly fruit harvests started on Feb. 13. Regardless of the conditions, 4579 and 4 of the hybrids had more rapid plant growth and flower cluster and fruit development than ICR.9 and they developed their first cluster after producing less leaves (9.2 or less). Their biweekly per plant averages for total flowering and fruiting clusters, fruiting clusters, fruit set, height and number of leaves were in the following ranges: 6.9-4.6; 3.9-2.6; 27-9; 155-125cm; and 25-22, respectively. The low end of these ranges were all higher than what was recorded for ICR.9. There were large differences between genotypes for fruit yield, size and quality.

391 (PS 16)

FACTORS AFFECTING IN VITRO TOMATO FRUIT GROWTH

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Pollinated tomato ovaries, about 8-10 mm in diameter, were cultured in M-S media containing 0, 2.5, 5.0 and l0.0µM IBA. The fruit size and root mass at ripening increased with an increase in IBA concentration. When pollinated ovaries were cultured with and without the abscission layer in solid and liquid media, different responses were observed in the two media. In solid media, a higher percentage of the ovaries cultured with the abscission layer developed roots as compared to those cultured without the abscission layer. The fruit size and root mass were also greater in ovaries cultured with the abscission layer. However, in liquid media, 100% rooting was observed in the ovaries cultured both with and without the abscission layer. Nevertheless, the fruit size and root mass at ripening were slightly higher in the ovaries cultured with the abscission layer.

392 (PS 16)

EVALUATION OF GEL-RITE VERSUS TRADITIONAL METHODS OF SEED GERMINATION FOR RICE, TOMATO, AND SPINACH

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Variability in plant development at the seedling stage can be a significant source of experimental error due to inadequate germination procedures. The method of germination is especially important to the uniformity and quality of transplants. Rice (Oryza sativa), tomato (Lycopersicon esculentum), and spinach (Spinacia oleracea) seeds were

disinfected in a solution containing 10% sodium hypochlorite. Seeds were then germinated in 1) petri dishes, 2) soil or vermiculite, 3) rolled towel method, and 4) gelled medium containing gel-rite and l/2 strength Hoagland's nutrients. Evaluated parameters included rate and percentage germination, and height and dry weight after 10 days. Overall, the gel-rite method allowed for more uniform germination and upright seedling growth compared to all other methods. In addition, the capability to evaluate root uniformity and ease of transplanting was increased with the gel-rite medium. This method is ideal for studies involving transplant to hydroponic culture, because a root-zone environment similar to that used in germination is employed during subsequent plant growth.

393 (PS 16)

IMPACT OF ELEVATED CO, AND TEMPERATURE ON STOMATAL DENSITY AND FUNCTION IN RICE

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The 'greenhouse effect' of increased global atmospheric CO, and temperature (2-5 °C) potentially affects tropical rice cultivation and yield in many different ways. One important influence is on stomata1 density and function. Rice possesses the greatest density of stomata (nearly 600 mm^{-2}) of all major crops. An increased density could result in increased gas exchange and concomitant improved temperature regulation and photosynthesis in hot, humid climates. To determine effects of increased CO_2 and temperature on stomata1 density and function, four cultivars of indica rice (IR36, IR46, IR52, IR74) were grown in two different treatment regimes in the greenhouse: 350 µmol·mol^{-1} CO_2 and 31/27 °C day/night temperature (control) or 660 µmol·mol^{-1} CO_2 and 37/33 °C day/night temperature. Flag leaf area and stomata densities were measured on the adaxial and abaxial leaf surfaces at 30 day intervals. Stomata1 densities were determined from leaf impressions made with clear nail polish by direct macroscopic observation with a video image analysis system. The impact of change in stomata1 density on leaf function was determined from gas exchange measurements with a Li-Cor 6200 portable photosynthesis system.

394 (PS 16)

ROOTING VOLUME INFLUENCE ON WHOLE-PLANT GROWTH AND PARTITIONING OF BELL PEPPERS

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Bell pepper (Capsicum annuum L.) plants were grown in container volumes ranging from 0.45 L to 10.00 L. Leaf, flower, and fruit numbers were determined twice weekly as was stem height. Plants were sampled 0, 13, 23, 45, and 58 days after transplanting (DAT) to determine leaf area and dry weights of plant parts. Whole-plant photosynthesis measurements were made for a sub-sample of plants 44 DAT, and chlorophyll content was determined from leaf samples 44 and 57 DAT. Leaf area differences between the largest and smallest rooting volume were apparent by 23 DAT, and by 45 DAT leaf area was proportional to rooting volume with significant differences between all treatments. Photosynthesis was proportional to leaf area of plants, with the exception of the smallest rooting volume which had a lower photosynthetic rate per unit leaf area. Chlorophyll content of leaves was proportional to rooting volume. Dry weights up until 45 DAT revealed no marked effect of the various rooting volumes on root-to-shoot ratio.

395 (PS 16)

MORPHOLOGICAL AND BIOCHEMICAL COMPARISON OF A PURPLE-LEAFED AND A GREEN-LEAFED PEPPER CULTIVAR

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The production of anthocyanins in leaf tissue represents an investment of metabolic energy in compounds which may reduce the harvest of solar energy in the photosynthetic apparatus through the shading of chloroplasts. It is therefore reasonable to suspect that purple-leafed cultivars would be less productive at all developmental stages than standard green-leafed cultivars. Two pepper varieties were selected for comparison, 'Zerto', a typical F1 hybrid sweet pepper and 'Pretty Purple', a short, bushy plant with small leaves and dark purple foliage. Plants were grown for 12 weeks in the winter greenhouse and then transferred to a controlled environment chamber with a 14 hr photoperiod of 400 µmol/s-m^2 PAR at 22 C for two weeks. Leaf area, FW/area, DW/area and total soluble protein content were similar in both cultivars. Chlorophyll content was 40 and 26 µg/cm^2 in 'Pretty Purple' and 'Zerto', respectively and anthocyanin content was 75 times greater in the former. 'Pretty Purple' had higher light-saturated rates of photosynthesis and lower rates of light-limited photosynthesis and respiration. The 'Pretty Purple' appears to be more tolerant to water stress and efforts are underway to determine the role, if any, of anthocyanins in differential responses to stress.

396 (PS 16)

RESPIRATION OF IMBIBED AND PRIMED MAIZE SEED

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Studies were conducted on corn (Zea mays) seeds using a Clark electrode to monitor the O_2 uptake during the first 3 days of germination. Lots with germinations of 71% and 25% stored for 12 and 30 years, respectively, and fresh seed lots with high germination were selected for study. Individual seeds were evaluated sequentially at 8 to 12 hr intervals for periods of 20 min and returned to the germination toweling. Seed weights were recorded prior to respiration in order to estimate seed moisture content. After completion of the respiration analyses the seeds were evaluated at 7 days for germination and root length. Seeds were primed in PEG for 48 to 96 hr, dried and reimbibed. Based upon time of imbibition, respiration of viable seeds was higher than for non-viable seeds beginning at about 12 hr. However, comparisons of respiration of viable and non-viable seeds having the same moisture content showed similar values for 12 yr old seed, but not for 30 yr old seed. Seeds primed for 48 hr responded similarly to unprimed seeds, while seeds primed for 96 hr did not germinate.

397 (PS 16)

EFFECT OF DEVELOPING FLOWER BUDS ON EMBRYO ABORTION IN BUCKWHEAT.

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Buckwheat yields are limited by the failure of most flowers to produce seeds, even though there is apparently ample pollination and adequate photosynthetic capacity to support much higher seed production. We tested the hypothesis that developing flower buds suppress embryo development. Two approaches were used. Greenhouse grown plants were hand pollinated for three days, then subsequent buds were removed on half the inflorescences. The differences were not significant.

	n	% swollen ovary	% seed set
Buds retained	155	44	41
Buds removed	141	50	44

For a second approach we cultured isolated 3-day old ovules on nutrient agar for 10 d, with young flower buds placed adjacent the half the ovules. In contrast, the growth of embryos which emerged from cultured ovules was depressed by the presence of buds (t=2.26, P=.03).

	n	% surviving	embryo length
Adj. buds	28	86	2.3 ± 1.1
No buds	25	72	3.2 ± 1.4

It appears that the growth of embryos may be suppressed by growth of later flower buds, but that the effect on per cent seed set is small.

398 (PS 16)

MORPHOLOGICAL DEVELOPMENT OF OILSEED RAPE GROWN AT THREE LEVELS OF BORON NUTRITION

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Rape *(Brassica napus* var. *olefera)* plants grown in perlite were supplied with nutrient solutions containing three levels of added boron (0.04, 0.08, or 0.80 mg L^{-1}). Plants grown in these solutions exhibited severe (SD), moderate (MD), or no (ND) boron deficiency symptoms, respectively. Leaf boron concentrations at maturity for the SD, MD, and ND plants were 62, 118, and 161 µg g^{-1} dry wt, respectively. Both number of primary leaves per plant (19(SD), 20(MD), 22(ND)) and primary stem height in cm (36(SD), 55(MD), 63(ND)) were reduced at the lower boron concentrations. Moderately deficient plants had a 90% reduction in number of seed per plant and seed production was completely inhibited in SD plants. Only the SD plants exhibited symptoms normally associated with boron deficiency (external stem cracks and pith degradation (hollow stem)). Therefore, a significant yield reduction occurred in plants (MD) not exhibiting obvious boron deficiency symptoms.

399 (PS 16)

GERMINATION AND SUBSEQUENT DEVELOPMENT OF EARLY PLANTED COWPEAS.

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Germination and development of twenty-five genotypes of cowpea (Vigna unguiculata) were evaluated during two years of early planted field studies. Seeds were planted on April 15, 1989, and on

May 1, 1990. During the three weeks following planting the minimum weekly soil temperature averaged below 10°C for 1 week in 1989 and for 2 weeks in 1990. Due to low soil moisture, percent germination was less than 10 at 21 days after planting but increased to 65 by 40 days for some genotypes in the 1989 study. In the 1990 evaluations the germination at 21 days ranged from 1 to 46%. Genotypes flowered between 64 and 112 days and produced fresh pods within 81 to 150 days. Total fresh pod weight varied from 3 to 491 g/plant, pod length from 14 to 19 cm, seeds per pod from 9 to 1.5, and weight of 25 seeds from 5 to 10 g.

400 (PS 16)
VIABILITY AND VIGOR OF CORN SEEDS AFTER REPEATED IMBIBITION/DRYBACK

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A non-central tendency measure of viability based on 100 individual seed leachate conductivities has been developed to monitor seed deterioration. We report here the effects up to 5 cycles of imbibition/dryback with soak times of 2, 4, 6, 7 and 8 hours at 25°. Seed dryback (12 to 16 days) to 18%. (14 to 23%) and 10% (7 to 14%) DW basis provided a data grid of 5 x 5 x 2 or two grids of 5 x 5. Eight thousand seeds of Zea mays cv. 3541, lot 88-9, initial germination 96%, were used. Factorial ANOVA and all subsets regression methods were used for data analysis. By the fourth cycle viability had leveled at 93% ($P < .05$). Decline caused by cycle duration (soak time) was significant ($P < .05$) after 4 hours and 6 hours considering low and high seed moisture contents respectively. The maximum cycle by duration treatment reduced relative vigor (based on non-soaked cycle responses) by 27%. However, a "priming" effect is suspected. Viability and vigor estimates based on multiple regression models will be discussed.

401 (PS 16)
RESPONSE OF 'ALASKA' PEA SEEDLINGS TO FREEZING AND CHILLING STRESSES AFTER EXOGENOUS APPLICATION OF ABSCISIC ACID.

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Alaska peas (Pisum sativum 'Alaska') germinated in a dark growth chamber were treated ABA dissolved in a small amount of acetone before diluting in distilled water with 0.1% spreader. A blank solution was identically prepared without ABA. Both solutions were applied via paintbrush to the epicotyls of the peas every twelve hours for seven days following emergence. The blank solution was applied to two controls, chronological and physiological. A methanol bath was used to induce freezing and chilling stresses. ABA significantly improved cold tolerance (electrolyte leakage) in the pea seedlings for both freezing and chilling stress as compared to the physiological and chronological controls. Visual observation of the pea stems suggested a difference in stem flexibility among ABA treated peas and the controls. Pea stem elasticity and plasticity were measured along with plant dry weight, cell wall weight/gram fresh weight, and the quantity of cell wall sugars and amino acids.

402 (PS 16)
EFFECT OF TWO DIFFERENT ACCELERATED AGING REGIMES ON ONION SEED LIPIDS AS DETERMINED BY CAPILLARY SUPERCRITICAL FLUID CHROMATOGRAPHY

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One traditional method for accelerated aging of seed has used elevated temperatures of >40C, and elevated atmospheric moisture of >90%RH. This study compares the effect of the high moisture/temperature regime to one which used elevated oxygen concentration (97-99% 0_2) along with elevated temperatures of >40C. Germination, seedling vigor, and CSFC/FID profiles of whole lipids extracted from seed stored in these two environments were compared. There were significant differences in not only the rates of loss of vigor and viability of the seed, but distinct differences in the chromatographic profiles of the seed lipids between the two accelerated aging storage conditions. Significant quantitative differences were also found when comparing the aged seed to the 'non-aged' control. These data indicate that different biochemical processes may be associated with the loss of viability of onion seed exposed to different aging regimes.

403 (PS 16)
EFFECT OF HIGH CARBON DIOXIDE CONCENTRATIONS ON POTATOES GROWN IN CONTROLLED ENVIRONMENTS

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Potatoes, (Solanum tuberosum L.) cvs. Denali and Norland, were grown at 1000 ubar (ppm) and 5000 ubar CO_2 to study effects of high CO_2 on growth and development. All plants were grown for 105 days using nutrient film technique (NFT) with a 12-h photoperiod, a 20°C/16°C thermoperiod, and approximately 260 µmol m^{-2} s-1 PPF. Radiation was provided from fluorescent lamps filtered through a clear acrylic barrier. At 5000 ubar CO_2, 'Denali' plants showed extensive oedema (intumescence) on young, expanding leaves, but this diminished as plants aged. No oedema was present on 'Norland', regardless of CO_2 or plant age. Throughout growth, stomata1 conductance of upper canopy leaves for both cultivars was consistently higher at 5000 ubar CO_2 in comparison to 1000 ubar. Increasing CO_2 from 1000 ubar to 5000 ubar decreased 'Norland' tuber yields 13% and decreased 'Denali' yields about 5%. Harvest index (tuber DW/total plant DW) values for 'Norland' were near 0.81 for both CO_2 levels and 0.80 and 0.73 for 'Denali' at 1000 and 5000 ubar, respectively. Results suggest that under these environmental conditions, 5000 ubar CO_2 may be supraoptimal but not toxic for cvs. Denali and Norland.

404 (PS 16)
EFFECT OF THERMOPERIODS ON GROWTH AND TUBERIZATION IN POTATOES

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Plants of four potato *(Solanum tuberosum)* cultivars, 'Denali', 'Norland', 'Haig', and 'Kennebec', were grown for 42 days under different temperature cycling periods (thermoperiods) with continuous irradiation in controlled environment rooms. Three thermoperiods (6h:6h, 12h:12h, 24h:24h) were established with the temperature change of 22/14°C and controlled vapor pressure deficit of 0.60 kPa. 'Denali' produced higher tuber and total dry weights under 6h:6h thermoperiod than under the thermoperiods of 12h:12h and 24h:24h. 'Kennebec' produced greater tuber dry weight under 12h:12h thermoperiod than under the thermoperiods of 6h:6h and 24h:24h. 'Norland' and 'Haig' showed similar tuber and total dry weights under the three thermoperiods. Root dry weights were not changed significantly with the three different thermoperiods in all four cultivars. The thermoperiod of 24h:24h significantly promoted tuber initiation but slowed tuber enlargement in all cultivars, as compared to the thermoperiods of 6h:6h and 12h:12h. The results suggest that the thermoperiod can be used to affect tuber development of potatoes in controlled environments.

405 (PS 16)
ABA-INDUCED QUIESCENCE OF SWEETPOTATO IN VITRO

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Axillary buds of sweetpotato [Ipomoea batatas L. (Lam.11 cultured on Murashige and Skoog medium supplemented with l-10 mg/l abscisic acid (ABA) failed to develop into plantlets yet remained viable over a 12 month culture period. The growth retarding effects of ABA were not reversed by addition of gibberellic acid (GA_3) to the culture medium in the presence of ABA. Transfer of nodal segments cultured for 12 months on MS supplemented with 10 mg/l ABA to basal MS (absence of ABA) resulted in rapid axillary shoot development. Plantlets from these quiescent buds were free of visually detectable morphological variation when compared to controls. This "zero" growth (as opposed to minimal growth) protocol is presently being evaluated for use in sweetpotato germplasm maintenance programs.

406 (PS 16)
ROOT AND SHOOT PERCEPTION OF LIGHT QUALITY AND PHOTOMORPHOGENIC GROWTH OF WATERMELON

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Early photomorphogenic growth responses of watermelon *Citrullus lanatus* cv. 'Sugar Baby' were evaluated as influenced by root and shoot perception of light quality. Roots and shoots were independently treated with end-of-day Red (R), Far Red (FR), and Far Red followed by Red light. Plants were grown in hydroponics with Hoagland's solution. Shoot

irradiation with FR light increased dry weights of stems and petioles. Root irradiation with FR light increased dry weight of petioles. End-of-day FR light treatment of the shoot increased petiole lengths of first four leaves. Roots irradiated with FR light increased the petiole length of the fourth leaf. Both FR treated root and shoot petiole growth responses were reversed by R light treatments implicating a phytochrome response.

407 (PS 16)

SPECTRAL CHANGES IN METAL HALIDE AND HIGH PRESSURE SODIUM LAMPS EQUIPPED WITH ELECTRONIC DIMMING

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Electronic dimming of high intensity discharge lamps offers control of photosynthetic photon flux (PPF) but is often characterized as causing significant spectral changes. Growth chambers with 400 W metal halide (MH) and high pressure sodium (HPS) lamps were equipped with a dimmer system using silicon controlled rectifiers (SCR) as high speed switches. Phase control operation turned the line power off for some period of the AC cycle. At full power the electrical input to HPS and MH lamps was 480 W (RMS) and could be decreased to 267 W and 428 W, respectively, before the arc was extinguished. Concomitant with this decrease in input power, PPF decreased by 60% in HPS and 50% in MH. The HPS lamp has characteristic spectral peaks at 589 and 595 nm. As power to the HPS lamps was decreased the 589 nm peak remained constant while the 595 nm peak decreased, equalling the 589 nm peak at 345 W input, and was almost absent at 270 W input. The MH lamp has a broader spectral output but also has a peak at 589 nm and another, smaller peak, at 545 nm. As input power to the MH lamps decreased the 589 nm peak diminished to equal the 545 nm peak. As input power approached 428 W the 589 nm peak shifted to 570 nm. While a spectral change was observed as input power was decreased in both MH and HPS lamps, the phytochrome equilibrium ratio (P_{fr}/P_{tot}) remain unchanged for both lamp types.

39 ORAL SESSION (Abstr. 408-418) Collegiate Branch Forum

408

PRODUCTION OF SCOTCH BONNETT PEPPER IN MISSOURI: AN ECONOMIC EVAULUATION

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Scotch Bonnet peppers are presently sold in speciality shops in several cities in the United States. This pepper, with a heat reading of over 250,000 Scoville units, is sold as the most pungent pepper available on the market. Scotch Bonnet was developed in the Caribbean for its shape and flavor and is presently grown in several areas in the United States. This study was undertaken to determine the cost of producing this crop and the economic returns. Cost of production was determined in three sections (1) establishment (seedlings and field), (2) growing and (3) harvesting. Over 85% of the total costs were distributed between establishment and harvesting. Growing cost was reduced relative to that of other peppers, as a result of the low maintenance needed by this crop after it was established. Pepper yields were sustained over an 8 week period with mature green pods available until the first frost. Yields of pepper averaged between 16560 kg per ha with maximum yields in mid-September to mid-October. There was no significant fluctuation in price during the harvest period. Direct sales to specialty shops generated $16. 24 per kg for the entire harvest.

409

INTERACTION OF CULTURE VARIABLES AND RESPONSE OF MINIATURE DWARF TOMATOES TO A SALINE TEST SYSTEM IN VITRO.

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In vitro selection screens to test for salt response of crop plants can provide an efficient, realistic alternative to field tests. In developing such a system for a highly determinant miniature dwarf tomato selection, Lycopersicon 'Micro-Tom', key refinements were required to provide test conditions that accurately paralleled in vivo responses. For example, only nodal segments from seedlings could be used as initial explants, since use of apical tips led to premature flower development. During the test, plant growth performance and osmotic adjustment were evaluated at two week intervals. These frequent, repeated observations during the. course of the experiments provided a more. accurate assessment of plant adaptation responses than an end-point evaluation. Individual plants were trimmed to a standard size prior to subculture to gradually increasing salt levels (from 3.3 [control] to 18 dS m^{-1} of NaCl or Na_2SO_4) to permit adaptation, or alternatively, transferred directly from control to a high salt treatment to determine shock response. In adaptation experiments, neither NaCl or Na_2SO_4 caused significant inhibition of shoot growth until the highest salt treatment. Root growth was more severely inhibited by NaCl at intermediate concentrations than by parallel concentrations of Na_2SO_4. In contrast, plants were not able to survive the shock of direct transfer to the high Na_2SO_4, whereas parallel transfer to the high NaCl treatment resulted in eventual recovery.

410

DRY MATTER PRODUCTION AND NITROGEN UPTAKE OF ROZELLE

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Rozelle (Hibiscus sabdariffa) is grown primarily for its fleshy calyx and fiber. A preliminary study indicated that planting date affected growth rate and yield of rozelle, but very limited information is available on the cultural and nutritional requirements of the plant. A study was conducted to determine the effects of varying rates of applied nitrogen on the growth, dry matter production and nitrogen uptake of rozelle. Six-week-old transplants were treated with a base rate of 200 mL of 2.0 g.L 20-20-20 (N-P-K) per week plus rates of 0, 100 and 200 mg.L^{-1} N in irrigation water. There was a significant increase in plant dry matter as nitrogen rates were increased. Plant height and stem diameter of rozelle were also affected significantly by increased nitrogen rates. There was a decrease in the rate of stem diameter increase as rozelle plants matured. Stem diameter increase ranged from 3.5 to 0.1 mm per week for plants that were measured after three weeks to nine weeks after transplanting. Leaf nitrogen content of rozelle leaves was 2.97% for treatments given an additional 200 mg.L^{-1} N in irrigation water. Plant height, dry matter and stem diameter were correlated &thin nitrogen treatment.

411

EFFECTS OF MULCH TYPES AND COLORS ON GROWTH AND YIELD OF MUSKMELONS

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Mulches are beneficially used in most farming areas in the world. They are useful in soil moisture conservation, weed suppression, reduction in temperature extremes and erosion control. Other beneficial effects include earlier production and greater total yield. This study was initiated to compare the effects of mulch types and colors on the soil microclimate and some growth characteristics of muskmelon plants. A field experiment using a randomized complete block design and four replications was conducted on Olivier silty clay loam. Treatments included Control, Newspaper, Hay, Pine Needles and five colored Polyethylene Mulches (clear, green, steel-colored, black or brown). A variation in soil temperatures was observed among mulch types and colors. Vine spread was significantly affected by mulch types. Mulches also affected the total soluble solids and total yield of fruits. Other factors such as soil moisture, soil nutrient movement, and insect infestation of plants will be discussed.

412

2n POLLEN, FLOWERING, AND TUBERIZATION IN Solanum SPECIES

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One method of potato breeding is to obtain tetraploids from tetraploidXdiploid matings. The diploids (2X) are haploid X wild species hybrids. Some of these hybrids produce diploid (2n) pollen, which is necessary to successfully cross them with the tetraploids. The objective of this work was to screen 59 Plant Introductions (PI) representing 13 wild Solanum species. The PIs were grown in a greenhouse, their pollen collected, stained with acetocarmine glycerol, and microscopically examined. Pollen was collected from a total of 578 plants, of which less than 1% had a useful amount of 2n pollen, although 20% had 1 or more 2n pollen grains. This percentage varied between PIs and between species. Some PIs failed to flower, but they did tuberize, allowing their storage for future investigation. Other PIs did not flower or tuberize.

413

EVALUATION OF VEGETABLE SOYBEAN CULTIVARS FOR HELIOTHIS ZEA RESISTANCE UNDER INDUCED INFESTATION

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Consumers fear of dietary cholesterol have increased demand for food such as soybean. However, use of pesticides on crops have consumers concerned about residual build up. As

a result vegetable soybean breeders seek to develop cultivars resistant to economic pests.

Forty-nine vegetable soybean cultivars (MG III to V) were tested under field conditions for their resistance to H. zea. Each cultivar planted in 4.5 m single row plot with row spacing of 0.75 m were arranged in randomized complete block design with four replications. Five, first instar larvae were used to infest each of five plants during 50% flowering stage. After physiological maturity, plants were harvested and pods damaged by H. zea recorded.

Results indicated that cultivars Fuji (MG III), SAT0 (MG IV) and PI 417.288 (MG V) were most resistant. These cultivars might be a good source for the development of high yielding vegetable soybean cultivars resistant to H. zea.

414

EFFECTS OF ENVIRONMENTAL VARIABLES ON CARBON DIOXIDE EXCHANGE RATES OF A SOYBEAN STAND GROWN IN NASA'S BIOMASS PRODUCTION CHAMBER

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Dept. of Horticulture, Colorado State Univ., Ft. Collins, CO 80521 (GMV): Dept. of Plant & Soil Sciences, Univ. of Massachusetts, Amherst, MA 01003 (KAC); NASA Biomedical Operations and Res. (JCS) Kennedy Space Center, FL 32898 (RMW & JCS).

A 20 m^2 stand of soybeans [Glycine max (L.) Merr. cv. McCall] was grown in NASA's biomass production chamber using metal halide lamps with a 12 hr light/l2 hr dark regime. Rates of dark respiration and photosynthesis were determined daily from measurements of CO_2 evolution during the dark and drawdowns to the CO_2 setpoint of 1000 ppm. Net photosynthesis at an average photosynthetic photon flux (PPF) of 500 to 550 µmol/m^2s was 15 µmol/m^2s at 24 days after planting (DAP), reached a peak of 25 µmol/m^2s at 28 DAP, and then declined gradually after podset (50 DPA. Rate of photosynthesis was linear in the range of PPF used (0 to 550 µmol/m^2s) and PPF compensation points increased from 76 µmol/m^2s at 22 DAP to 110 µmol/m^2s at 78 DAP. Increasing the temperature to 30 C resulted in an increase in dark respiration and a decrease in the net CO_2 assimilation (NA). From 42-45 DAP, the highest NA were obtained at regimes of 26 C light/l8 C dark and 22 C light/22 C dark.

415

INFLUENCE OF IRON DTPA CHELATE CONCENTRATIONS ON THE OCCURRENCE OF A SPECIFIC PHYSIOLOGICAL DISORDER IN GERANIUM.

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A specific physiological disorder affecting the leaves of geranium *(Pelargonium hortorurn)* has been reported to occur in commercial production. Early symptoms of the disorder often resemble mite damage. Advanced stages are characterized by chlorotic speckling and/or marginal chlorosis and necrosis of older leaves. The disorder has been associated with high concentrations of Fe and Mn in affected tissues and susceptibility may vary with cultivar. Primary objectives of this experiment are to induce the disorder with high concentrations of iron DTPA. Two cultivars reported to be susceptible to the disorder, 'Aurora' and 'Grace', were grown in peat-based media under greenhouse conditions. Iron DTPA treatments of 1, 5, 15, or 20 ppm were supplied in the regular liquid fertilizer program using 20-10-20 Peters (Grace/Sierra Inc, Fogelsville, PA.). Leachate samples of media were collected weekly throughout the study to monitor pH, and concentrations of soluble salts, Fe, and Mn. Leaves were collected at harvest and divided into symptom and non-symptom tissue for dry weights and Fe and Mn analysis. Symptom occurrence and progression of the disorder will be discussed.

416

HYBRIDIZATION BETWEEN DIPLOID AND TETRAPLOID PELARGONIUM XHORTORUM BAILEY

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Pelargonium x hortorum, the zonal geranium, is an important floriculture crop with desirable qualities exhibited in both diploid (2x) and tetraploid (4x) cultivars. The production of a triploid form, and indeed, hybridization between 2x and 4x types has not been reported. Thus, transfer of characteristics between ploidy levels has been impossible. A plant, 78-139-7, derived from a 4x breeding line in the Penn State Geranium Breeding Program may be able to bridge the ploidy levels by the production of unreduced gametes. This plant was hybridized in earlier studies with both diploid and tetraploid cultivars and fertile offspring were produced. Chromosomes from root tip cells of 78-139-7 and its progeny were observed and counted. The unique plant was determined to be diploid, 2n=2x=18. All hybrids of 78-139-7 with either 2x or 4x cultivars exhibited ploidy levels consistent with the cultivar parent. In most crosses, 78-139-7 was used as the maternal parent and genetic markers were included in the paternal parents. Pollen grains from 78-139-7 were also observed and measured; the majority of the pollen grains were consistent with pollen sizes of known diploid cultivars. Based on the production of fertile 2x or 4x offspring, the most plausible explanation is the production of unreduced gametes in 78-139-7. The presence of unreduced gametes in 78-139-7 insures that important horticultural characteristics can be transferred between cultivars of different ploidy levels.

417

PERFORMANCE OF ROCKWOOL AND PEAT MIXTURES AS GROWING MEDIA FOR EASTER LILY

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Five different mixtures of rockwool (RW) and peat (PT) as growing media for Easter lily (Lilium longiflorum Thunb.) cv. Nellie White were evaluated. Media water retention porosities were 77, 75, 72, 49 and 36%. respectively, for 100% RW, 75% RW + 25% PT, 50% RW + 50% PT, 25% RW + 75% PT, and 100% PT. Aeration porosities of these mixtures, respectively, were 8, 11, 17, 38, and 54%. The total porosities of these mixtures ranged from 85 to 90%. All the media had lime and triple superphosphate as base fertilizers. When Easter lilies were grown with a constant feed program, plant height and the number of leaves and flowers per plant were not affected by media formulations. The required irrigation frequency decreased as the percentage of rockwool in the mixture increased. The health and vigor of plants grown in the 5 mixtures were similar to those grown with peat-lite or soil containing media.

418

CONSUMER EVALUATION OF A GROWING MEDIUM CONTAINING COMPOSTED BROILER LITTER

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Composted broiler litter has been used to grow crops yet a negative perception of media odor may prevent its use in the home. The purpose of this study was to determine if composted broiler litter would be an acceptable amendment to a soilless potting mix. Liners of Dallas fern [Nephrolepsis exaltata dallasii, cv. Dallas Jewel] were planted in one of three growing media: Baccto, Hyponex, and SMAL (soilless mix amended with composted broiler litter). Garden club members (112 of 120) completed a six-week blind survey in their homes. Weekly ratings were made for each plant on frond color, media odor, water added, and plant health. Media odor ratings were similar for both commercial mixes, but slightly less than the rating of SMAL. Hyponex required more water than Baccto or SMAL. Frond color was similar in Baccto and SMAL; frond color in Hyponex was a lighter green than in Baccto or SMAL. SMAL performed as well as Baccto and better than Hyponex. Composted broiler litter could be used as a component of a soilless mix.

40 ORAL SESSION (Abstr. 419-426) Genetics and Breeding: Germplasm I

419

GENETIC IMPROVEMENT OF SLICING CUCUMBER, 1786 TO 1982

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Cucumber *(Cucumis sativus* L.) breeders have provided growers with many useful cultivars since production began in the U. S. in the 1600s. The objective of this study was to determine how much breeding progress has been made for yield, earliness, quality, and anthracnose resistance. The experiment was a split-split-split plot in a randomized complete block with 3 replications. Treatments were 2 years (1989, 1990), 2 seasons (spring, summer), 2 production systems (stress, elite), and 14 cultivars (2 important ones from each of 7 time periods, from 1786 to 1982). Plants were grown at Clinton, N. C. using recommended cultural practices, except for the stress treatment, which received half the recommended amount of fertilizer, irrigation, and pesticides. Total yield over 8 harvests increased from approximately 20 Mg/ha for the old cultivars to 30 Mg/ha for the new cultivars. Similar increases were measured for marketable and early yield. Fruit quality (rated 1 to 9) also was improved by breeding, with shape improved 2, and fruit color improved 3 rating points. Part of the improvement in yield was probably due to improved anthracnose resistance. However, improved yield also was obtained in the spring season where anthracnose was absent. In conclusion, the relatively small cucumber breeding effort produced large gains for most traits measured.

420
GENETIC INPROVEMENT OF CUCUMBER NUTRITIONAL VALUE
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Pickles are generally regarded as a tasty, crunchy, low-calorie food with little nutritional value. To evaluate the potential for genetic improvement of cucumber nutritional value, vitamin C and carotene content was examined. Cucumber fruit flesh varied from 15 ppm to 76 ppm vitamin C and peel varied from 22 ppm to 71 ppm vitamin C among ten cucumber cultivars or USDA breeding lines of diverse genetic background. Cucumbers are generally thought to contain very little carotene (0-2 ppm) since, unlike melons, they are white-fleshed. However, we have found that darker green cucumbers do contain up to 45 ppm carotene in their peel, which is approximately 5 ppm on the basis of total fruit weight. In addition to the carotenes in cucumber peel, a few rare cucumbers are yellow-fleshed. We have utilized a yellow-fleshed Chinese cucumber to examine the possibility of developing yellow- or orange-fleshed cucumbers for pickling. We have identified cucumber fruits with flesh carotene content of up to 11 ppm in pickling-sized fruits and up to 31 ppm. in mature fruits among these derivatives.

421
PERFORMANCE OF PARENTS AND PROGENIES IN CARIBBEAN X TEMPERATE CROSSES OF CUCURBITA MOSCHATA
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Caribbean pumpkins (Cucurbita moschata) are large plants with vines that extend up to 15 m from the base of the plant. Temperate genotypes are much more compact with smaller fruit. We compared growth, fruit quality, and disease reaction of parents and progenies of some Caribbean x temperate crosses of C. moschata grown in Puerto Rico. Temperate parents flowered in 30-40 days vs. 60-70 days for tropical genotypes. Temperate plant internodes were a third as long as those of tropical types with the first flower at node 12 vs. node 35 for tropical types. Yields of tropical parents were 10 times greater than those of temperate genotypes. Temperate genotypes were highly susceptible to both powdery and downy mildew compared with tropical types. F1 plants were similar to their temperate parent. F2 and BC progeny exhibited a combination of desirable traits such as intermediate plant and fruit size with a high degree of mildew resistance.

422
MOLECULAR SYSTEMATICS OF ALLIUM SECT. CEPA
Michael J. Havey*, USDA/ARS Department of Horticulture, University of Wisconsin, Madison, WI 53706

The bulb onion (Allium cepa exists only in cultivation and no single progenitor is known. Onion and four wild species (A. galanthum, A. oschaninii, A. pskemense, and A. vavilovii) have been classified to Allium section Cepa, but the phylogenies of species within this section are unclear. Restriction fragment length polymorphisms in the chloroplast and nuclear genome are useful for estimation of phylogenetic relationships. Mutations at restriction enzyme sites and structural changes in the chloroplast and ribosomal DNA have been identified. No wild species was identical to the bulb onion for all mutations. However, A. oschaninii and A. vavilovii possess relatively few differences from onion. These two species represent wild germplasm potentially useful in genetic improvement of onion.

423
SCREENING ALLIUM GERMPLASM FOR REACTION TO 0NION MAGGOT
James R. McFerson*[1], Charles J. Eckenrode, Jr.[2] and Paul S. Robbins[2], [1]USDA -ARS Plant Genetic Resources Unit and Dept. of Entomology, Cornell Univ., Geneva, NY 14456-0462

Onion maggot (Delia antiqua Meigen) is a major pest of common onion (Allium cepa L.) throughout the northern USA. Identification of useful host plant resistance in either A. cepa or related species offers the potential for introgression into acceptable genotypes. Over two growing seasons we screened approximately 600 accessions of 25 Allium species for reaction to onion maggot. Plots were grown with no insecticide protection in commercial fields with a history of infestation. Entries were examined for first generation larval attack by counting seedling mortality twice weekly during early summer. Surviving entries were examined for percent infestation by third generation larvae in October. Results indicated significant intra- and inter-specific variability. The greatest damage occurred on A. cepa with a 79% mean stand loss, but several A. cepa accessions showed both a reduced total stand loss and a reduced rate of seedling decline over both years. Certain Allium spp were much less damaged than A. cepa. Stand loss to first generation larvae in A. ampeloprasum (leek) and A. schoenoprasum (chive) averaged 39% and 36% respectively; while infestation level from third generation larvae averaged 9% and 55%.

424
RELATIONSHIP AMONG FRUIT QUALITY AND ARCHITECTURAL TRAITS IN Lycopersicon chmielewskii DERIVATIVE TOMATO POPULATIONS
James Nienhuis*, Steve Schroeder and Gretchen King, Dept. of Horticulture, Univ. of Wisconsin, Madison, WI 53706; H.J. Heinz Co., Stockton, CA 95201 and NPI, Salt Lake City, UT 84108

A wild species of tomato from Peru, L. chmielewskii, has been shown to have higher levels of fruit soluble solids (10%) compared to the cultivated tomato (5%). Two processing tomato lines, M12 and M144, were developed through 5 generations of pedigree selection from a cross between an accession, LA1028, from L. chmielewskii and a processing tomato, L. esculentum cultivar, UC82. The derivative line Ml44 was crossed with a Heinz line, H3041, and 100 random F_3 families evaluated in replicated trials in two locations for an array of traits. Phenotypic correlations between soluble solids and other traits were as follows: fruit weight (-0.76**), pH (0.09^{ns}), Color L (0.62**), color A/B (-0.45**), main stem length (0.49**), node number of main stem (0.13^{ns}), main stem internode length (0.53^{**}) and length/diameter ratio of mature fruit (-0.11^{ns}).

425
CHARACTERIZATION OF *Brassica napus* RESYNTHESIZED BY INTERSPECIFIC SOMATIC HYBRIDIZATION FROM HIGHLY HETEROZYGOUS PARENTS.
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To broaden the narrow genetic base and to develop new vegetable forms of *Brassica napus*, the progenitors of this natural amphidiploid, *B. rapa* (turnip X chinese cabbage) and *B. oleracea* (cauliflower X purple kale), were hybridized by PEG-mediated protoplast fusion. Seventy somatic hybrids have been produced. Most hybrids exhibit a rosette form with thin, green, hirsute foliage. Others have distinct internodes, with thick, blue-green, glabrous, waxy foliage. Hybridity was confirmed with isozyme markers. RFLPs specific to chloroplast DNA showed non-random plastid segregation favoring those of *B. rapa*. Some hybrids appeared to be heteroplastidic, displaying both parental banding patterns. Most hybrids have high (> 90%) pollen viability and set abundant selfed seed. An apparent self-incompatibility was found in hybrids derived from one of the two self-incompatible *B. rapa* individuals used in two fusion experiments. This incompatibility contrasts with the natural self-compatibility of *B. napus*.

426
PHENOTYPIC PLASTICITY OF TRICHOME DENSITY
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Trichomes are ubiquitous on higher plants, and they may play various roles in defense against stresses. Of the 7 distinct types of trichomes occurring in the genus *Lycopersicon,* certain types, the type IV and type VI, defend against arthropod attack. Both these types are genetically canalized; the type IV trichome is diagnostic for *L. hirsutum,* and the form of the glandular head of the type VI differs between *L. hirsutum* and L. *esculentum.* However, the densities of each of these types responds to day length and are, therefore, phenotypically plastic. Under short days, type IV trichome densities are 5 to 10 times greater than under long days. Conversely, under long days type VI densities are often double those under short days. Such responses could be reaction norms. To test this hypothesis, 4 genotypes were grown in each of three photoperiods, 8, 12 and 16 hours. All plants received 8 hours of photosynthetically active radiation. Day length was extended by equal dawn and dusk periods (2 and 4 hours for the 12 and 16 hour day lengths respectively) with low levels of incandescent irradiation. Type IV trichome densities varied continuously with the length of day, indicating this phenotypic plasticity is likely reaction norm, Type VI density was polyphenic but did not display a reaction norm.

41 ORAL SESSION (Abstr. 427-433) Floriculture: Water Utilization

427
EVALUATION OF A CONTAINERIZED GRADIENT CONCEPT
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In an effort to reduce water requirement, eliminate pollutants and improve productivity, a containerized gradient concept has been initiated and is being evaluated as a potential globally competitive sustainable production system. By using a gradient as *a* basic container component, it becomes possible to approach and sustain a favorable nutrient/water balance without periodic flushing. The composition of the media, the container size and shape, and the integration of water (micro source) and nutrients (soluble K and N banded in the container) are components being evaluated. A containerized system that uses minimal water, eliminates pollutants and has a potential maximum production efficiency must be based on maintaining a nutritional environment that has a maximum nutritional accountability.

428
THE EFFECTS OF CONTAINER SHAPE ON THE GROWTH OF THE WEEPING FIG (Ficus benjamina) .
Graham J. Wright and Dennis B. Mc Connell, Dept of Environmental Hort., IFAS, University of Florida, Gainesville, FL 32611

Ficus benjamina was grown in four different container configurations with varied diameter to depth ratios but a constant volume of growing medium. Best overall top and root growth was found in plants grown in a container with a 1:1 diameter:depth ratio. Plant root distribution patterns within the containers were influenced by the container configuration.

A second experiment was then conducted to compare the standard round container (1:1 diameter to depth) with three other shapes of equal volume. They were a square, a three sided inverted pyramid and a four sided inverted pyramid. Plants in square containers had increased top growth but decreased root growth. Both pyramid shaped containers produced plants with reduced top growth and increased root growth.

429
FERTILIZER LEVELS AND MEDIUM COMPOSITION AFFECT FOLIAGE PLANT GROWTH IN AN EBB AND FLOW IRRIGATION SYSTEM
Richard T. Poole* and Charles A. Conover, University of Florida, Institute of Food and Agricultural Sciences, Central Florida Research and Education Center-Apopka, 2807 Binion Road, Apopka, FL 32703

A 3 x 4 factorial experiment tested the performance of 3 peat-based growing media and 4 N application rates in an ebb and flow irrigation system. Plants received 50, 100, 150 or 200 ppm N from a liquid 24N-4P-14K stock solution applied through the irrigation system. Little difference was observed in height increase and plant grade of plants grown with Fafard #4 and Vergro Container Mix A, the two commercially manufactured mixes tested. Foliage grown in the Canadian peat:pine bark mix were shorter and received lower plant grades. Increasing fertilizer rate from 50 ppm N to 150 ppm N increased plant height and quality. Increasing the rate to 200 ppm N increased growth and quality measurements only slightly for Croton and Dieffenbachias and produced smaller Spathiphyllums. Soluble salts levels of the leachate from media of Dieffenbachia 'Camille' show pots receiving 200 ppm N accumulating salts at a much faster rate than plants receiving 150 ppm N or less.

430
WATER UTILIZATION OF NINE FOLIAGE PLANT GENERA UNDER TWO INTERIOR LIGHT INTENSITIES
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Watering requirements for interior plants is a major obstacle to increased plant use in the home or office. Introduction of "self-watering" containers to the marketplace has been marginally beneficial because they have not been widely accepted by consumers. This factorial experiment was established to determine levels of water use by 9 popular foliage plant genera planted in self-watering containers and maintained under 2 light intensities commonly found in the home or office (10 $\mu mol \cdot s^{-1} m^{-2}$ and 20 $\mu mol \cdot s^{-1} \cdot m^{-2}$). Plant growth was better at 20 $\mu mol \cdot s^{-1} \cdot m^{-2}$ than at 10 $\mu mol \cdot s^{-1} m^{-2}$ for most genera, but not for *Dieffenbachia, Saintpaulia* or *Spathiphyllum.* Water utilization varied widely between genera, from a low of 1.5 ml to a high of 4.7 ml $H_2O \cdot cm^{-2}$ of leaf area over a 6-month period. All genera except *Saintpaulia* utilized more water at 20 $\mu mol \cdot s^{-1} m^{-2}$ than at 10 $\mu mol \cdot s^{-1} m^{-2}$. Depending on light intensity and plant genus, and based on the availability of 400 ml water in the container, plants needed to be watered every 5 to 29 days.

431
CHARACTERIZATION OF *Chrysanthemum morifolium* Ramat. WATER STATUS
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This study intended to refine water status measurements for determining *Chrysanthemum morifolium* Ramat. water requirement. 'Bright Golden Anne' plants were vegetatively grown for 7 weeks under conventional glasshouse container culture prior to initiating the experiments. Water was then withheld from the plants and relative water content *(water deficit),* total water potential *(pressure chamber),* and osmotic potential (vapor pressure osmometer) were measured 4 times daily on leaves of 3 different *ages (different positions along the shoot)* over a period of 4 days. The first fully-expanded leaf proved to be the most representative of overall plant water status. The most consistent sampling time, regardless of weather conditions, was just before dawn. Because the plants osmotically adjust in response to water deficit, neither total or osmotic potentials by themselves give adequate indices of *Chrysanthemum morifolium* Ramat. water status. Both must be measured to account for the tissue turgor potential component *(important in expansion growth and stomatal conductance)* which doesn't necessarily exhibit a constant relationship to total or osmotic water potentials.

432
MEASUREMENT OF CROP WATER USE IN NEW GUINEA IMPATIENS AS AN INDICATOR CROP PERFORMANCE
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Measurement of water use in potted plants is difficult to measure except through repeated weighings and adjustments for evaporative losses. Little data on specific water use is available in the literature and parameters for specific water use equations are needed. A system for measuring plant water use of New Guinea Impatiens is based on the capillary-matric action of soils and plants. Watering systems have been developed on this principle and based on plant water demand. The system can become a useful quantitative measurement device based on saturated water flow from a graduated water supply cylinder and selection of a supply line of correct hydraulic resistance. Data collected on plants grown in a controlled environment included air and dewpoint temperatures, light intensities, and air flow velocities across the plants. The data was used to calculate plant water use with the Monteith Penman equation. The predicted water use agreed closely with the measured values.

433
GROWTH OF HYBRID LILIES IN ROCKWOOL-BASED MEDIA.
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Four different granulated rockwool (RW) aggregates were combined with peat at 15, 30, or 45 percent (v/v) RW resulting in twelve different peat:RW media. The RW aggregates used were either fine or coarse textured and absorbent or repellent to water. A soil based medium was used as a control. Bulk volume, bulk density, total porosity, water porosity (WP), and aeration porosity (AP) were determined for all media. Hybrid lily, cvs. 'Enchantment' and 'Jamboree', growth in these media were compared by measuring the dates of visible bud and anthesis, flower number, leaf number and area, plant height and dry weight of stems, leaves, and flowers. Physical properties of the RW media varied significantly from the soil based medium. Increasing the volume percent RW had a negative linear effect on WP but a positive linear effect on AP for all RW aggregates. Lily growth in the soil based medium was statistically similar to all RW media. The dates of visible bud and anthesis, as well as leaf number and area decreased linearly as the volume percent repellent coarse RW increased.

42 ORAL SESSION (Abstr. 434-440) Postharvest Physiology: Modified and Controlled Atmospheres

434

QUANTITATIVE ANALYSIS OF THE IMPORTANT FACTORS THAT DETERMINE FRUIT TOLERANCE TO LOW-OXYGEN ATMOSPHERES

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Experiments were done to study the effects of 0.25% or 0.02% 0, at 0, 5, or 10°C on postharvest physiology and quality attributes of 'Granny Smith' and 'Yellow Newtown' apples, 'Angeleno' plums, 'Red Jim' nectarines, 'Bing' cherries, and '20th Century' pears to determine their tolerance to low O_2 atmospheres. The occurrence of alcoholic off-flavor was the most common and important detrimental effect that limited fruit tolerance to low O_2. Higher temperature, higher respiration rate, and greater resistance to gas diffusion increased off-flavor development. Higher soluble solids content was associated with enhanced fruit tolerance to low O_2. Using a SAS computer program to do multiple regression analysis with temperature, O_2 concentration, CO_2 production rate, resistance to CO_2 diffusion, and soluble solids content as variables, models were developed for quick prediction of fruit tolerance to insecticidal low O_2 atmospheres. Comparison of fruit tolerance and published information on the time to completely kill specific insects by O_2 levels at or below 1% indicates that low O_2 atmospheres may have a good potential for use as postharvest quarantine treatments for certain insects on some commodities.

435

MICROPERFORATED POLYMERIC FILM FOR PACKAGING OF HORTICULTURAL CROPS

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Microperforated films produced by an electro-mechanical process were used for packaging of tomatoes and mushrooms. By varying the density of the microperforations it was possible to provide control of in-package levels of 0, and CO,. The level depended on the respiration rate of the produce as influenced by the ambient temperature, the overall permeability of the film, the free volume in the packages, and the tightness of the heat seals. Using an appropriate density of the perforations, safe limits of 0, and CO, could be maintained despite the large difference in respiration rates of the two crops. Another major feature of a suitably microperforated film is to control moisture loss without allowing excess CO_2 buildup or O_2 deficiency.

436

PROLONGING THE POSTHARVEST LIFE OF BLUEBERRIES USING MODIFIED AND CONTROLLED ATMOSPHERES IN CONSUMER PACKAGES

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Cooled Blueberry cv. Bluecrop fruit packed in consumer packs was placed in Controlled Atmosphere (CA) chambers, or wrapped in various films for Modified Atmosphere (MA) studies. Gas mixtures were monitored to maintain preset values. Fruit was stored for 32 and 76 days. In MA studies, films were applied to boxes as pillow packs, shrink wraps or diffusion windows in impermeable surfaces. Data on fruit quality, decay and softness were collected. Fruit was also fumigated with Deccodione Smoke tablets and stored at 0 C. After 32 days in storage approximately 90 % of the blueberries in the best CA treatment were rated as "good fruit". The berries after 32 days of CA storage were firmer than those after 76 days of storage.
MA packages with diffusion windows gave some of the best retention of quality. Area of the diffusion windows affected the percent of good fruit and firmness. Fumigation with smoke tablets gave acceptable quality in storage up to 10 weeks.

437

THE EFFECTS OF MODIFIED ATMOSPHERE PACKAGING AND TEMPERATURE ON POSTHARVEST STORAGE LIFE OF THREE HIGHBUSH BLUEBERRY CULTIVARS

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Blueberry fruit (cultivars 'Bluecrop', 'Elliot', and 'Jersey') were stored under various O_2 and CO_2 regimes generated using modified atmosphere packaging (MAP) techniques at 0, 5, and 20C. Target O_2 concentrations were obtained using a respiratory model developed from the previous year's data. Quality was determined using a visual rating system in which mold development and cracking of the blueberries were the limiting factors of quality. Storage life was a function of both temperature and package O_2 levels. As O_2 declined (and CO_2 increased) shelf life increased. Optimal O_2 concentrations (defined as the lowest O^2 levels permissible without inducing anaerobic respiration) yielded an approximate doubling of visual storage life. In a related experiment with the same lot of fruit, the relationship between package O_2 and CO_2 and flavor was examined. Flavor was detrimentally affected at O_2 concentrations below 1.0, 1.5, and 3.0% at 0, 5, and 20C, respectively. The effects of temperature and modified atmosphere packaging on visual and flavor quality will be discussed.

438

MODIFIED ATMOSPHERE PACKAGING (MAP) OF RED RASPBERRIES: EFFECTS OF TEMPERATURE, OXYGEN, AND CARBON DIOXIDE

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Modified atmosphere packaging can be used to provide O_2, CO_2, and/or water vapor levels within a package that are optimal for the storage of a commodity. Previously, we found that low oxygen in MAP systems extends the storage life of blueberries. Recently, we studied whether this approach could be used for red raspberries. Specifically, our objective was to determine the relationships between temperature, product respiration, and steady state O_2 and CO_2 levels.

A range of O_2 (≈ 0.5 to 12 kPa) and CO_2 (> 1 to 18 kPa) levels was produced in packages of fruit stored at 0, 10, and 20C by varying fruit weight within packages made of low density polyethylene film. Unlike blueberries, the lowest aerobic 0, level, as determined by the respiratory quotient breakpoint, was not distinct. Similarly, ethanol produced by anaerobic respiration could not be readily distinguished from high levels of background ethanol production. Steady-state O_2 respiration rates gradually increased with O_2 level and did not reach plateau at high oxygen. In general, respiration rates doubled with each 10C increase for all O_2 levels.

Mold development was depressed for fruits stored in low O_2/high CO, packages as well as low temperature. However, non-package studies in which O_2 and CO_2 were independently controlled showed that molds are suppressed by high CO_2 (50 kPa) rather than low O_2 (3 kPa) levels. For fruits stored in CO_2, accumulation of acetaldehyde may have imparted a solvent-like flavor.

439

EFFECT OF MODIFIED ATMOSPHERE PACKAGING (MAP) ON BIOCHEMICAL CHANGES OF 'HIMROD' TABLE GRAPE BERRIES.

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Application of modified atmosphere packaging (MAP) for small fruits is gaining popularity. However, there is limited knowledge regarding MAP effects on fruit biochemical changes that occur during storage. Changes of individual sugars and acids of 'Himrod' grapes berries were monitored using high pressure liquid chromatograph (HPLC). Our results show that there are obvious changes during storage of grapes.

Weight loss and synthesis of biochemicals are considered the primary reasons for these phenomena. The reflection of these changes is on final taste of the grapes stored under MAP conditions.

440

RESPONSES OF 'BARTLETT' PEARS TO INSECTICIDAL 0, AND CO, ATMOSPHERES

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Atmospheres with ≤ 0.5% O_2 and/or ≥ 60% CO_2 have the potential to be used as a postharvest insect quarantine treatment. Postclimacteric 'Bartlett' pear fruits were exposed to air or to one of 3 controlled atmospheres (CA) for up to 3 days at 20°C. CA treatments included low O_2 (0.25% O_2 + 99.75% N_2), high CO_2 (20% O_2 + 80% CO_2), and low O_2 + high CO_2 (0.25% O_2 + 80% CO_2 + 19.75% N_2). Fruits were evaluated daily immediately aftcr removal from CA, and after holding for an additional 2 days in air at 20°C. Fruit injury (skin discoloration) was noted after one day in CA and became more severe thereafter. The low-O_2 atmosphere resulted in more fruit injury than the high-CO_2 treatment. Both low O_2 and high CO_2 increased fruit ethanol and acetaldehyde content, but their combined effect was not synergistic. Low O^2 and/or high CO_2 treatments increased the activities of alcohol dehydrogenase, pyruvate decarboxylase, and lactate dehydrogenase. However, their mechanisms of initiating anaerobic respiration and associated fruit injury seem to be different.

43 ORAL SESSION (Abstr. 441-448)

Vegetables: Nutrition

441
NITROGEN FORM, RATE, AND TIME OF APPLICATION EFFECTS ON POTATO
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Potato (Solanum tuberosum L.) was grown on a sandy soil to evaluate N fertility on crop growth. The N was supplied as 5, 25, and 45% NO_3-N from NH_4NO_3 and urea at 112, 224, and 336 kg N.ha^{-1} applied at 0, 33, and 66% at planting with the remainder applied 30 days later. In a wet season (46 cm), yields were highest with the highest N rate. The % NO_3-N had no effect on yield but time of application and N rate interacted. With 112 kg N.ha^{-1}, yields were highest with 0 N applied at planting but with the higher N rates, yields were highest with 66% N applied at planting. In a drier season (30 cm), tuber yields were higher with 224 and 336 than 112 kg N·ha^{-1}, Time of N application and % NO_3-N interacted in effects on yield. With 0 preplant N, yields were lowest with 5 than 45% N as NO,, but with 67% N applied preplant, yields were lowest with 45% N as NO, and similar with 5 and 25% NO_3-N. Leaf N content at harvest was higher with the higher N rate but not generally influenced by N form or time of application.

442
EFFECTS OF NITROGEN NUTRITION, TIMING OF NITROGEN APPLICATION, AND PLANTING DENSITY ON DEVELOPMENT AND YIELD OF *BRASSICA NAPUS*
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Response Surface Methodology is being used to determine the effects of nitrogen nutrition, timing of the application, and planting density on crop development and yield of dwarf rapeseed *(Brassica napus)*. The crops are being grown under controlled environment conditions, including ambient and elevated CO2 levels. Optimization of the experimental variables will be determined with respect to maximum crop yield, minimum growing time, and oil content of the harvested seeds. The information from this study will be used to evaluate dwarf rapeseed as a potential oilseed crop in NASA's Controlled Ecological Life Support system program. This research is sponsored in part by the NASA NSCORT center for bioregenerative life support.

443
Use of an aeroponic plant growing system to evaluate growth and N-fixation capacity of pea cultivars.
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Three pea (Pisum sativum) cultivars, Darkskinned Perfection (DSP), Sprite-afila leaf type (Spr-A) and Sprite-normal leaf type (Spr-N), were inoculated and grown to maturity in an aeroponic system to determine the effect of 2 root parameters on growth and N fixation capacity of the cultivars. The parameters were root temperature (18C and 23C) and NO3-N concentration of the nutrient solution (1, 2, 3, 4, 5, 6, 7, 8 mM). For both DSP and Spr-N cultivars, a root temperature of 23C resulted in a significantly greater shoot weight than at 18C. All three cultivars increased in plant fresh weight as N03-N increased from 1 to 4 mM, leveling off or decreasing slightly from 5 to 8 mM. A root temperature of 23C resulted in root nodules forming further down the root system than at 18C. The nitrogen fixation capacity (%NDFA) varied among cultivars but was highest at 1 mM and decreased in a negative exponential curve to 8 mM. %NDFA of the three cultivars was never completely eliminated at 8 mM of N03-N but was at about a 13% capacity at this N03-N level. For Spr-N and Spr-A, lower root temperature gave a higher %NDFA at all nitrogen concentrations.

444
YARD WASTE AND POULTRY MANURE COMPOSTS AS SOIL AMENDMENTS FOR VEGETABLE PRODUCTION
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This study was undertaken to test the long term effects of locally produced yard waste compost and poultry manure for vegetable production in sandy soils. Yard waste compost (YW) and poultry manure (PM) were tested in factorial combinations using rates of 0, 22.4 and 44.8 MT ha^{-1}. Two treatments using 6-6-6 fertilizer at 84 and 168 kg N ha^{-1} were included. Plots were planted with okra cv 'Clemson Spineless', sweet potatoes cv 'Beauregard', and Southern peas cv 'Cream Elite. Mean weight of okra harvests from PM treatments were 773.36 kg ha^{-1} at the high rate; 708.3 kg ha-1 at the low rate; and 401.13 kg ha^{-1} at 0 PM. The high rate was significantly different from the treatment with no PM. Mean harvest weights for yard waste treatments were not significantly different. Mean sweet potato harvest weights were 4171.80, 3127.86, and 2765.28 kg ha-1 for high, low, and 0 PM, respectively. Mean harvest weights of cream peas were 2977.77, 2729.66, and 2677.92 kg ha^{-1} for high, low, and 0 PM. Although there was a tendency for yields to go up with higher rates of poultry manure, there were no significant differences within sweet potato or cream pea harvests.

445
EFFECTS OF IRRADIANCE AND N:K RATIO ON GROWTH OF SWEET-POTATO IN NFT
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G. W. Carver Ag. Expt. Station, Tuskegee University, Tuskegee, AL 36088

Growth chamber studies were conducted to evaluate the effect of 2 levels of photosynthetic photon flux (960 and 480 PPF) and 3 N:K ratios (1:1.1, 1:2.4) and 1:3.6) on yield of sweet potato (Ipomoea batatas) when grown using NFT. Four vine cuttings (15 cm length) of 'Georgia Jet' and 'TI-155' were grown for 90 days and 120 days, respectively. The 960 PPF level produced a higher number of storage roots/plant, storage root fresh and dry weight, and foliage dry weight of 'Georgia Jet' than did 480 PPF. For 'TI-155', storage root fresh and dry weight and percent dry matter were higher with 960 than 480 PPF. Foliage fresh and dry weight response to N:K for 'TI-155' were defined by both linear and quadratic relations. It appears that the level of PPF was more important than N:K ratio in enhancing sweet potato yield in NFT.

446
POTASSIUM NUTRITION OF PICKLING CUCUMBERS AS RELATED TO FRUIT GROWTH AND PLANT PHOTOSYNTHESIS
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Potassium (K^+) deficiency was reported to affect expansive fruit growth and result in an increased incidence in misshapen pickling cucumber fruit, especially under plant water deficit conditions. Field experiments were conducted in 1990 to determine the effects of K^+ application rates and sources on both vegetative and reproductive growth under different irrigation regives and to investigate the potential physiological roles of K^+. In a rainout shelter experiment (Exp. A), cucumbers (cv. Calypso) were preplant fertilized with 0 or 225 lbs K^+/acre (K_2SO_4) and subjected to either irrigated or drought stress treatments. A sandy soil site with low native K^+ application rate, 0, 75, 150 and 250 lb K^+/acre, and source, KC1 and K_2SO_4 (Exp. B). K^+ fertilization did not influence assimilation rates except during the morning hours when the plants were at a vegetative developmental stage. Although fruit growth, yield and quality were also not affected by K+ fertilization rates, irrigation was found to have a large affect on these vegetative shoot growth or fruit yield.

447
CALCIUM CONCENTRATION EFFECT ON GROWTH, TUBERIZATION, AND MINERAL ACCUMULATION IN POTATOES
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The responses of plant growth, tuberization, and mineral accumulation were studied in potatoes *(Solanum tuberosum,* cv. Norland) maintained at different Ca solution concentrations using a non-recirculated nutrient film system. The plants were grown for 42 days at six Ca concentrations of 0.14, 0.54, 2.04, 5.08, 10.13, 15.60 meq l^{-1} with a constant flow of 4 ml min^{-1}. Plant leaf area, tuber and total dry weights were significantly lower at 0.14 and 15.60 meq l^{-1} of Ca than at 2.04 meq l^{-1} of Ca which produced highest plant growth. Ca concentration of 0.14 meq l^{-1} promoted tuber initiation, increased incidence of internal brown spot, inhibited tuber enlargement, as compared to higher Ca concentrations. The plants at 0.14 meq l^{-1} of Ca developed aerial tubers in axils of leaves on both primary and secondary stems. Ca levels in leaves increased with increasing Ca concentrations in solution in a curvilinear relationship of $Y=X/(a+bX)$ with R^2 of 0.97. The accumulation of Mg and Mn in leaves decreased with increasing Ca accumulation in leaves. Plants at 0.14 meq l^{-1} of Ca had higher P, lower S, B, Zn and Cu levels than at higher Ca concentrations. Fe accumulation was higher at 15.60 meq l^{-1} of Ca than at lower Ca concentrations.

448
ADJUVANTS TO ENHANCE CALCIUM PENETRATION INTO CAULIFLOWER LEAVES
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Detached cauliflower leaves and leaf discs-were treated with nine adjuvants and two forms of calcium to increase calcium penetration and uptake. Calcium content of the leaf portions was determined by atomic absorption-spectrophotometry. An ethoxylated alkyl phenol surfactant (Flo Mo S45) gave moderate spreading and maximum penetration. Three organosilicone surfactants (L-77, Q2-5152, X2-5309), and an ethoxylated alcohol surfactant (Flo Mo 6T) gave maximum spreading and intermediate penetration. Other adjuvants (Flo Mo S100, AG-98, LI 700, and crop oil concentrate) gave minimal spreading and did not increase penetration over calcium in water. Calcium nitrate was more effective than calcium chloride as a calcium source to increase penetration.

52 ORAL SESSION (Abstr. 449-456) Growth and Development: Effects of Light, Temperature, and CO_2

449
CO_2-EXCHANGE RESPONSES OF DEVELOPING PEACH FRUITS TO LIGHT, TEMPERATURE, AND CO_2
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The CO_2-exchange of attached peach fruits was measured under different light flux densities and temperatures in the field during the 1989 and 1990 growing seasons. Light (1200 $\mu mol \cdot m^{-2} \cdot s^{-1}$) and dark fruit CO_2-exchange rates and calculated fruit photosynthesis rates (difference between CO_2-exchange rates in darkness and light) per unit dry weight decreased as fruits developed. On any given date calculated fruit photosynthesis rates increased with increasing temperatures and light flux densities. Generally, responses to environmental conditions were greater in young than in more mature fruits. Calculated photosynthesis rates increased with increasing $C0_2$-concentrations in young fruits but not in more mature fruits. In young fruits 70% of the calculated fruit photosynthesis was due to CO_2-refixation and this increased to 100% in nearly mature fruits.

450
PEACH SEED CHILLING EFFECTS ON HEAT OF METABOLISM
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Differential scanning microcalorimetry was used to study the effects of the duration of peach seed chilling on the heat of metabolism. 'Lovell' peach seeds were chilled for zero to 70 days at 4°C and under moist conditions. The heat of metabolism was measured on a minimum of two replicate samples. As the amount of chilling increased, the heat of metabolism at 25°C increased linearly. The break temperature, where the maximum heat of metabolism occurred, decreased as the chilling time increased. However, the amount of heat produced at the break temperatures increased as chilling time increased. Changes in CO_2 and O_2 production and utilization at different chilling times will also be presented.

451
LIGHT EXPOSURE AND THE PRESENCE OF DEVELOPING FRUIT INFLUENCE NITROGEN CYCLING THROUGH SPUR LEAVES OF MATURE WALNUT TREES
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Mature walnut *(Juglans regia)* trees were fertilized with ^{15}N-depleted $(NH_4)_2SO_4$. Changes in labeled and total N in fully expanded spur leaves were monitored in 3 different years between June, the period of rapid embryo development, and the time of fruit and embryo maturation in September. Fruiting and defruited walnut spurs in shaded and exposed regions of 6 mature walnut tree canopies were monitored. One leaflet per selected spur was processed and analyzed in June. A second leaflet (opposite the position sampled in June) was processed and analyzed in September. Changes between June and September in total and labeled N between these closely associated leaflets were considered indicative of fruit and light exposure effects on N cycling in these spurs. The presence of developing fruit accentuated leaf N efflux relative to influx. In contrast, fruit removal increased net influx relative to efflux. There was a positive correlation between the magnitude of net N efflux per unit leaf area and specific leaf weight (SLW) in fruiting spurs. Thus, N cycling through leaves to fruit is greater in exposed vs. shaded canopy positions.

452
MODELING SAINTPAULIA IONANTHA TEMPERATURE AND IRRADIANCE DRIVEN LEAF UNFOLDING AND FLOWER DEVELOPMENT RATES
James E. Brown-Faust* and Royal D. Heins, Department of Horticulture, Michigan State University, East Lansing, MI 48824-1325

Saintpaulia ionantha 'Utah' plants were grown in growth chambers at constant 15, 20, 25, and 30°C temperatures and daily photosynthetic irradiances of 1, 4, 7, and 10 $mol^1 m^{-2} day^{-1}$ delivered by 23, 92, 161, and 230 $\mu mol\ m^{-2} s^{-1}$ for 12 hours. Models were developed describing leaf unfolding rate (LUR) and flower development rate (FDR) as a function of temperature and irradiance by recording the dates of leaf unfolding and flower opening over the course of the experiment and then calculating rates using regression. Both LUR and FDR increased as temperature increased from 15 to 25°C and then decreased. Both LUR and FDR increased as irradiance increased from 1 to 4 $mol\ m^{-2} day^{-1}$. Increasing daily irradiance above 4 $mol\ m^{-2} day^{-1}$ did not significantly increase LUR or FDR. Model validation data are being collected from plants growing under 3 irradiance levels in greenhouses maintained at 15, 20, 25, and 30°C air temperatures.

453
DIURNAL VARIATIONS IN TEMPERATURE AFFECT CARBON PARTITIONING IN NEW GUINEA IMPATIENS AND FUCHSIA SHOOTS.
John E. Erwin*, and Royal D. Heins. Department of Horticultural Science, University of Minnesota, St. Paul, MN, 55108 and Department of Horticulture, Michigan State University, East Lansing, MI, 48824.

Impatiens hawkeri 'Mimas' (New Guinea impatiens) and *Fuchsia x hybrida* 'Dollar Princess' (fuchsia) were grown under 16 different day/night temperature (DT/NT) regimes ranging from 10-30C. Dry weight (DW) determinations were made on stem, leaf, and flower tissue on 3 shoots at flowering from each of 3 plants in each treatment. The DT/NT optima for total shoot DW for New guinea impatiens and fuchsia were 25/15 and 20/12C, respectively. Stem DW was greatest on New Guinea impatiens and fuchsia when plants were grown with a 30/15 and 20/12C DT/NT regimes, respectively. Flower DW was greatest on New Guinea impatiens and fuchsia when plants were grown at constant 20C. Leaf DW on New Guinea impatiens and fuchsia was greatest when plants were grown with a 30/15 DT/NT regime and constant 12C, respectively. Carbon partitioning to stems increased as DT increased. Partitioning to flowers was at the expense of partitioning to leaves in New Guinea impatiens. Partitioning to flowers was at the expense of partitioning to stems in fuchsia. The implications of this information with respect to stock plant management and flowering of these crops will be discussed.

454
EFFECT OF SUPRAOPTIMAL CARBON DIOXIDE CONCENTRATIONS ON SOYBEANS GROWN IN CONTROLLED ENVIRONMENTS
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In tightly sealed, Controlled Ecological Life Support Systems (CELSS) that might be used for human life support in space, CO2 concentrations might exceed optimal levels for many plants. To study this, soybeans [Glycine max (L.) Merr.] cvs. McCall and Pixie were grown at 500, 1000, and 5000 ubar (ppm) CO_2. All plants were grown for 90 days using nutrient film technique with a 12-h photoperiod, a 26°/20° thermoperiod, and approximately 300 $umol^{-2} s^{-1}$ PPF. Throughout growth, stomata1 conductance of upper canopy leaves for both cvs. was equally high at 500 and 5000 ubar and lowest at 1000 ubar. McCall consistently produced higher seed yield and total biomass than Pixie across all CO_2 treatments. There was a trend of decreasing harvest index (seed DW/total DW) with increasing CO_2 for both cvs. McCall seed yields at 1000 ubar were 15% higher than the other CO_2 treatments (which were about equal). Pixie seed yield was about 10% greater at both 500 and 1000 ubar when compared to 2000 and 5000 ubar. Results suggest that under these environmental conditions, 2000 and 5000 ubar CO_2 may be supraoptimal, but plants were not seriously affected or damaged by these high CO_2 levels.

455
ROOT-ZONE TEMPERATURE EFFECTS ON CONTINUOUS IRRADIATION INJURY ON POTATO
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Previous studies have reported continuous irradiation injury in certain potato (Solanum tuberosum L.) cultivars grown under constant temperature and have shown prevention of injury by daily temperature fluctuations. This study investigated the role of air versus root-zone temperature (RZT) on continuous irradiation injury on Kennebec, a cultivar sensitive to injury, and Denali, a tolerant cultivar. Two four-week experiments were conducted in rooms at the UW-Biotron. Air temperature in the first experiment was constant at 18°C and in the second fluctuated 14°C/22°C on a 12:12 hour cycle. For both experiments, RZT for half of the plants was held at constant 18°C and for the other half fluctuated 14°C/22°C. RZT was controlled by circulating water through impolene tubing coiled within insulated pots. Plants were grown in peat-vermiculite media in one-gallon pots. Plants were observed for chlorosis, stunting. and necrotic lesions. Growth measurements were taken at harvest. Results indicate that fluctuations in shoot temperature, and not root temperature, control continuous irradiation injury in sensitive cultivars.

456
PHOTOMODULATION OF WATERMELON PLANT GROWTH AS INFLUENCED BY LIGHT QUALITY
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Specific Far Red (FR) light treatments on the abaxial (bottom) and adaxial (upper) surface of the leaf were evaluated for photomorphogenic growth responses of watermelon *Citrullus lanatus* cv. 'Sugar Baby.' Whole plants and the first leaf of whole plants were treated with 15 minutes of end-of-day FR light. FR light treatment to individual leaves was applied using fiber optics. FR light treatment of the whole plant increased the length of the first two internodes and petioles. The adaxial leaf treated with FR light increased the length of the first petiole and internode. Both whole plant and adaxial leaf treated plants had acute petiole angles (angle from petiole to stem) and obtuse leaf angles (angle from leaf to petiole). Abaxial leaf treated plants had less acute petiole angles and less obtuse leaf angles. These results suggest photomodulation of leaf and petiole growth by light quality.

53 ORAL SESSION (Abstr. 457-464) New Methodologies and Techniques

457
THREE NON-CIRCULATING HYDROPONIC SYSTEMS
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Three, simple, non-circulating hydroponic systems which do not require electrical power and specialized equipment are described. One system utilizes a layer of window *screen* (to encourage the development of roots) located 100 mm below an opaque tank cover and 10 mm or more above the nutrient solution. In the second system, plastic forestry tubes, 220 mm deep, are filled with 160 ml of a capillary medium and the bottom 25 mm of the tubes are immersed in nutrient solution. The tubes are suspended by the top cover. The third system employs larger containers filled with a capillary medium; they are supported by the tank floor. At the beginning of the growing period, all of the systems require a tank containing 50 mm or more of nutrient solution: this level may be allowed to recede, remain constant or be increased by not more than 10 mm as time passes. Lettuce (leaf and semi-head) has been successfully grown.

458
MULTIFACTOR EXPERIMENTATION IN HYDROPONIC, PLANT NUTRITIONAL RESEARCH, MAKING USE OF "MIXTURE" THEORY
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A nutrient solution is defined as an aqueous solution of a given number of chemical substances, whose effects on a certain process are of interest. The nutrient solutions for plant growth consist exclusively of inorganic ions (exception made for chelating agents, humic acids, …). The fact that plants need ions but the solution is made up [of dissociated salts, imposes the major constraint upon nutrient solutions: the sum of the cation equivalents must be equal to the sum of anion equivalents. This constraint is the major reason for the impossibility of classical orthogonal experimentation with nutrient solutions and the main argument to define nutrient solutions as 'mixture' systems, namely as systems where the components can not be varied independently, because the sum of the components must remain constant. So in a mixture system the proportions are of importance and not the total amount of a component. This ionic balance constraint reduces the unrestricted factor space of q dimensions to a q-l dimensional simplex. Moreover dissociation, precipitation and complexation constraints further reduce the experimental region to a highly irregular polyhedron in a multidimensional simplex.

459
VERIFICATION OF THE ACCURACY OF VIDEO IMAGE ANALYSIS MEASUREMENT OF PLANT SPECTRAL CHARACTERISTICS
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Many horticulture production and research applications compel visual evaluation of product yield or experimental effect. These observations are typically subjective and consequently inconsistent, inaccurate, and difficult to quantify. Machine vision is objective and its horticultural use has increased tremendously. When color information is desired, currently available vision systems are significantly limited. Means for specifying absolute color are particularly lacking. Spectroradiometers utilizing integrating spheres can make accurate color measurement and are considered the standard against which other methods are compared. Spectroradiometers are much more expensive and much less versatile than color machine vision systems and are therefore often unavailable or unsuitable for many horticultural applications. The fundamental limitation to the application of color machine vision resides in the complex interaction between the illumination, subject, optical path, and sensor spectral-properties. This study verified the rudimentary ability of RGB video image analysis to accurately perceive zinnia flower color by its direct comparison with spectroradiometric measurement under carefully controlled conditions. When the spectral characteristics of both systems' light sources and sensors were meticulously characterized and normalized, video image analysis color perception proved consistent with that of the spectroradiometer. The translation of machine color perception into useful information was also determined.

460
NUCLEAR MAGNETIC RESONANCE IMAGING OF WATER DISTRIBUTION IN THE TRUNK AND SCAFFOLD ROOTS OF 'VALENCIA' ORANGE TREES WITH AND WITHOUT CITRUS BLIGHT
H. K. Wutscher*, USDA, ARS, Horticultural Research Laboratory, 2120 Camden Road, Orlando, FL 32803, and P. C. Wang, Department of Radiology, Howard University, Washington, D.C. 20060

Nuclear magnetic resonance (NMR) images of the trunks and two scaffold roots of two 16-year-old 'Valencia' orange, Citrus sinensis (L.) Osberk, trees on rough lemon, C. limon L. Burm f., rootstock, one affected by citrus blight, the other healthy, were obtained by scanning them axially and longitudinally with 1.5 Tesla and 4.5 Tesla nuclear magnetic resonance imaging (MRI) instruments. Uneven image intensity throughout the trunks gave detailed pictures of internal structures, such as annual rings, and water distribution. The healthy trunk had more water in the center than the blighted trunk. The roots also had an area of high water concentration in the center, but the difference was less pronounced than in the trunks. There were no visible differences between healthy and blighted wood in sections made after the NMR scans.

461
SONIC VIBRATION AS A NONDESTRUCTIVE METHOD FOR APPLE FIRMNESS MEASUREMENT
Judith A. Abbott* and Louis A. Liljedahl, Instrumentation and Sensing Laboratory, USDA ARS, Beltsville, MD 20705.

Sonic vibrational characteristics of intact apples are related to flesh elasticity which is, in turn, related to firmness. Firmness changes in Golden Delicious and Delicious apples were followed

during accelerated ripening and under storage conditions. Firmness was measured by Magness-Taylor puncture force and by compression of tissue cylinders (modulus of elasticity and rupture strength) for comparison with sonic vibrational characteristics of intact apples. Influences of apple temperature, size, shape, and skin on sonic spectra were investigated. Sonic resonant frequencies were significantly correlated with destructive firmness measurements and decreased as storage time increased. Sonic amplitudes were not closely related to firmness. Regression equations incorporating sonic data and size were developed to predict Magness-Taylor force. Use of sonic vibrational characteristics is proposed as a rapid nondestructive method for firmness sorting of apples.

462
DEVELOPMENT OF AN ELISA TO ASSESS MATURATION AND RIPENING DEVELOPMENT IN APPLE FRUIT
Jianping Kuai*, D.R. Dilley, D. Dixon-Holland[1] and B. Miller[1], Dept. of Horticulture, Michigan State University, East Lansing, MI 48824 and Neogen Corporation[1], Lansing, MI 48912.

Two proteins developmentally related to ripening in apple fruit were purified. One is NADP malic enzyme and the other of unknown function has been termed pAp_5. Polyclonal antibodies were raised against these proteins and ELISAs developed to each. Western blot analysis indicates that pAp_5 is absent from apples prior to the onset of the ethylene climacteric but increases markedly as the climacteric develops. The Mol. Wt. of pAp_5 has been estimated to be 40 kD. In vitro translation of m-RNA from ripe apples yielded a polypeptide that was immunoreactive with the pAp_5 antibody.

463
ASSESSMENT OF POLLEN VIABILITY IN TOMATOES BY FLUORESCENCE
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A procedure was developed for determining pollen viability in tomatoes *(Lycopersicon esculentum* Mill.) by growing the pollen in a growth medium containing 0.29 M sucrose, 1.27 mM $Ca(N0_3)_2$, 0.16 mM H_2B0_3, and 1 mM $KN0_3$, pH 5.2, to which 0.001% fluorescein diacetate (FDA) added. The procedure allows the evaluation of pollen viability within 30 min by determining the % of fluorescing pollen in the sample. It further allows the determination of % germination in vitro and pollen tube growth within 1.5 h. Neither the germination medium nor FDA has any adverse effects on germination and pollen tube growth. Data on % fluorescence and % total germination of tested samples exhibit a high correlation suggesting an agreement between the fluorescence and the in vitro germination procedures. The combined fluorescence-germination procedure is simple and adapted to routine screening of a large number of samples.

464
LIPID DETERMINATIONS FROM LETTUCE (Lactuca sativa L.) SEED BY CAPILLARY SUPERCRITICAL FLUID CHROMATOGRAPHY FOR SEED AGING INVESTIGATIONS
Richard M. Hannan*, USDA, ARS, Regional Plant Introduction Station, Washington State University, Pullman, WA 99164. Herbert H. Hill, Department of Chemistry, Washington State University, Pullman, WA 99164.

Significant differences in the extractable, nonpolar lipid fraction of naturally aged and fresh seeds of lettuce *(Lactuca sativa* L.) were observed using liquid carbon dioxide extraction followed by capillary supercritical fluid chromatographic separation and flame ionization detection. In the aged seed, the occurrence of both low molecular weight products and high molecular weight polymeric products was observed with a concomitant decrease in the triglycerides present in the fresh seed. The analytical methodology developed for this study was found to be quantitatively reproducible for a mixture of five test triglycerides with a coefficient of variability of less than 0.6%. While the appearance of degradation products has previously been associated with the aging process, the appearance of polymeric products in association with the seed degradation process has not been reported, but was made possible through the use of supercritical fluid chromatography.

54 ORAL SESSION (Abstr. 465-472) Woody Ornamentals/Landscape/Turf: General

465
GROWTH AND WATER RELATIONS OF KENTUCKY COFFEE TREE AND SILVER MAPLE FOLLOWING TRANSPLANTING
Roger Kjelgren* and Brian Borkowicz. Dept. of Plant and Soil Science, Southern Illinois University, Carbondale. IL 62901

The effect of root loss on crown development and water relations following transplanting was investigated in Kentucky coffee tree (KCT) and silver maple (MAP). Four field-grown, two-inch trees of each species were were hand-dug prior to budbreak and then transplanted in place, and four each were left non-dug. Predawn water potential (WP) was monitored semi-monthly during the growing season, and diurnal WP and stomata1 conductance *(Gs)* were measured twice in midsummer. Shoot elongation, leaf size, and total leaf area were determined in late summer. There were no consistent differences in either diurnal and predawn WP between dug and non-dug trees of either species. Both diurnal and seasonal WP, however, was more negative in KCT than MAP. There were also no differences in *Gs* between treatments and among dates in MAP, and between treatments in KCT when predawn WP was above -0.5 MPa. It was, however, lower in dug KCT on the date when predawn WP fell below -0.5 MPa. Shoot elongation and leaf size were reduced 50%, and total leaf area was reduced 75%, in the dug trees of both species. Reduction in transpiring leaf area appeared to moderate internal water deficits in dug trees and allow stomata to open at levels similar to non-dug trees. Kentucky coffee tree stomata appeared to be more sensitive to dry soil conditions than silver maple.

466
ADAPTIVE RESPONSES OF RED MAPLE ECOTYPES TO WATER STRESS
T. H. Whitlow, C. M. Kearns, A. Howard, and N. L. Bassuk, Urban Horticulture Institute, Cornell University, Ithaca, NY 14853

Half-sib progeny from maternal parents occurring on wet sites (3 families) and a dry site were subjected to a gradually imposed drought under greenhouse conditions. Gas exchange and cellular water relations were monitored for a 5-week drought stress followed by a week of recovery. The experiment was blocked over time to permit relication within weekly measurement cycles.

Under well-watered control conditions, the dry site ecotype grew more slowly and had lower light saturated photosynthetic rates than the wet site ecotypes, but stomata1 conductances were similar between the 2 groups. Under drought stress, the dry site ecotype maintained higher photosynthetic rates and stomata1 conductances yet had higher water use efficiency. Evaluated both at full saturation and at the turgor loss point, both wet and dry site groups osmotically adjusted to drought, but the dry site ecotype had a greater capacity for adjustment and lost turgor at lower relative water content. Both gas exchange and cellular water relations confirm the hypothesis that red maple has undergone ecotypic differentiation and that opportunity exists to select drought adapted cultivars from native germplasm.

467
GROWTH, FALL COLOR DEVELOPMENT, LEAF SCORCH, AND XYLEM WATER POTENTIAL OF SUGAR MAPLE UNDER STRESS.
John C. Pair, Kansas State University, Horticulture Research Center, 1901 E. 95th South, Wichita, KS 67233.

Eight Acersaccharum and two A.nigrum selections, established in 1983 in an open, exposed site, were evaluated for growth leaf qualities and fall color development. superior height growth occurred on Caddo, a southern ecotype, followed by 'Bonfire', Commemoration', 'Fairview', 'Endowment', 'Wright Brothers', 'Green Mountain' and Legacy'. A.nigrum 'Green Column' grew significantly taller than the species. Although xylem water potential (exceeding -3.3 Mpa in 1990) was not significantly different, leaf scorch and leaf tatter were highly significant among cultivars. Drought stress produced serious leaf scorch symptoms on 'Endowment', 'Fairview', 'Green Mountain' and 'Wright Brothers'. Caddo, 'Legacy' and 'Commemoration' showed superior foliage quality and significantly less leaf tatter than other cultivars. Fall color was earliest on 'Bonfire' and 'Green Column'. 'Commemoration' and 'Legacy' colored well in late October. Caddo maples initiated bud break earliest and exhibited superior fall color although later than cultivars above. Poorest color development occurred in 'Endowment', 'Fairview' and 'Green Mountain'.

468
COMPARATIVE DROUGHT RESISTANCE AMONG FLOWERING CRABAPPLE *(MALUS)* SCIONS

Thomas G. Ranney*, Dept. of Hort. Sci., North Carolina State Univ., 2016 Fanning Bridge Rd., Fletcher, NC 28732-9216.

Variation in response to water deficits was compared among six crabapple scion species: Siberian *(Malus baccata* 'Jackii'), Japanese *(M. floribunda)*, Tea *(M. hupehensis)*, Prairie *(M. ioensis)*, and Tschonskii *(M. tschonskii)*, all grafted onto EMLA111 rootstocks. After 39 day without irrigation, Siberian trees maintained significantly higher rates of photosynthesis (P_n) than Japanese, Prairie, or Tschonskii trees, despite having similar or more negative leaf water potentials. Leaf osmotic potential at saturation ($\psi_{\pi, sat}$), determined on expressed sap, for stressed plants ranged from a low of -2.81 MPa for Siberian trees to high of -2.08 MPa for Tschonskii trees. The capacity for maintaining P_n at low soil water potential was negatively correlated with $\psi_{\pi, sat}$. These data suggest that $\psi\pi$, $_{sat}$ is a useful index for predicting the capacity of crabapple scions to maintain photosynthesis under water stress. However, due to the varying capacity for osmotic adjustment found among these species, it is necessary to evaluate this aspect of drought resistance on drought acclimated plants.

469
RELATIONSHIPS BETWEEN WATER USE OF CONTAINER-GROWN LANDSCAPE PLANTS AND TURF EVAPO-TRANSPIRATION RATES

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Daily water use of Japanese privet (Ligustrum japonicum), Oleander (Nerium oleander), Apache plume (Fallugia paradoxa), Coyote bush (Baccharis pilularis), Purple cone flower (Echinacea purpurea) and Blanketflower (Gaillardiagrandiflora) grown in 1 gal containers was determined gravimetrically. Containers without plants were included as controls. Total daily water use (evaporation plus transpiration) was between 112 and 555 ml (1.1 to 2.6 times control), depending on plant species and environmental conditions. Turf evapotranspiration (ET) rates were obtained from a MAXI-COM system and ranged between 0.46 and 0.89 cm. These rates were 87±14% of actual water lost from the controls. Daily water use was linearly correlated with ET ($r > 0.73$; $P > 0.03$) for each species except Ligustrum suggesting that ET may be used to schedule container irrigation for a range of plant species.

470
THE EFFECT OF SODIUM CHLORIDE CONCENTRATION ON HYDROGEL WATER HOLDING CAPACITY AND ON A HYDROGEL'S ABILITY TO REDUCE WATER STRESS

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The primary objectives of this study were to determine if various sodium chloride (NaCl) concentrations affect the water holding capacity of a polymeric hydrogel (Viterra 2 Planta-gel), and if coleus (Coleus blumei Benth.) plants grow" in medium amended with that hydrogel maintain a less negative predawn leaf water potential during induced water stress than plants grow" in a like medium without the polymer, Plants in both hydrogel and non-hydrogel amended media were irrigated with solutions that contained: 0, 38, 250, 500 or 1000 ppm NaCl. Hydrogel reduced water lost to evapotranspiration, but had no effect on predawn water potentials, after either of two 5-day dry periods. There was an inverse linear relationship between NaCl concentration and water lost for all plants in both dry downs.

471
THE EFFECT OF A WATER ABSORBANT GEL AND A SOIL WETTING AGENT ON ESTABLISHMENT OF BEDDING PLANTS.

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Establishment of Bedding Plants can be difficult under adverse conditions. In a two year study, it was shown that both a soil wetting a agent (AquaGro) and a water absorbant gel (SuperSorb) could be beneficial in increasing plant establishment, improving plant growth and improving soil/water/plant relationships. It was found that the combination of the two materials was the most beneficial treatment. Impatiens were the most responsive species, followed by Ageratum, Begonia and Petunia. In Salvia and Petunia root/shoot ratios were positively affected.

472
AN IMPROVED STEADY STATE HEAT BALANCE METHOD TO MEASURE MASS FLOW RATE OF SAP IN TREES

Patricia Lindsey* and Nina Bassuk, Urban Horticulture Institute, Cornell University, Ithaca, N.Y. 14850

An improved steady state heat balance technique is presented for measuring mass flow rate of sap in trees using a set temperature difference between sensors. A new gauge has been designed that utilizes a series of thermistor controlled heaters to precisely maintain this temperature gradient across the xylem. The result is a gauge that measures mass flow of sap accurately both during low and high periods of transpiration. In addition, a counter on the electronic temperature control unit simultaneuosly logs heat input and total elasped time for a 24-hour period, eliminating the necessity for a data logger. Sensing devices are kept to a minimum and because they are inserted through the bark directly into the xylem, larger diameter trees are able to be used. The control unit can be battery powered, allowing the gauge to be used readily in the field. Most importantly, the necessity of calculating sapwood area, sheath conductance, and thermal conductivity of the wood has been eliminated, reducing potentially large error factors. The accuracy of the gauge was tested on trees ranging from 3/4" to 2" in caliper.

55 ORAL SESSION (Abstr. 473-479) Tree Fruit: Prunus Culture and Management

473
INTEGRATED FRUIT PRODUCTION OF PEACH UNDER MICHIGAN CONDITIONS

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Objectives of this experiment are: 1) to compare crop quality and yield, and insect disease populations between orchard systems that employ integrated crop management technologies with conventional systems, and 2) to monitor soil and fruit chemical residues to determine the effectiveness of these systems. In 1990, 6 one-acre plots were established at the Southwest Michigan Research and Extension center, with 1/3 acre of peaches planted in the center of each plot. Plots were separated by at least 200 m. Conventional culture (clean cultivation, ground application of fertilizer, scheduled pesticide application, dormant pruning) and Integrated Crop Management plots (use of fertigation or manure for N, pesticide application based on trap counts, endophytic rye, pheromone disruption of oriental fruit moth and mulch for weed control) were established. In phase I of the project (1990), insects and diseases, as well as crop growth (Reproductive and Vegetative) were monitored. In phase II (1991), soil and fruit pesticide residues will be determined and compared for the three different strategies. This paper is intended to stimulate discussion and only limited data will be presented for the 1st year results.

474
PREHARVEST WATERSPROUT REMOVAL, CANOPY LIGHT RELATIONS, FRUIT QUALITY AND FLOWER BUD FORMATION OF 'REDSKIN' PEACH TREES

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Mature bearing trees, all uniformly dormant pruned, of 'Redskin' peach on 'Lovell' rootstock were summer pruned or not summer pruned 40 days before harvest. Summer pruning consisted of removal of all watersprouts (WSR) more upright than 45° in orientation on scaffolds from the crotch to the top of the tree. WSR increased photosynthetic photon flux density (PPFD) initially in the canopy but there was no effect 49 days after treatment. PPFD was higher in the center of the tree in WSR trees 120 days after treatment. WSR had no effect on fruit ground color, red overcolor or flesh firmness. However, WSR increased percentage of fruit

that were greater than 62mm in diameter and decreased percentage less than 55mm in diameter. WSR increased foliar N and decreased foliar K levels on shoots inside the tree. WSR increased flower number per shoot and per cm shoot length.

475
EFFECT OF ROOT PRUNING ON WATER RELATIONS AND SHOOT GROWTH OF 'BELLAIRE' PEACH.
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The effect of root pruning on shoot length and water relations of 'Bellaire' peach was investigated as a means of controlling vegetative growth. On 27 April, 25 May, and 23 June, 1990, five-year-old trees were root pruned to a 0.35 m depth at either 0.4 or 0.8 m from the tree trunks along both sides of the row. Shoot growth was measured bi-weekly through the growing season, and the diurnal pattern of stomatal conductance and water potential was followed in late June, July, and August. Stomata1 conductance of the root-pruned treatments was less than the control, while there were no differences in water potential among treatments. Reduced shoot elongation was evident within a month of root pruning at 0.4 m for all timing treatments, but at 0.8 m it varied with the date of pruning. The first root pruning at 0.4 m reduced cumulative shoot elongation 39% compared to the un-pruned control trees, while the remaining treatments reduced it 14%. While root pruning limited cumulative shoot elongation in all treatments, the earliest 0.4 m treatment was most effective, possibly due to pruning of a larger percent of the root system prior to rapid shoot elongation. Stomata1 closure in root-pruned trees appeared to moderate diurnal water deficits at levels similar to the control.

476
EVALUATION OF PRUNUS FOR RESISTANCE TO NATURAL INFECTION OF TOMATO RINGSPOT VIRUS.
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Rooted cuttings of Prunus varieties Halford, Redhaven, Stanley, and Marianna 2624 were planted in soil containing approximately 38 tomato ringspot virus (TmRSV) infested Xiphinema americanum nematodes per 100 cc. After 10 and 22 weeks, separate sap extracts were made from root, bark, and leaf tissues of test plants and controls. Aliquots of these samples were assayed by rub inoculation onto Chenopodium quinoa and by enzyme linked immunosorbent assay (ELISA). Total nucleic acid extracts were prepared from the remainder of each sample and analyzed by dot blot hybridization using a cRNA probe for TmRSV. In both sets of assays, ELISA failed to detect TmRSV in any test plant, while bioassay identified only one Stanley and one Redhaven as positive. However, dot blot results indicated that 2/2 Stanley, 2/3 Halford, 4/5 Redhaven, and 0/6 Marianna cuttings were infected. These results illustrate the sensitivity of dot blot for TmRSV detection in Prunus and indicate that Marianna 2624 may possess resistance to TmRSV or its nematode vector.

477
SHORT-AND LONG-TERM EFFECTS OF SOURCE MANIPULATION IN SOUR CHERRY (Prunus cerasus L.)
Desmond R. Layne* and J.A. Flore, Dept. of Horticulture, Michigan State University, E. Lansing, MI 48824-1325, U.S.A.

A series of experiments were conducted with one-year-old potted sour cherry trees to evaluate the effects of source reduction (removal of 70% of the expanded leaves = Defol.) or source enhancement (continuous illumination = C.L.) on source leaf gas exchange. There was a significant increase in net CO2 assimilation (A) and stomata1 conductance (gs) of Defol. within one day in contrast to the non-defoliated control (Cont.). Defol. had lower daily dark respiration rates (Rd) and higher A values throughout the 14 h diurnal photoperiod than Cont. Defol. had daily assimilation rates 50% higher than Cont. in as early as 3 days. One month later, specific leaf weight, leaf chlorophyll and A was higher in Defol. Non-defoliated plants were also placed under either a 14 h photoperiod (Cont.) or a 24 h photoperiod (24h). A of 24h was reduced from Cont. by 50% after one day. The diurnal response of A in Cont. was removed when plants were put in C.L. Following 7 days in C.L., 70% defoliation of 24h plants resulted in a complete recovery from photosynthetic inhibition within 48 hours. The short-term effects of source manipulation on photochemical and carboxylation efficiencies, photorespiration and stomatal limitations will also be addressed.

478
EFFECT OF TRITON X SURFACTANTS ON GA_3 UPTAKE BY SOUR CHERRY
Moritz Knoche* and Martin J. Bukovac , Department of Horticulture, Michigan State University, East Lansing, MI 48824

Gibberellin A_3 (GA_3) inhibits flower initiation and promotes spur formation in virus-infected sour cherry (Prunus cerasus 'Montmorency') trees, and annual foliar application increases yield potential and cropping efficiency. Further, surfactants markedly affect GA_3 uptake and spray performance. To better understand surfactant enhancement of GA_3 uptake we investigated the effects of a homologous series of surfactants (octylphenoxypoly (ethoxy) ethanol) on spray solution and GA_3 deposit characteristics, and GA_3 absorption by the abaxial surface of sour cherry leaves. Increasing ethyleneoxide (EO) chain length (5 to 30 EO) increased surface tension (28 to 35 mN m^{-1}) and contact angles (28 to 49 degree). Deposits from droplets containing GA_3 and surfactant with 5 EO units were localized at the periphery of the droplet/leaf interface. With increasing EO content, deposit form changed from annulus shaped deposits (7.5 EO) to globular forms covering increasingly smaller interface areas (9.5 to 30 EO). Deposition was often associated with veins. GA, absorption was log linearly related to EO content and decreased from (49.4% of applied) to the control level (12.5% of applied) when EO chain length was increased from 5 to 30 EO units. GA_3 absorption is discussed in relation to solution and deposit characteristics.

479
EFFECT OF CARRIER VOLUME RATE ON ETHEPHON PROMOTION OF FRUIT ABSCISSION AND CHEMICAL DEPOSIT FORMATION IN SWEET CHERRY
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Ethephon is used to promote fruit abscission in sweet cherry as a harvest-aide. The efficiency of a given dose was increased as spray volume/hectare was decreased, e.g. fruit removal force decreased from 40 to 60% as carrier volume was reduced from 2350 (high-volume) to 118 $l \cdot ha^{-1}$ (low-volume), respectively. Two spray factors change dramatically as a given dose is applied in progressively lower carrier volumes, namely spray droplet spectra shift to smaller droplet sizes and ethephon concentration increases. Ethephon deposit formation on leaf surfaces was followed by spraying detached sweet cherry leaves with a constant dose of ethephon in carrier volumes ranging from 1200 to 20 $l \cdot ha_1$ using a monodisperse droplet generator (droplet size 57 to 443 µm). Ethephon deposits on leaf surfaces were evaluated by SEM/EDAX. Deposits were observed as discrete residues and deposit area was related to inflight diameter unless droplets impacted on veins or other features which resulted in droplet shattering or extensive spreading. As carrier volume decreased, the amount of deposit/unit interface area increased, leaving large quantities of unabsorbed chemical on the leaf surface. Droplets impacting on gummed areas spread rapidly and extensively.

56 ORAL SESSION (Abstr. 480-487)
Cell and Tissue Culture I

480
RESEARCH TO PRODUCTION: ROOTING AND ACCLIMATIZATION STRATEGIES FOR MICROPROPAGATED ACER SACCHARINUM L.
Carl A. Huetteman*, John E. Preece, W. Clark Ashby, and Paul L. Roth, Departments of Plant and Soil Science (CAH, JEP), Plant Biology (WCA), and Forestry (PLR), Southern Illinois University, Carbondale, IL 62901

The greatest challenge in our transition from micropropagation research to larger-scale production of silver maple plantlets has been rooting and acclimatization. Initially, during the research phase, using shoots in capped culture vessels with vermiculite or in a small mist bench, rooting plus acclimatization (efficiency) were 90-100%. Efficiency was only 17% when thousands of shoots were in a large mist bench because of uneven mist coverage. When roots were initiated in vitro, efficiency improved to 24% on the mist bench. Efficiency was 40% using in vitro-rooted shoots transplanted to a fog enclosure and increased to 58% if shoots were pulsed previously in vitro on auxin-containing medium for eight days in darkness. When pulsing for 2-7 days was followed by planting into commercially-prepared peat plugs in high humidity flats, efficiency increased to 72%.

481
IN VITRO RESCUE OF A MATURE MALE KENTUCKY COFFEETREE (GYMNOCLADUS DIOICUS L.) GENOTYPE
M.A.L. Smith* and A. A. Obeidy, Department of Horticulture, University of Illinois, Urbana, IL 61801-4720

Terminal shoots and watersprouts were collected from a mature, 70 ft. tall male Kentucky Coffeetree on the University of Illinois campus, in an effort to preserve the genotype following severe lightning damage. Axillary buds were explanted on a low salts medium supplemented with a wide range of BAP and TDZ levels. Stable, nondescript cultures were established from watersprout bud explants at low BAP concentrations. Multiple shoot buds were induced after subculture to a medium with 36 µM BAP and 5 µM IBA. An average of 35 adventitious buds/month were produced on each 0.5 cm^2 clump of this regenerative tissue. Shoot elongation was achieved by subculturing to a medium with 9 µM BAP and 0.5 µM NAA. Shoots elongated at a rate of 3 cm/month over a 90 day period. Shoots 3-6 cm long were transferred to a low salts medium with 7.5 µM IBA and held one week in the dark, then exposed to light. Roots emerged after 21 days, with 22% efficiency. Rooted microplants were transplanted into a 1: 1: 1 mix and held in a growth room under high humidity for an additional 2-3 weeks, with gradual reduction of humidity, prior to transfer into the greenhouse for continued growth.

482
MICROPROPAGATION OF CHESTNUTS (CASTANEA SPP.)
Charles Auko* and Paul E. Read, Department of Horticulture, University of Nebraska-Lincoln, Lincoln, NE 68583-0724

Buds and shoot apices were used as explant materials and cultured on Woody Plant Medium at a pH of 5.6. The plant growth regulators (PGR) used were zeatin, benzyladenine, and chloropyridyl phenol urea (CPPU) in our first, second, and third experiments respectively. We used concentrations of 0, 0.05, 0.5, and 50µM zeatin while for BA and CPPU, we used 0, 0.5, and 20µM concentrations.

More shoot proliferation (3-6 shoots/plantlet) was obtained in media with 0.05µM and 0.5µM of zeatin. Explants cultured on medium containing no zeatin did not produce any shoots. Fifty µM zeatin also did not show any shoot proliferation or elongation; ninety percent of the shoots were suppressed and necrosis of shoot tips was observed.

Media containing BA and CPPU concentrations of 0.5 and 20µM or PGR-free media were tested. Preliminary results suggested that 0.5µM BA and 0.5µM CPPU enhanced bud proliferation. Further research will be conducted to determine the most optimum levels of these PGR.

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IN VITRO PROPAGATION OF ACANTHOPANAX SIEBOLDIANUS
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Shoot proliferation of Acanthopanax sieboldianus was achieved in vitro from softwood growth taken from actively growing stock plants and cultured on woody plant medium (WPM) supplemented with BA or thidiazuron (TDZ) under 16 hours of light per day provided by cool white flurescent tubes at 37.6 ± 10.1 umol $sec^{-1}m^{-2}$ and at 23 ± 2°C. Shoots were produced at a high frequency on WPM containing 1 uM BA and were successfully rooted in in the same medium and under the same culture conditions without auxin. After 12 weeks, the rooted plantlets were transplanted into a pelting mix consisting of 2 peat : 2 perlite : 2 vermiculite : 1 soil and were maintained in a humidity chamber for acclimatization and then were transferred to the greenhouse. The transplanted plantlets grew vigorously both in the humidity chamber and the greenhouse, with apparently normal morphology.

484
IN VITRO SHOOT PROLIFERATION OF THUJA OCCIDENTALIS 'HETZ WINTERGREEN'.
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Adventitious shoot formation from cotyledons has been the most successful method of proliferating conifer shoots; however, plantlets derived adventitiously can exhibit genetic or epigenetic variation. If clonal integrity is desired, then axillary shoot proliferation should be used. Thuja occidentalis 'Hetz Wintergreen' shoots were disinfested and established in vitro on MCM medium without growth regulators. Shoots were cut to 3 cm lengths and subcultured to MCM medium with benzyladenine (BA) (0, 0.1, 1, or 10 uM) and naphthaleneacetic acid (NAA) (0, 0.1, 1, or 10 uM) in a factorial arrangement to test for axillary shoot proliferation. Shoot length, shoot area, number of axillary and basal axillary shoots were determined at 90 days. The mean number of basal axillary shoots was 9.4 for 0.1 uM NAA and 10 uM BA compared to 0 for no NAA or BA in the medium. Thidiazuron and BA were also used in combination for shoot proliferation.

485
SHOOT ORGANOGENESIS FROM FLORAL ORGANS OF RHODODENDRON 'P.J.M. HYBRIDS'
A. Shevade* and John E. Preece, Department of Plant and Soil Science, Southern Illinois University, Carbondale, IL 62901

During the dormant season, flower buds collected from field-grown plants were surface sterilized, scales were removed and florets, anthers with filaments, and pistils were placed in vitro onto Anderson's (1984) medium supplemented with various combinations of IAA, IBA, 2iP, and TDZ. Growth and organogenesis were better when explants were incubated under cool white fluorescent lamps than in darkness. Adventitious shoots formed from the base of the florets, petals, and stamens; both ends of the filaments, but mainly at the cut, proximal end; and the style and ovary. Shoots were visible within four weeks from 66% of stamen cultures when 1 µM TDZ, 10 µM 2iP, plus 10 µM IAA were in the medium. Twenty-eight percent of the florets formed adventitious shoots across all media. Florets responded best on media containing 10 µM IAA, 10 µM or higher 2iP, plus 10 µM TDZ. Shoots appeared to form directly from the explants without an intervening callus.

487
ORCHID MICROPROPAGATION ON POLYPROPYLENE MEMBRANES
Jeffrey Adelberg* and Nenita Desamero, Department of Horticulture, Andrew Hale and Roy Young, Department of Agricultural and Biological Engineering, Clemson University, Clemson, SC 29634

Several clones of Cattleya orchid were micropropagated on MS medium using a polypropylene membrane (Cel-life™, Hoechst-Celanese Separations Products Division, Charlotte, NC). In comparison with agar, plant proliferation was greater on membranes and the individual plants were larger. Membrane cultures maintained active growth without subculture several months longer than agar cultures. Water loss was more limiting than nutrient uptake in growth of cultures. Studies of media dilution and nutrient supplementation showed better growth in response to dilution. Implications of nutrient availability in agar versus membrane culture will be discussed in context of current experiments with alternative media formulations.

73 ORAL SESSION (Abstr. 488-495) Floriculture: Culture and Management

488
FACTORS INFLUENCING THE FORCING OF DUTCH-GROWN ASTILBE
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Dutch-grown Astilbe cultivars were harvested in late September, cut immediately into single eyes, washed, and hot water treated before being air freighted to North Carolina state university. Studies were undertaken to evaluate the effects of various preplant storage conditions of the crowns; the influence of drying of the crowns at planting

time and at the marketing and full flower stages of development; basic fertilization requirements; forcing temperature requirements; and daylength effects on the forcing characteristics of Astilbe. Other studies included the determination of specific cold week requirements for the cultivars and a study to determine the floral development of the crop, using the scanning electron microscope. Fifteen commercially available cultivars were used in these studies.

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EFFECTS OF COPPER HYDROXIDE-TREATED CONTAINERS ON GROWTH AND ROOT MORPHOLOGY OF *PELARGONIUM X DOMESTICUM*

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One of the salient characteristics of the Ohio Production System for nursery production involves applying $Cu(OH)_2$ dissolved in latex paint to the inside surface of the pot. This prevents root binding through root tip inhibition. An experiment was initiated to determine the effects of $Cu(OH)^2$ treated pots on the root morphology and growth of *Pelargonium X domesticum* to begin assessing possible applications of the system to floricultural crops.

Uniform cuttings of four cultivars were stuck in AC4-8 units which had been painted with latex paint containing 0, 25, 50, 75 or 100 g/l of $Cu(OH)_2$ plus a control treatment of no latex paint. The experimental design was a split plot with 5 blocks. The cuttings were rooted under intermittent mist then grown using normal greenhouse culture.

Cuttings which had been produced in pots painted with $Cu(OH)_2$ impregnated latex paint had a very different root morphology than those of the control.

490

GREENHOUSE PHYTOXICITY AND RESIDUE STUDY OF INSECTICIDES ON BEDDING AND POT PLANTS.

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A commercially popular cultivar of each of 7 species of potted flower crops and 13 flower bedding plants plus pepper and tomato were grown in the greenhouse to early flowering and then sprayed with 18 commonly used insecticide formulations or combinations. Standard practices were used throughout, except that sub-irrigation was employed at least from 1 week before spraying until termination and half of the test plants were water-stressed about 3 days before insecticide treatments were applied. Plants were set up in a 3 replicate CRD and sprayed at 1x (labeled rate), 2x, and 4x rates. The talk will summarize the combined results (with symptoms) from both 2 and 9 day observations at the labeled (lx) rates for flower and leaf injury and visual residues. Generally, flower or bract injury was greater than anticipated at the lx rate. Lilies even showed split corollas. Leaf injury was much less common, but with notable exceptions. Residue was especially common with Malathion 25 WP, but on pot plants 8 other insecticide formulations also caused moderate residues.

491

EFFECTS OF SEEDLING COVERING MATERIALS ON GERMINATION AND TRANSPLANT YIELD

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Germinating seeds under mist can result in poor seedling emergence and low survival because of difficulties in water management. Low germination can be due to excess water around the seed and limited gas exchange. This study investigated common seed covering materialand a new one made from granulated reed-sedge peat (Bacctite). The granular structure provides an unusually high percentage of macro-pores for gas exchange and allows excess water to drain off. When the granules are in contact with the seed, water is pulled away by capillary action.

In three separate experiments, seeds of different ornamental and vegetable species were sown into 406 plug trays and covered with the growing media, vermiculite, perlite, and fine or medium sized bacctite. Four depths of covering were used: no covering, shallow, medium, or deep 0, 1, 2, or 3 liter covering/mater surface area). Seedlings were germinated under intermittent mist and grown to transplant stage. Then plants were transplanted and grown to a marketable stage. Percentage and rates of emergence, survival, and days to marketability were recorded and data analyzed.

Different species varied significantly in covering responses. Percentage of emergence varied with depth of covering. Survival often increased with covering depth and varied between different covering materials. Days to marketability were shorter for plants covered with medium or fine bacctite than those with no covering or with shallow covering of perlite or vermiculite. Results from the data suggest that covering seed with some materials sill give higher germination, greater survival rates and decreased time to marketability. These results are contrary to currently recommended practices. A summary of results will be presented.

492

EFFECTS OF STORAGE TEMPERATURE AND LIGHT CONDITIONS ON SHELF LIFE AND PLANT QUALITY OF ASIATIC HYBRID LILIES

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Easter lilies can be held at low temperatures (2 to 10 C) for up to 4 weeks with minimal loss in plant quality. However, there is no information on how long the Asiatic hybrid lilies can be held under these conditions without loss in quality. 'Rouge Pixie' and 'Pink Pixie' of the GDAH lilies were grown in a greenhouse until the first flower bud was showing color, then placed in coolers at 4 or 10 C with or without lighting at 40 µmol m^{-2} s^{-1} for 15 days. Plants treated at both 4 and 10 C unexpectedly flowered in the coolers about 7 days after treatments started while the controls flowered 3 days after being placed in a simulated consumer environment. Plants held at 5 or 10 C had longer flowering period (from anthesis of the first flower to the shattering of the last) than the control. Plants of 'Pink Pixie' treated at 5 C without lighting had more flower bud abortions than controls or plants of other treatments. Flower color of plants treated at 5 or 10 C without light were lighter than that of controls or plants with other treatments. Tepals of plants treated at 5 C with light had patches of darker color probably resulting from accumulation of anthocyanin.

493

AN ALTERNATIVE TO THE TRADITIONAL METHOD OF OVERWINTERING PERENNIALS.

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Traditionally, perennials are overwintered outdoors under some form of insulated covering to meet the plants' vernalization requirement. Little information is available regarding the need for vernalization or alternative overwintering methods. An experiment was conducted to test the vernalization requirement for Rudbeckia fulgida Gaillardia lanceolata, and Coreopsis lanceolata. Controls were maintained in a greenhouse at a minimum of 17°C, while vernalization treatments were conducted outdoors or in refrigerated units. Plants in refrigerated units were precooled for two weeks at 5-7, 8-10, or 11-13°C and then vernalized at temperatures of 2-4, 5-7, or 8-10°C, respectively, for an additional 2, 4, 6, 8, or 10 weeks. Measurements were recorded on survival rate, number of buds, days to flower, number of leaves, plant size, plant height, visual abnormalities, and root development ratings. The optimal temperature and duration for vernalization was determined for each species.

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SINGLE STEM CUT FLOWER PRODUCTION OF *Salvia leucantha* AND *Achillea millefolium* IN THE GREENHOUSE

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Velvet sage (Mexican bush salvia), *Salvia leucantha*, and yarrow, *Achillea millefolium* 'Fanal' and 'Paprika', were evaluated for greenhouse cutflower performance from October, 1990 to June, 1991. Velvet sags and yarrow stock plant production, cutting propagation and initial stages of cutting growth were completed under LD from HPS lighting 100 µmole $s^{-1}cm^{-2}$ from 1800-2400HR. Cutflower production of velvet sage occurred under ambient SD or under black cloth 1800-800HR while cutflower production of yarrow occurred under the same supplementary light regime. Plants were grown in ProMix in 5 cm pots or in 2.5 cm rockwool cubes and subirrigated with 100 mg N/liter (20N-8.7P-16.6K) 1-5 times per day. Stem length of velvet sage was controlled by the number of weeks of LD before SD; 8-9 weeks of SD was required for flowering. Stem length of yarrow ranged from 35-55 cm and plants required 6-7 weeks from rooted cutting to flowering. Velvet sage grew equally well at 50, 100 and 150 stems m^{-2} and yarrow grew equally well at 100. 200 and 300 stems m^{-2}.

495

THE INFLUENCE OF SHADE ON FIELD-GROWN SPECIALTY CUT FLOWERS

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Flowers of *Anemone coronaria* L., *Centaurea americana* Nutt., *Echinops ritro* L., *Eryngium planum* L. and *Zantedeschia* Spreng. were produced under ambient irradiance, 55 or 67% shaded conditions outdoors. Plants grown in shade had longer flower stems than those in ambient but flower yield was species dependent. *Centaurea americana*, an annual, and *Eryngium planum*, a perennial species, significantly declined with each reduction in irradiance.

Yield of *Echinops ritro,* a perennial, was significantly greater in 55% shade than in ambient conditions. Longer stems of Anemone coronaria, a tuber, occurred in highest shade conditions but yield was unaffected. Tubers of *Zantedeschia,* grown in 67% shade, gave significantly lower yields compared to those grown in ambient conditions and 55% shade. Scape length and spathe width increased significantly for plants grown in 55% for all cultivars.

74 ORAL SESSION (Abstr. 496-502) Growth and Development: Dormancy

496
TOPOCLIMATIC EFFECTS ON SPRING FREEZE CHARACTERISTICS AND PEACH PHENOLOGY
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Peach production in Tennessee has suffered a decline in the past decade due to late and severe spring freezes. East Tennessee is an area of diverse topography. It may be possible to use topoclimate exposure to ameliorate the low temperatures in spring and therefore lessen the damage to peach buds. Exposure also may also influence the accumulation of chill units and growing degrees, therefore affecting the stage of peach bud development when the freeze occurs. Five automated weather stations were located in topoclimatically different areas of a peach orchard in Dandridge, Tennessee, from September, 1990 to May, 1991. Hourly chill units (base 6.1 °C) and growing degrees (base4.4 °C) were calculated. Twigs from peach trees close to each weather station were forced every three days to determine the date of completion of rest. Hourly freeze data were collected from each weather station. Preliminary results on the effects of topoclimate on spring freeze characteristics, accumulation of chill units and growing degrees, and peach phenology will be presented.

497
BOUND VERSUS FREE WATER IN DORMANT APPLE BUDS.
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Magnetic Resonance Imaging (MRI) was used to image endodormant and paradormant apple buds. The image created by MR depends on the transverse exitation properties of water and the relaxation time is measured as T2. Endodormant buds had too short T2 times to create an image but as soon as chilling requirement was satisfied image was produced. Free water is not distributed in the buds uniformly. Groups of cells are clearly produce an image others are not. T2 times measured are in the range of bound water, they were not lengthened but somewhat shortened when images are produced after chilling. This anomaly need to be resolved with further research. Paradormant buds always contained free water. A theory was advanced that endodormancy involves structuring, shielding or perhaps bounding the water and chilling changes this configuration allowing resumption of growth.

498
THE ROLE OF CHILLING AND RELEASING OLIVE FLORAL BUDS FROM DORMANCY
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This investigation was designed to explore an alternative explanation for the confusing concept surrounding the role of chilling in olive floral induction. Leafy olive explants were collected from November thru March and subjected to various temperature conditions. Growth of floral buds was first recorded from 5 January samples. After that date the percent of growing floral buds and rate of their development increased with later collection dates. Manual defoliation in adult trees during the period of shoot explant collection indicated that leaves play a critical role in growth once floral buds have completed dormancy. Shoots collected 20 January and given chilling demonstrated that 7.2°C was sufficient to complete chilling requirement while 12.5°C allowed both the completion of chilling requirement and the proper temperature for subsequent floral bud growth. Our interpretation of these results is that winter chilling is required to release from dormancy previously initiated floral buds and we question the previous concept that the role of chilling was to induce the olive floral initiation process.

499
EFFECT OF DURATION OF LOW TEMPERATURE TREATMENT ON FLOWERING OF CONTAINERIZED 'TOMMY ATKINS' MANGO
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Low temperatures promote flowering of mango. Three durations of a cool, floral-inductive temperature regime were tested *on* small trees (up to 1m in height and with 4-9 stems) generated by air-layering. Two growth chambers were set at 30C day/25C night, and 18C day/10C night (non-inductive and inductive regimes). A 13-h photoperiod was used in both chambers. Four treatments were tested: 30/25C throughout (control), and 18/10C for 20, 30, or 40 days, followed by transfer to 30/25C. Only vegetative growth occurred on control and 20-day-chilled trees. Flowering of 30-day or 40-day-chilled trees occurred only on lignified shoots; younger ones remained dormant. If tender, apical vegetative shoots were removed prior to treatment, vegetative shoots emerged from dormant, sub-apical buds in all treatments. Mature, dormant stems and 30-40 days of chilling at 18C day/10C night are required for flower induction of 'Tommy Atkins' mango.

500
ENDOGENOUS IAA AND WATER UPTAKE IN DEVELOPING COFFEE FLOWER BUDS
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Dormant coffee *(Coffea arabica* L.) flower buds require water stress to stimulate regrowth. A xylem specific water-soluble dye, azosulfamide, was used to quantify the uptake of water by buds after their release from dormancy by with-holding water. In non-stressed flower buds, the rate of water uptake was generally slower and variable. In stressed flower buds, the rate of uptake tripled from one day to 3 days after rewatering and preceded the doubling of fresh and dry weight of buds. Free, ester, and amide IAA levels of developing flower buds were measured by GCMS-SIM using an isotope dilution technique with [$^{13}C_6$] IAA as an internal standard. Throughout development, the majority of IAA was present in a conjugated form and the dominant form was amide IAA. The proportions of amide and free IAA changed rapidly after plants were water stressed until day 3, and preceded the doubling of fresh and dry weight. Correlation coefficients of 0.9, 0.7, and 0.7 ($p<0.l$) were found between auxin content and fresh weight, dry weight, and rate of water uptake, respectively.

501
DIFFUSIVITY OF CO_2 IN THE SKIN AND FLESH OF POTATO TUBERS
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The diffusion coefficient of CO_2 ($D^{co}2$) in the skin and flesh of potato tubers (cv. Russet Burbank) was determined under steady-state conditions using the rate of CO_2 evolution, the dimensions of the tuber, and the concentrations of CO_2 in the atmospheres, under the skin, and at the center of the tuber. The skin was treated es being a metabolically inert, hollow, cylindrical shell, whereas the flesh was considered to be a metabolically active solid cylinder. The results showed that (a) the values of $D^{co}2$ at 10C were 6.32 $cm^2.sec^{-1} x 10^{-7}$ and 1.18 $c m^2.sec^{-1} x 10^{-4}$ for the skin and flesh, respectively, and (b) the gas exchange in both skin and flesh takes place predominantly through gaseous channels. The validity of the data was tested by computing $D^{co}2$ at 27C from observed values at 10C. Furthermore, using the computed values of $D^{co}2$ along with the required variables, the rate of respiration of the tuber was calculated and compared with the observed rate. The results show that the computed and the measured values were similar.

502
CHANGES IN POLYAMINE AND ACC CONTENTS DURING ALLEVIATION OF THERMOINHIBITION OF LETTUCE SEED GERMINATION

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To further unravel the mechanism of thermoinhibition and its alleviation during soaking of lettuce seeds (Mesa 659) at 35°C, changes in polyamine and ACC contents were investigated. The major free polamines in the dry seed were spermidine (40-50µg/l00 seeds) and putrescine (10-15µg/100 seeds). Preconditioning of seeds with the moist solid carrier, Micro-Cel E at 15°C for 20h completely removed the thermoinhibition. Time course studies of polyamine and ACC levels at 35°C following the 20h preconditioning at 15°C indicated that polyamines did not function directly in the relief of the thermoinhibition whereas ACC was involved as shown by a pregermination peak after 6h imbibition (preconditioned seeds begin to germinate after 8-10h soak at 35°C). Further, AVG, an inhibitor of ACC biosynthesis, reduced the pregermination ACC level and germination, whereas a-difluoromethylarginine (DFMA), a polyamine biosynthesis inhibitor, failed to inhibit germination. The data indicate that ACC biosynthesis during the pregermination phase is a critical event for the alleviation of thermoinhibition in preconditioned seeds whereas polyamine biosynthesis may not play an active role in this process.

75 ORAL SESSION (Abstr. 503509) Citrus: Nutrition

503
THE INFLUENCE OF CITRUS ROOTSTOCK ON LEAF MINERAL CONTENTS AND FRUIT QUALITIES OF VALANCIA ORANGE.

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Trees of valancia late oranges were budded in 1972 on five citrus rootstocks - namely : Troyer citrange, sour orange, Rangpur lime, Rough lemon, and Cleopatra mandarin. The trees were planted at the Research Experimental Station of the Faculty of Agriculture at Tripoli, Libya. The effect of the five rootstocks on leaf mineral composition, fruit qualities, and maturity were studied. The results of leaf and fruit analysis for three growing seasons indicated the trend of greater influence of Cleopatra mandarin and Troyer citrange on fruit weight, length and diameter, juice content, total soluble solids and acidity. Maturity and ripening of the fruits was influenced by rootstocks and it was concluded that valancia fruits could not be harvested before April under the environmental conditions of Tripoli.

504
NITROGEN RATE EFFECT ON GROWTH OF CONTAINERIZED CITRUS NURSERY PLANTS

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Production of containerized citrus nursery plants has increased greatly in recent years but little work has been done to establish nitrogen levels needed to optimize plant growth while minimizing potential ground water contamination. Carrizo citrange *[Citrus sinenis* (L.) Osb. x *Poncirus trifoliata* (L.) Raf.] seedlings budded with 'Hamlin' orange *[Citrus sinensis* (L.) Osb.] were greenhouse grown in 2-liter containers using washed sand medium, The plants received one liter daily of either 0, 12.5, 25, 50, 100, or 200 ppm of N as NH_4NO_3 dissolved in a complete nutrient solution. After 26 weeks, there were no differences for rootstock or scion stem diameters among the treatments containing N, but they all were greater than the no N treatment. Length and leaf number of the first scion flush were greater for the two highest N rates than for the no N treatment. Total leaf area of the first scion flush for the four highest N rates was greater than for the no N treatment. Budbreak was greater for the highest N rate than for the no N treatment. Longer term work is continuing with different citrus rootstocks to determine N rate effects on containerized trees.

505
NITRATE UPTAKE BY TWO CITRUS ROOTSTOCKS AS INFLUENCED BY SALINITY

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The objective of this experiment was to study interactions between salinity stress, nitrate (NO_3^-) uptake efficiency and NO_3^- allocation of citrus seedlings. Six replicates of relatively saline-tolerant Cleopatra mandarin (CM) and salt-sensitive Volkameriana (V), were grown in a Candler fine sand and subjected to either non-saline (160 mg l^{-1} total dissolved salts [TDS]) or saline (4000 mg l^{-1} TDS) treatments for 4 weeks. A single application of $K^{15}NO_3$ (20% ^{15}N) at 212 mg l^{-1} N, was substituted for the normal weekly fertigation. Plants were harvested 7 days later. Salinity reduced the growth and uptake of $^{15}NO_3^-$ and total N ($^{14}N + ^{15}N$) of each rootstock. $^{15}NO_3^-$ uptake was positively correlated with whole plant transpiration. Chloride and NO_3^- allocation patterns within rootstocks were significantly affected by treatment. The potential for NO; loss by leaching may therefore be enhanced under conditions where irrigation water is saline.

506
EFFECTS OF SALINITY ON CITRUS ROOTSTOCKS

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Salinity is becoming a problem in Florida coastal areas due to increased salt water intrusion. Hence, a study was conducted to investigate the potential salt tolerance and the effects of NaC1 at 3 osmotic potentials (-0.10, -0.20, and -0.35 MPa on 7 popular citrus rootstocks. NaC1 reduced growth, disturbed water relations, and altered leaf mineral concentrations of all tested rootstocks. Depending on the rootstock, at -0.10 MPa, plant dry weight (DW) and root hydraulic conductivity (RC) were reduced by 17 to 32% and by 19 to 86%, respectively. DW and RC were reduced the least in sour orange (SO) and Cleopatra mandarin (CM) and the most in Milam lemon (ML) and trifoliate orange (TO). Swingle citrumelo (SC), Carrizo citrange (CC), and rough lemon (RL) had an intermediate response to salinity. Leaf burn injuries caused by NaCl followed the same trend as DW and RC with the least injury occurring to SO and CM and the most injury to ML and TO. NaCl reduced leaf N, Ca, Mg, Zn, and Fe but increased leaf P. Leaf K was not affected in Na-excluder rootstocks (TO, CC, SC), but was reduced in Na-accumulator rootstocks (SO, CM, RL, ML).

507
MICROSPRINKLER IRRIGATION OF YOUNG GRAPEFRUIT TREES WITH RECLAIMED WATER

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Field studies were designed to evaluate the growth and development of young -'Redblush' grapefruit trees (Citrus paradisi Macf.) on 'Swingle' citrumelo rootstock irrigated with reclaimed water. Experiments were arranged in a 3X3 factorial experiment at two locations, on Kanapaha and Arrendondo fine sands. Treatments included reclaimed water (≤0.023 kg N/tree/yr), well water plus fertigation (0.23 kg N/tree/yr) and reclaimed water plus fertigation (0.23 kg N/tree/yr). In addition irrigation rates of 472, 1619 and 2746 L/tree/yr were used. Trees receiving reclaimed water alone showed visual symptoms of nitrogen deficiency. Tree growth was greatest with reclaimed water plus fertigation and lowest for reclaimed water alone based on visual ratings. Treatments affected trunk diameter similarly on the Kanapaha fine sand, but trends were inconclusive on the Arrendondo fine sand. No differences in tree growth or vigor were observed among irrigation rates. Initial findings indicate that reclaimed water has no deleterious effects and may enhance young tree growth.

508
CHANGES IN SOIL CHEMICAL PROPERTIES AS RELATED TO FLOOD IRRIGATION IN A CITRUS GROVE

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Severe nutrient leaching in a deep sandy soil may occur under two worse-case scenarios in Florida: excessive rainfall or use of large volumes of water on successive nights for cold protection. Our objective was to determine the changes in selected soil chemical properties induced by flood irrigation in a 30-year-old grove of Valencia orange [Citrus

sinensis (L.) Osbeck]. The soil was Astatula sand (Typic Quartzipsamments). Four trees received 41 cm of water from flood irrigation over a 6-hr period in February. Samples of soil in 15-cm layers in the 3.2 m profile were collected for chemical analysis prior to flooding and 5 days later. Substantial losses of soluble salts occurred in the top 2 m, some of which were found in the fine-textured soil at the 3-m depth. The pH values measured in the 0.01 M $CaC1_2$: soil suspension were from 0.2 to 0.6 units lower after flooding in the top 2.4 m and 0.5 unit higher in the subsoil. Exchangeable Ca^{2+}, Mg^{2+}, and K^{+} cations were reduced in the surface 30 cm of soil.

509
ATTEMPT TO INDUCE BLIGHT-LIKE SYMPTOMS IN CITRUS SEEDLINGS BY STRESS TREATMENTS
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Elevation of Zn concentration in stem phloem has been identified as a pre-decline blight symptoms in mature citrus trees. In an effort to determine any possible influence of stress factors (excess Zn, Cu, salt and drought) in causing a similar Zn redistribution, a green-house study was conducted with 10 month-old, blight-susceptible rough lemon and blight-tolerant sour orange seedlings. Moderate stress levels from the treatments did not affect the growth significantly. Percent Zn allocation to stem bark of sour orange decreased with excess Zn application, whereas in rough lemon the percent remained same, later indicating a greater ability to redistribute Zn to phloem. Stem bark of drought treated rough lemon accumulated significantly higher Zn concentration compared to sour orange despite similar dry weights. With excess Cu, both cultivars showed a decreased percentage of Cu allocation to stem bark. Accumulation of Zn & Cu was significantly higher in fibrous roots. Moderately higher treatment levels of anions and salinity treatments did not change the Zn distribution as occurs in blight.

76 ORAL SESSION (Abstr. 510-515) Marketing and Economics: Cross-Commodity

510
USING MULTIMEDIA COMPUTER SIMULATIONS FOR MARKETING RESEARCH
W. Timothy Rhodus* and Laura Widhalm, The Ohio State University, Department of Horticulture, 2001 Fyffe Court, Columbus, OH 43210.

Human subject research in the area of information processing is complicated by the inability to unobtrusively measure a subject's behavior. By using computer simulations, individuals are able to interact with the system and exhibit preferences that are automatically recorded by the computer. A simulated garden center was created for both Macintosh and IBM compatible computers using actual color photos and "Authorware," an interactive multimedia software program. The objective of this research was to determine the informational needs of garden center consumers. Subjects were asked to use the system as a means of gaining information prior to making a plant purchase decision. Pictures of actual garden center signs, posters, and tags related to perennials were available as information sources. Knowledge gained from this project will be used to suggest improvements for information delivery mechanisms.

511
GREENHOUSE VEGETABLE INDUSTRY CHANGES: 1949 - 1989
Margaret Balbach, Department of Agriculture, Illinois State University, Normal, IL 61761.

On the surface, it seems apparent that the number of U.S. firms producing greenhouse vegetables has declined. Analyzed broadly, Mexican import competition, as well as higher costs of operation, including those related to conformance to environmental protection mandates, have reduced greenhouse vegetable production to an unprofitable enterprise in many regions. The area under glass has decreased from 27.4 million square feet in 1949 Lo 19.5 million square feet in 1987. Where formerly, using data available in the 1949 through 1979 Census of Agriculture, *one* could compare the numbers of firms growing each of the three major greenhouse crops (cucumbers, lettuce and tomatoes) in each state and region of the country, the more recent census data of 1982 and 1987 do not contain crop specific information. Since 1982, the Census reports vegetables under the one category "greenhouse vegetables." This lack of detail may, in turn, be attributed to the fact that greenhouse vegetables are less and less likely to be separately identified at the terminal markets. Reduced funding for monitoring of these crops severely hampers research into historical changes that have taken place since 1979.

512
DIFFERENCES IN FRESH MARKET TOMATO CONSUMERS AT FOUR TYPES OF RETAIL OUTLETS
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Surveys were conducted at supermarkets, roadside stands, farmer's markets and at-the-farm stores to determine what motivates consumers to purchase Jersey Fresh tomatoes at these outlets and to determine the differences in the demographics of the respondents at different locations. Respondents at roadside stands tended to be seasonal purchasers while the majority of respondents at the other three outlets purchased tomatoes year-round. Although preference for Jersey Fresh tomatoes was high at supermarkets, it was nearly 20% higher at the other three retail outlets. Supermarket shoppers rated the attributes of Jersey Fresh tomatoes lower than shoppers at non-supermarket venues. A possible explanation may be that supermarket shoppers shop for convenience and are not as knowledgeable about vine-ripened tomatoes and do not go out of their way to purchase locally grown produce. Respondents at all locations felt supermarkets were the most expensive tomato outlet even though prices at supermarkets were lower than at other locations. Supermarket shoppers had higher household incomes and were more educated than shoppers at other locations.

513
EXTENSION'S ROLE IN THE FORMATION OF A STATEWIDE VEGETABLE GROWERS ASSOCIATION
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Missouri has over 1200 independent vegetable growers and marketeers. Most of these operations are small family businesses with limited resources. Because this audience is diverse, both geographically and operationally, it is difficult for Extension to address their needs. A statewide vegetable growers organization was desired to provide better educational programs to this audience, to promote the industry within and outside the state, and also to facilitate grower self-help and *grower* cooperation. Lincoln University Cooperative Extension in conjunction with University of Missouri Cooperative Extension and the Missouri Department of Agriculture identified and surveyed over 1000 known growers within the state. Over 60% of these growers indicated a desire for a statewide vegetable association, An inaugural meeting of interested growers was hosted by University Extension for the purpose of establishing *a* Constitution and By-laws committee as well as determining the goals and needs the organization was to address. Subsequently, a Constitution and By-laws was drafted and accepted by the general membership. University Extension's involvement will be limited to advisement and educational support. However, the enthusiastic response of the membership indicate the relationship of Extension and the association will be highly synergistic.

514
INVESTIGATION OF ATTITUDES OF WHOLESALE FLORICULTURE GREENHOUSE GROWERS TOWARD COMPUTER USAGE FOR MARKETING PURPOSES
Laura Sue Kippen* and W. Timothy Rhodus, The Ohio State University, Department of Horticulture, 2001 Fyffe Court, Columbus, Ohio 43210.

A focus group was conducted to ascertain the attitudes and behaviors of wholesale floriculture greenhouse growers toward the use of computers for marketing purposes. The focus group consisted of nine individuals from nine different wholesale greenhouses in the Greater Cleveland - Lorain area. The greenhouses were selected according to their sizes which ranged from one-half acre of production under cover up to 70 acres. Each individual was either the owner of the greenhouse operation or charged with the marketing function in that company. The study was conducted for the purposes of identifying possible factors related to the speed of adoption of computer technology for marketing purposes and its possible future course within the wholesale greenhouse industry. Variables that were identified from the focus group study were tested using a national survey.

515
IMPORTANCE OF PRODUCTS AND SERVICES OFFERED BY NURSERY STOCK PRODUCERS IN THE INTERMOUNTAIN WEST

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The goal of this research was to determine critical factors that influence purchases of nursery stock by garden centers and landscape contractors in the Intermountain region. Surveys were mailed to gardening stores and landscapers throughout Idaho and selected cities in Alaska, Colorado, Montana, Nevada, Utah, Washington and Wyoming. The marketing parameters addressed in the survey included quality, selection and distribution of plants as well as services and promotional help offered by the supplier. The response rate was 73.6% (310 responses from 421 eligible businesses). Of all the factors that influence a nursery stock buyer to purchase plants from a particular supplier, plant quality was chosen as most important by 77% of the respondents. The next highest response, plant price, was rated most important by only 10% of the businesses. In addition, 98% of the respondents rated the need for disease- and insect-free plants as very important. Details of responses to the other marketing parameters will be discussed. This information should enhance marketing techniques and competitiveness of plant suppliers.

87 ORAL SESSION (Abstr. 516422) Small Fruit: Postharvest and Physiology

516
ENVIRONMENTAL FACTORS AND ETHEPHON AFFECTS RELIANCE TABLE GRAPE QUALITY

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The effects of light, ethephon and cluster thinning on the quality of Reliance table grapes were examined over a 2-year period. Grapes were exposed to two levels of solar radiation, two levels of preharvest ethephon, and thinned to basal clusters or left unthinned in a factorial design. Berries were sampled weekly following veraison, with final harvest at maturity. Environmental differences in solar penetration and temperature were monitored. Yield was significantly affected by thinning. Color, taken on the skins of 100 berries at harvest, showed significant differences for **L, a,** and **b** values of light treatments; **b** values of thinned treatments; and a values of thinned and ethephon treatments for both years. Significant differences in **L, a,** and **b** values occurred between the two years. Soluble solids of raw juice from final harvest berries of thinned and light treatments were significantly different. Cooked juice had significant differences for: pH - ethephon vs. non-ethephon; titratable acidity - thinned vs. non-thinned, light vs. non-light, and ethephon vs. non-ethephon; **L** - thinned vs. non-thinned; - ethephon vs. non-ethephon; and **b** - light vs. non-light.

517
THE USE OF VAPOR PHASE HYDROGEN PEROXIDE TO INHIBIT POSTHARVEST DECAY OF GRAPES

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Vapor phase hydrogen peroxide (VPHP) was tested as a potential substitute for SO, fumigation to control postharvest decay of grapes *(Vitis vinifera* L.). Thompson Seedless and Red Globe grapes were inoculated with Botryris cinerea spores and placed in polyethylene bags. Bags were flushed for 10 minutes with VPHP generated from a 30% to 35% solution of liquid hydrogen peroxide at 40C. Immediately following treatment bags were sealed and held at 10C. Twenty-four hours after sealing the number of germinable *Botrytis* spores on inoculated grapes treated with VPHP was reduced 81% and 62% on Thompson Seedless and Red Globe grapes, respectively. The incidence of decay of inoculated Thompson Seedless and Red Globe grapes was reduced 33% and 16%, respectively, after 8 days of storage at 10C when compared to controls. Vapor phase hydrogen peroxide reduced the decay of noninoculated Thompson Seedless and Red Globe grapes 73% and 28%. respectively, after 12 days storage at 10C. Treatments with VPHP did not affect grape color or soluble solids content.

518
EFFECT OF BERRY CUTICLE AND EPICUTICULAR WAX DEVELOPMENT ON OCCURRENCE OF BOTRYTIS CINEREA PERS. IN VITIS VINIFERA L. cv. RIESLING GRAPES

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Leaf removal treatments were applied to Vitis vinifera L. cv. Riesling grapevines to improve light and infiltration during the 1990 season. Shaded and exposed clusters were gathered prior to veraison (10.2° Brix) and at final harvest (17.7° Brix). Cuticle and epicuticular wax were examined qualitatively using cryogenic scanning electron microscopy and quantitatively using enzymatic separation and chloroform extraction. Incidence of Botrytis cinerea was monitored at weekly intervals throughout the season on shaded and exposed clusters. The amount and appearance of berry cuticle and epicuticular wax differed prior to and at harvest. Significant differences in incidence of Botrytis were present prior to veraison. However, those differences were no longer apparent at harvest (41 days later). Cluster exposure and its influence on wax and cuticle development does not seem to play a major role in the suppression of Botrytis on V. vinifera L. cv. Riesling when grown in a temperate climate.

519
THE INFLUENCE OF CANE FRUITING STATUS, LEAF TYPE, AND LEAF POSITION ON RED RASPBERRY *(Rubus idaeus* L.) PHOTOSYNTHESIS

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The gas exchange rates of leaves from-fruiting (F) and deflowered (DF) canes of 'Meeker' red raspberry were compared during fruit development. Leaves on F laterals had carbon dioxide assimilation (A) rates significantly ($p \leq 0.01$) higher when green (87%) and red (22%) fruit were present, but rates of A were similar after harvest. During this time, leaves on DF laterals had greater dry weight accumulation as well as greater chlorophyll a and total chlorophyll content compared to leaves on F laterals. Accumulated attenuance and fourth-derivative spectra of leaves from F and DF canes were compared. Peak wavelengths were similar, but variation was noted in peak amplitudes.

Unifoliate leaves subtending fruiting spurs had significantly higher ($p<0.01$) rates of A than larger trifoliate leaves subtending the entire lateral. Trifoliate leaves subtending F laterals had higher chlorophyll a and total chlorophyll content than unifoliate leaves on F laterals. Leaves at each node along F laterals had significantly higher rates of A than did corresponding leaves on DF laterals. Photosynthetic activity decreased 60-70% in leaves along the lateral between the exterior and interior portions of the canopy.

520
CHANGES IN RIPENING RASPBERRY FRUIT

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Although raspberry fruit ripen rapidly, the involvement of ethylene in the initiation of ripening is unclear. Raspberry fruit were harvested at different stages of ripening and held in water to prevent water stress. Respiration and ethylene production were monitored for green, yellow, mottled, pink, red, and dark red fruit. No climacteric pattern of respiration was found during raspberry fruit ripening. Ethylene production was below detectable limits until color was initiated at the mottled stage. The drupelet cap and calyx were isolated from intact fruit to determine their respective roles in raspberry fruit ripening. The drupelet cap followed the respiration and ethylene production rates of intact fruit more closely than did the calyx. Application of silver thiosulfate to green and yellow fruit via peduncles did not block ethylene production. Ethylene-forming enzyme appeared at the mottled stage. These results demonstrate nonclimacteric respiration in a rapidly ripening fruit.

521
QUALITY CHANGES IN RABBITEYE BLUEBERRY FRUITS IN RESPONSE TO PREHARVEST APPLICATION OF Ca, ETHYLENE, AND POSTHARVEST CA STORAGE

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Nutrical, a trihydroxyglutarate chelate (4.5 l/hectare/season), $CaCl_2$ (4.0 lb/hectare/season) and ethephone,and ethylene generating compound (150 ppm) were foliarly sprayed on Tifblue rabbiteye blueberry (Vaccium ashei Reade) to study their effects on fruit quality. Appli-

cation of nutrical and $CaCl_2$ were made from fruit set and repeated at 2 week intervals until harvest. Ethephone application was made during maturation (75% blue). The harvested fruits were stored in CA of 2.5% O_2 10% CO_2 and at 5°C for 3 weeks. Firmness, TSS, acidity, ethylene evaluation as well as other fruit qualities varied significantly among different treatments.

522
INFLUENCE OF RIPENESS. STORAGE TEMPERATURE. AND LIGHT CONDITIONS ON STRAWBERRY QUALITY
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A study was conducted to examine the influence of initial stage of ripeness, temperature, and light intensity on postharvest changes in the content of soluble solids (SS), titratable acids (TA), anthocyanin pigments as well as surface color and surface pH of strawberries. Strawberries (cv. Blomidon) were harvested at 3 stages of maturity based on surface color: 0 (white-unripe), 2 (pink-partially ripe) and 4 (red-ripe) and subjected to all combinations of the following levels of temperature and light: 5, 10, 20, and 30C and 0, 100, and 200µmol $m^{-2}s^{-1}$. 1, 2, 5, and 8 days, berries were sampled for the following; variates: % SS, TA, surface color (1(white) - 5(dark-red)), surface pH and whole-berry anthocyanin content. The results indicated that during the 8 day storage period, the initial berry ripeness and temperature had the greatest influence on the measured variates. The influence of light intensity was comparatively small. The relative influence of the experimental factors differed, depending on the variate e.g. the effect of temperature on the development of pigments was great, while temperature had less influence on changes in % SS. The results illustrate how fresh strawberry color can be controlled by initial stage of ripeness and storage conditions.

88 ORAL SESSION (Abstr. 523529) Growth and Development: Hormonal and Enzymatic Effects

523
ETHYLENE EVOLUTION RATES DURING FRUIT MATURATION ARE NOT NORMALLY DISTRIBUTED
Christopher S. Walsh* and Karen A. Klozenbucher, Department of Horticulture, Marla S. McIntosh, Department of Agronomy, University of Maryland, College Park, MD 20742 USA.

Ethylene evolution rates were measured on apple, peach, nectarine and kiwifruit. Rates were measured on individual fruits using a sealed, static system. Using this system large numbers of fruits could be measured on each sampling date. Ethylene evolution rates were low, ranging between 0.0 and 2.0 nl/g-hr during maturation. In Fantasia nectarine and Gala apple ethylene increased during the two to three weeks prior to harvest. Individual fruit ethylene evolution rates were not distributed normally. Certain rates were measured frequently, while others were rarely observed. In peach, nectarine and apple, observations were clustered at 0.05 nl/g-hr, 0.3 nl/g-hr, and 1.0 nl/g-hr. Far fewer observations were made between these values. Clustering of ethylene data was also observed in imported kiwifruit. From these data, it is inferred that fruit ethylene evolution increases in a stepwise pattern during maturation. This is in contrast to the smooth quadratic function typically measured in bulk fruit samples after harvest.

524
CELL WALL CHANGES IN RIPENING AVOCADO FRUIT
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Avocado Cx-cellulase is a prominent cell wall enzyme whose synthesis is temporally associated with ripening. Although the enzyme is known to degrade substituted β–1, 4-glucans, its native substrate has not been identified. In this study, avocado cell wall components were characterized in order to identify potential substrates for Cx-cellulase. Cell walls and ethanol-insoluble solids were prepared from avocado of various stages of ripeness. Associated with a dramatic loss of fruit firmness is a decrease (mg/g mesocarp fresh weight) in cellulose (22%), and an increase in total uronic acids (8%), soluble pectins (288%) and hemicelluloses (14%). Gel-permeation chromatography of hemicelluloses characterized these polymers as having a broad molecular weight range in unripe fruit with a slight shift to a lower average molecular weight as ripening proceeded; however, the changes were less dramatic than those observed for other fruit types. Some workers have suggested that xyloglucan (XG) is a possible native substrate for Cx-cellulase in avocado fruit. Although XG was present in the hemicellulose, its molecular size changed little during ripening and was unaffected in in vitro assays employing partially purified avocado Cx-cellulase.

525
ETHEPHON ORGAN PENETRATION AND HARVEST EFFECTIVENESS IN OLIVE
James O. Denney* and George C. Martin, Department of Pomology, University of California, Davis, CA 95616-8683.

The use of (2-chloroethyl)phosphonic acid (ethephon) as a harvest aid to effect fruit abscission in olive (Olea europaea L.) is constrained by a number of factors, the most important of which is concomitant leaf abscission. Leaf loss is a serious problem since leaves are required for return bloom and since leaf scars allow for entry by Pseudomonas savastanoi, the causal pathogen of olive knot disease. This study was undertaken to examine the dynamics of this problem by quantifying fruit removal force (FRF), percent leaf drop (%LD), and ethephon penetration of petioles and rachides 5 days after treatment of excised fruit-bearing olive shoots held in a growth chamber. Preliminary data indicate that ethephon penetration into rachides is only about 60% of that into petioles. Nevertheless, there is a stronger correlation between ethephon concentrations in rachides and decreased FRF than there is between concentrations in petioles and increased %LD. Raising the pH of the ethephon solution applied appears to increase both FRF and %LD, thereby decreasing harvest effectiveness. Water quality must, therefore, be considered when applying ethephon to olive under field conditions.

526
POLYGALACTURONASE ACTIVITY IN FRUIT OF ANTHRACNOSE-RESISTANT AND-SUSCEPTIBLE TOMATO LINES
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Tomato fruit anthracnose, caused by Colletotrichum coccodes and C. dematium, is primarily a disease of ripe fruit. Throughout fruit ripening and softening, substantial changes occur in cell wall composition. Analysis of polygalacturonase (PG), an enzyme active in the ripening process which breaks down cell wall pectins, indicated lower levels (7 to 10 fold) of PG activity in the outer fruit pericarp of ripe anthracnose resistant lines relative to susceptible lines. A decreased loss in cell wall arabinosyl (2.5 to 3.3 fold) and galactosyl residues (2.5-fold) was observed in the resistant lines relative to the susceptible lines throughout fruit ripening. Anthracnose resistance may thus be conferred by decreased PG activity in ripened fruit.

527
FINITE AND INFINITE DOSE DIFFUSION OF BENZYL ADENINE (BA) THROUGH ISOLATED TOMATO FRUIT CUTICLES
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The cuticular membrane (CM) is the primary barrier to the uptake of foliar applied chemicals. Thus, the transfer and consequent effectiveness of compounds such as BA are influenced by their interactions with the CM. For example, BA sorption by the hydrophobic CM at pH 3 is one-third that at pH 6. This may result from protonation of an amine group which imparts a charge to the molecule. We employed two systems to determine if diffusion is affected by pH: (1) infinite dose: five ml of 2 mM BA in buffer (20 mM citrate, 25° C) were placed in a donor cell. Diffusion of radiolabelled BA was followed through an interfacing CM by radioassay of the buffer in the receiver cell. (2) finite dose (Franz): one 5 µl droplet of 12 mM BA in buffer was applied to the outer CM morphological surface. The receiver cell contained buffer (stirred) in contact with the inner CM surface. BA transfer was monitored by radioassay of the buffer in the receiver solution through a side port. For infinite dose diffusion pH did not significantly affect the permeance coefficients or time lags of BA ($2.6x10^{-10}$ and 5.7 and $3.4x10^{-10}$ $m \cdot s^{-1}$ and 3.9 h for pH 3 and 6, respectively). For finite dose diffusion, however, the initial rate of penetration (0.2 and 1.0 % of amount applied$\cdot h^{-1}$ for pH 3 and 6, respectively) and the total amount which penetrated (5 and 30 % for pH 3 and 6, respectively) were less at the lower pH. Lag phases could not be determined at either pH in the finite dose system. Further, pH of the receiver cell buffer did not affect BA transport.

528
INHIBITION OF FLOWERING BY APPLE SEEDS: ROLE OF GIBBERELLIN METABOLISM
F.G. Dennis, Jr.*, M.L. Brenner, J.A. Ozga, and J. Pierson, Michigan State Univ., E. Lansing, MI 48824-1325, and Univ. of Minnesota, St. Paul, MN 55108.

[l4C]-Labelled GA_{12} and GA_{12}-aldehyde were fed to apple seeds and vegetative tissues in vivo to determine if fruit development inhibited flowering by affecting GA metabolism. Following application of labelled GA_{12}-aldehyde to seeds/ ovules of seeded and seedless 'Spencer Seedless' fruits, metabolites were present in both seed/ovule and fruit, as determined by high performance liquid chromatography. However, little or no radioactivity was detected in vegetative tissues, suggesting that metabolites were not transported from seed to bourse bud. Metabolism also occurred when the compounds were injected into 'Red Haralson' bourse shoots, but preliminary analysis revealed no major differences in the profiles of metabolites in bourse shoots from fruiting vs. defruited spurs. None of the metabolites has been identified to date, but three of them in both seeds and flesh of 'Spencer Seedless' co-chromatographed with GA_4, GA_{53}, and GA_{17} and/or GA_{19}, those in bourse shoots of 'Red Haralson' with GA_{53}, and GA_{17} and/or GA_{19}.

529
CARBOHYDRATEPARTITIONING IN CELERY: DISTRIBUTION OF A KEY ENZYME IN MANNITOL METABOLISM
John D. Everard and Wayne Loescher*, Department of Horticulture, Michigan State University, East Lansing, MI 48824-1325

In celery (Apium graveolens L.) both sucrose and the acyclic polyol, mannitol, are the primary photosynthates and translocated carbon species. Up to 50% of newly fixed carbon enters the mannitol pool, although the proportion that does is highly dependent on leaf age. We have purified a key enzyme of mannitol synthesis [Mannose 6-Phosphate Reductase (M6PR)] to homogeneity and have raised polyclonal antibodies against this protein. Immunocytochemical studies, at both the light and transmission electron microscope levels, show M6PR to be almost exclusively localized within the cytoplasm. These studies also revealed M6PR to have an uneven distribution within the leaf with the majority associated with palisade cells. The distribution of M6PR, as a function of leaf age and plant part (leaf, petiole, and root), has also been investigated using Western blotting. The results will be discussed in relation to our previous results on $^{14}CO_2$ labelling patterns and the significance of mannitol in the carbon economy of the celery plant.

89 ORAL SESSION (Abstr. 530437) Cell and Tissue Culture II

530
IN VITRO PROPAGATION OF TUBEROSE (POLIANTHES TUBEROSA L.)
Tsai-Mu Shen, Robin D. Cowen, and Martin M. Meyer, Jr.* Departments of Horticulture. Chai-Yi Inst. of Ag., Chia-Yi, Taiwan, R. 0. C. and Univ. of Illinois, Urbana, IL 61801

Explants of bulb segments, dormant buds, flower scapes, and young flower buds of tuberose were cultured on modified MS medium with naphthaleneacetic acid (NAA) and benzyladenine (BA). Young flower buds 0.3 cm in diameter or less with some pedicel tissue were the best explants for shoot initiation. The flower buds initiate shoots best on a MS medium with 2.5 uM NAA and 10 uM BA. Histological observations indicated shoots were regenerated from subepidermal layers in the pedicel tissue. A temperature of 30°C and photoperiod of 18-24 hrs. were optimum for shoot initiation. Shoots regenerated from flower buds could be further proliferated on MS medium with 0.5 uM NAA and 20 uM BA. Shoots proliferated better in a medium with 60 g/liter sucrose than either 30 or 120 g/liter. Shoots rooted in vitro when cultured on MS medium with 0.5 uM NAA or 5.0 uM indolebutyric acid (IBA). Shoots pretreated with 5.0 uM IBA and rooted directly in a light weight medium did better than those not pretreated. Rooted plantlets were easily acclimated to the greenhouse environment and appeared similar to the original plants.

531
IN VITRO SELECTION FOR HIGH ESSENTIAL OIL YIELD IN *ROSMARINUSOFFICINALIS*
Azza A. Tawfik* and Paul E. Read, Department of Horticulture, University of Nebraska, Lincoln, NE 68583-0724

The purpose of this study was to select for high essential oil yield and high levels of terpenoids in *Rosmarinus officinalis L.* proliferated *in vitro.* Callus cultures were induced from shoot tips and leaf segments cultured on Murashige and Skoog (MS) medium supplemented with 2 mg thidiazuron (TDZ)/Liter plus 0.5 mg 3-indole acetic acid (IAA)/Liter. The compact green callus were transferred to regeneration medium, where many shoots were formed. These shoots were transferred to the greenhouse and after reaching 15 cm they were subjected to oil analysis. Oil were extracted using hexane and GLC was used for oil analysis. Ten peaks were identified: (a pinene, camphene, β pinene, cymene, cineol, limonene, linalool, camphor, borneol and bornyl acetate. Highly significant differences in essential oil yield were found. The GLC-chromatogram of the essential oil extracts of the selected plants revealed significant differences in some monoterpene levels such as a pinene, cymene, linalool and borneol.

532
MICROPROPAGATION AND POST-TRANSPLANT GROWTH PERFORMANCE OF WETLAND PLANTS: *PONTEDERIA CORDATA*
M. E. Kane*, N. L Philman. T. M. Lee and M. A Jenks, Department of Environmental Horticulture, University of Florida, Gainesville, FL 32611

Many wetland plant species used for aquascaping and wetland revegetation projects are collected from donor wetland sites for planting elsewhere. Increased demand for wetland plants has lead to over collection and subsequent environmental damage to these donor sites. Micropropagation techniques could provide ecologically sound alternatives to field collection and allow for production of under utilized wetland species that are slow growing or difficult to propagate using conventional methods. Cultures of *Pontederia cordata* L (Pickerelweed) were established *in vitro* from surfaced sterilized rhizome buds cultured on agar-solidified full-strength Linsmaier and Skoog mineral salts and vitamins (LS) supplemented with 2.0 µM benzyladenine (BA) and 0.5 µM indole-3-acetic acid (IAA) and 87.6 mM sucrose. Maximum shoot proliferation (19 shoots/explant) occurred from single node explants cultured for 28 days on agar-solidified LS medium supplemented with 20 µM BA and 1.0 µM IAA. Maximum acclimatization and survival (100%) of microcuttings *ex vitro* occurred when 1.0 cm microcuttings were pre-rooted *in vitro* in agar-solidified LS medium without growth regulators. The post-transplant growth performance of 3670 plants outplanted in five central Florida retention ponds was evaluated through a growing season.

533
SYSTEMS FOR THE PROLIFERATION OF CASSAVA (Manihot esculenta Crantz.) IN VITRO
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Cassava has very strong apical dominance in vitro. To propagate cassava in vitro, it is necessary to develop a reliable method to break apical dominance and stimulate axillary 'shoot proliferation. Several cultivars of cassava were obtained from Puerto Rico (USDA, Mayaguez) and from South America (CIAT, Cali, Colombia). Some of these were disinfected and established in vitro on Murashige and Skoog (MS) medium supplemented with BA (1.0 µM) and NAA (0.25 µM). These were maintained on MS medium with IBA (2.5 µM) without cytokinin. Multiple shoots were obtained on double phase medium containing establishment medium overlayed by liquid medium which contained various concentrations of growth regulators such as thidiazuron (TDZ), BA, IBA, and GA_3. TDZ killed the apical meristem and stimulated multiple shoot development. Liquid phase GA_3, at very low concentrations, stimulated the elongation of dormant basal buds.

534
METHODS FOR PRODUCING GRAFT CHIMERAS IN VITRO
Huey-Jen Chen and Harry Jan Swartz, Department of Horticulture, University of Maryland, College Park, MD 20742

Several authors report the synthesis of periclinal chimeras generated from graft unions of Solanaceous plants grown in the greenhouse. As this technique requires shoot organogenesis, in vitro

conditions are necessary to adapt this technique to woody species. We now report several in vitro techniques necessary to mimic the in vivo graft chimera process. These include rootstock/scion preparation, micrografting and shoot organogenesis from graft unions. Zeatin and auxins have been helpful in preparing graftable material and for increasing the percentage successful grafts. A shorter exposure to organogenic medium containing thidiazuron resulted in greater percentage shoot regeneration from graft unions. Thorny/thornless Rubus and 'Liberty'/'Golden Delicious' or 'Gala' Malus (color) markers are being used to determine the percentage of these regenerants which are chimeral.

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EFFECT OF CO, LEVELS ON IN VITRO GROWTH AND DEVELOPMENT OF SHOOTS AND SOMATIC EMBRYOS OF *THEOBROMA CACAO* L.

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Previous results (Figueira, Whipkey, and Janick 1991 JASHS, in press) indicated that high CO_2 and high light promote in vitro growth and leaf development in cacao of axillary shoots from cotyledonary nodes as well as single-node cuttings from mature plants. Chambers were constructed to evaluate CO_2 levels from ambient to 18,000 ppm. Budbreak was unaffected by CO_2 level but shoot growth and leaf development increased with increasing CO_2 up to 18,000 ppm. High CO_2 levels in the absence of light were ineffective in promoting shoot growth and leaf development indicating that the CO_2 effect is directly related to photosynthesis. High CO_2 was effective in promoting growth and development of immature cacao somatic embryos (100 day stage).

536

PULSED EXCIMER LASER RADIATION AND SELECTED GROWTH REGULATORS INFLUENCE THE GROWTH AND DEVELOPMENT OF POTHOS (EPIPREMNUM AUREUM L.) IN VITRO CULTURE.

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Shoots of greenhouse-grown Pothos were surface disinfested and explanted on modified Murashige and Skoog (MS) medium. Later they were treated with pulsed XeCl excimer laser radiation for 30 sec. Cultures treated with 12 or 25 pulses of excimer laser radiation showed only 23% and 10% contamination, respectively, versus 75% control. Inaddition, we demonstrated that pulsed XeCl excimer laser radiation affected the subsequent growth and regenerability of in vitro plants. The reason for this increased growth needs further investigation. Both BA and TDZ were important for increasing the number of shoots generated from a microshoot as well as inducing shoot organogenesis from Pothos callus. Of the 50 rooted ex vitro plants from this experiment only 30% were variegated like parental clone. The others were either pure green or albino, suggesting chimera1 segregation.

537

SEMIPERMEABLE COVERS ENHANCE ACCLIMATIZATION OF MICROPROPAGATED TOBACCO PLANTLETS.

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Semipermeable covers (SPC; Suncap closure, Sigma) for tissue culture jars were compared with plastic B-caps (Magenta) relative to the following factors: rate of evaporative water loss from culture vessels, relative humidity (RH) within vessels, water loss of detached leaves, leaf epicuticular wax content, and wilting injury following establishment ex vitro. Jars capped with SPC showed an increased rate of evaporative water loss (250%) throughout the one month culture period, as compared to culture vessels with B-caps. The water potential of the media in vessels covered with B-caps was 300% greater than those with SPC at the end of the growth period. Relative humidity within the SPC capped vessels was 1-2% lower than that of the B-capped jars. Plantlets grown in vitro with SPC showed increased cuticular wax (50% greater) and reduced water loss (60%less) from detached leaves air dried as compared to B-capped vessels. When plantlets were transplanted into a 30 or 50% RH, those grown in B-capped vessels showed greater leaf injury as evidenced by wilting. Relative growth ex vitro of plantlets fromculture vessels of both types are currently under investigation. The results show that the SPC's improve the factors involved in acclimatization and may have the potential to reduce losses of micropropagated plantlets upon transfer ex vitro.

90 ORAL SESSION (Abstr. 538-545) Tree Fruit: Thinning and Fruit Set

538

BLOSSOM THINNING OF APPLES WITH MONOCARBAMIDE DIHYDROGEN SULFATE

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Tests were carried out on apple trees in Orange, N.S.W. Australia and in Washington State. Monocarbamide dihydrogen sulfate (MBDS) was applied to Delicious, Granny Smith, Golden Delicious, Gala and Fuji apple trees at 50% and 80% of full bloom. At the lowest rate (0.25%) the pistils of open flowers were damaged sufficient to prevent pollination and fertilization. At the next highest rate (0.5%) some leaf necrosis was present but did not affect tree performance and fruit growth. Higher rates of MBDS damaged blossom pedicles. The two lowest rates 0.25% and 0.5% reduced fruit set by up to 50% compared to untreated controls.

539

'EMPIRE' APPLE THINNING AND FRUIT GROWTH STUDIES

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Thinning studies with the relatively small fruited 'Empire' apple have been conducted over the last 6 years. In a four-year hand-thinning study using mature Empire/M.9 apple trees, thinning to single fruits per cluster at full bloom gave the largest average fruit size but the lowest yield compared to thinning at 10, 20 or 40 days after full bloom (DAFB). Total yield was greatest with the unthinned controls; however, bloom thinning gave the largest yield of fruit larger than 70 mm diam. In another study as the time of hand thinning was delayed later in the season, the improvement in fruit size decreased, but thinning as late as Aug. 23 gave significant increases in fruit size and all hand thinning treatments improved fruit red color.

Chemical thinning with Naphthaleneacetic Acid (NAA) at 10 or 20 DAFB reduced yield but gave only slight increases in fruit size compared to unthinned trees. Earlier timings at full bloom or 5 DAFB gave modest thinning and significant increases in fruit size and consistently resulted in greater total yield and yield of large fruit than thinning at 15 DAFB. NAA at 15 DAFB depressed fruit growth rate below that of controls for several days while the earlier timings did not. Higher rates were required at bloom than at 15 DAFB for similar levels of thinning. A factorial experiment with multiple NAA sprays using 4 rates at full bloom and 4 rates at 15 DAFB showed the rate of NAA at bloom was more important for increasing fruit size and yield of large fruits than the rate of NAA at 15 DAFB.

540

CHEMICAL-THINNER EFFECTS ON 'EMPIRE' APPLE CROP LOAD, FRUIT SIZE, GRADEOUT, AND STORAGE CHARACTERISTICS

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In several studies, 6-benzyladenine (BA) at up to 250 mg/liter consistently thinned 'Empire' apple trees as well as or better than carbaryl, NAA, or ethephon. Fruit size was increased to a greater extent by BA than by any of the other thinners. Comparing BA with Promalin (PR) (BA + GA_{4+7}) showed that BA applied at 10 mm fruit diameter was more effective in both thinning and fruit-size increase than PR. In one study, BA tripled the percentage of the crop in the largest fruit-size classes (88-count and larger) with no change in packout percentage (90%). Harvest tissue firmness was unaffected or slightly reduced by BA despite large increases in fruit size. Harvest maturity was unaffected by BA. After 20 weeks storage in air, BA-treated apples were only slightly softer than controls (2-3 N) after one day or one week at room temperature. BA treatment produced very minor effects on poststorage disorders.

541

EFFECT OF 6-BENZYLAMINO PURINE ON RELATIVE GROWTH RATE, SEED COUNT, AND ETHYLENE PRODUCTION OF 'EMPIRE' APPLE FRUIT

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Research was conducted to examine the mechanism of action of 6-Benzylamino purine (6-BA) as a thinner of 'Empire' apple fruitlets. Dilute sprays of 6-BA were applied at 75 or 150 ppm to 12-year old 'Empire'/M9 trees trained as slender spindles at full bloom, 12 days after full bloom (DAFB), or 24 DAFB. Relative growth rates of persisting primary and lateral fruitlets were influenced by treatments. Seed count from harvested fruits was not significantly different between 6-BA treated and control fruits. Ethylene production by fruitlets treated with 150 ppm of 6-BA at 24 DAFB was not significantly different from the control.

542

FRUIT GROWTH RATES AND LEAF ETHYLENE INDUCTION AS BIOASSAYS OF APPLE THINNING WITH NAA

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Two methods were compared to provide rapid estimates ofthinning effectiveness of NAA sprays without waiting 7 to 14 days to observe fruit drop. Ethylene induced in the leaves by the absorption of the auxin NAA was determined as a bioassay of thinner uptake both just prior to and just after NAA sprays applied at the 13 mm stage of Starkrimson fruits. Fruit diameter of marked fruits were measured before and after NAA sprays of 10 or 20 ppm on trees that were untreated or pre-thinned by hand shortly after petal fall to two lower crops loads. Induced spur leaf ethylene gave a poor correlation to fruit abscission rates (R2=5%), while fruit growth rates during the week after sprays gave higher negative correlations (R2 ranged up to 69% depending on days included). Fruit growth rates prior to or the diameter at the time of thinning were not well correlated to abscission and thus the sensitivity to thinning by NAA was not predicted prior to thinning. It appears that fruit growth rates may provide the best integration of the combined effects of the thinner. the environment and the internal status of the tree.

543

PHOTO-ASSIMILATE PRODUCTION AND PARTITIONING IN APPLES, AS AFFECTED BY FRUITING.

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The canopy of mature 'Millerspur Delicious'/MM.106 apple (Malus domestica Borkh.) trees was separated into three leaf categories: shoot leaves (SH), spur leaves on non-fruiting spurs (S-F), and spur leaves on fruiting spurs (S+F). In 1989 and 1990, seasonal photosynthetic rates for these leaf types were measured under field conditions, and trees which cropped heavily were compared to deblossomed trees, as well as the different leaf types. No differences were found between cropping and non-cropping trees, but shoot leaves had the highest Pn rate, while S+F leaves had the lowest. Morphological -anatomical differences among the three leaf types support our photosynthesis results. Comparison between the leaf distribution and dry weight, fruit dry weight, annual wood increment, and estimation of carbohydrate exported, for the two cropping levels will be presented on a cm limb cross-sectional area basis.

544

EARLY FRUIT THINNING DECREASES TOTAL REPRODUCTIVE EFFORT BUT INCREASES MARKETABLE YIELDS IN PLUM

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Fruit thinning studies were conducted in a 5-year-old high density (1.8x5.5m) plum *(Prunus salicina L,* cv Royal Diamond) research block at the University of California Kearney Agricultural Center, Parlier, CA, in 1990. In this heavy set year, the total fresh weight of fruit thinned around the time of commercial thinning on May 16 (24.1 Kg tree^{-1}) and later on June 1 (33.3 Kg tree-') were greater than the total weights of fruit harvested from these two treatments at fruit maturity on August 1 (19.3 and 18.9 Kg tree-'. respectively). Although early thinning reduced the total biomass partitioned to fruit compared to late thinned and unthinned treatments (29.5, 50.4 and 75.8 Kg tree^{-1}, respectively), marketable fruit yields were significantly higher in early thinnedversus late thinned trees (20.3 and 12.4 Kg tree^{-1}, respectively). These data clearly indicate marketable yield advantages of early thinning in heavy crop years and confirm predictions concerning interactions between thinning time, crop load and fruit sizing made by a computer simulation model based on fruit relative growth rate models of stone fruit growth (De Jong and Goudriaan, 1989, Acta Hort. 254:103).

545

EFFECTIVE POLLINATION PERIOD ON 'RED DELICIOUS' APPLE IN CUAUHTEMOC, CHIH. MEXICO.

Victor M. Guerrero-Prieto*, Mirna Carrasco and Alberto Rodriguez. Facultad de Fruticultura. Universidad Autonoma de Chihuahua. P. 0. Box 124 Chihuahua, Chih. Mexico.

'Red Delicious' cultivars represent 33% of the 7.5 million apple trees planted in the State of Chihuahua. One of their main problems is the need for cross-pollination, which involves choosing the correct pollinator and knowing several factors related to fertilization. In 1989, the Effective Pollination Period (EPP) of 'Red Delicious(was determined showing an initial fruit set of 69% for day 0, 52% for day 3 and 47% for day 5. These results indicate an EPP of 2-3 days and also indicate the possibility of female sterility on the flowers.

91 ORAL SESSION (Abstr. 546-553) Vegetables: Culture and Management I

546

OPPORTUNITIES FOR REDUCING APPLIED WATER TO PROCESSING TOMATOES

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Tests were conducted in commercial processing tomato fields during the 1988-90 growing seasons to evaluate potential stratagies for reducing water applied as supplimental irrigation. Treatments evaluated included one or two irrigations less then that supplied to the balance of the field by the grower, as well as alternate row irrigations. Data measured included effects on the timing of fruit maturity, fruit yields per acre and effects on fruit quality (soluble solids, color, viscosity). The water status of the soil was monitored by gypsum blocks, in a cooperative project with the Soil Conservation Service.

In two of the three tests, soluble solids were significantly increased, while yields were not adversely affected, by either one reduced irrigation or alternate row irrigations. In the third test, yields were reduced slightly and soluble solids were not affected by these same treatments, compared to the growers practice. While the potential water savings were not quantified, these approaches appear to offer significant opportunities for reducing the amounts of water currently supplied to processing tomatoes, under lower Sacramento Valley growing conditions.

547

A PERSPECTIVE ON LIVING MULCHES: PAST, PRESENT, AND FUTURE

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Living mulch is a refinement of a very old agricultural concept. Since the very first crops were sown, agriculturists have had IO deal with the problem of declining soil fertility. Fallowing land is an ancient and universal agricultural practice that ameliorates this problem. Over the centuries, farmers have developed a number of derivative practices for achieving the goal of renewing soil: crop rotation, cover crops, manures and green manures, and quite recently, chemical fertilizers. Farmers in developed countries have achieved remarkable productivity by relying heavily on chemical fertilizers and pesticides. The agricultural system that has developed out of this technology is not without problems, however, and today researches and farmers are working on solutions which combine some of the old farming techniques with current methods. One alternative that has come out of this research is the living mulch concept, which employs a live ground cover between crop rows during the growing season. In a living mulch cropping system, soil can be rejuvenated without being taken out of

production. In addition, research shows that chemical inputs, particularly herbicides can often be reduced when a living mulch is used. Our current work involves nitrogen cycling in a grass/clover living mulch system for vegetable production. Experimentation with this cropping system has revealed both strengths and weaknesses for its users and much more research needs to be done before the full potential of this cropping tool is realized.

548
ZONE TILLAGE FOR CARROT AND ONION PRODUCTION
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Carrots and onions were grown three years using preplant tillage systems either including or excluding zone tillage. Zone tillage loosened the soil to 40 cm deep primarily in the zone under the row where the root system develops. Zone tillage with commercially available units caused significant reductions in the soil strength in the top 40 cm of a Houghton muck as compared with plowed, disked and rolled soil. The average soil strengths in unplowed, plowed and disked, and zone tilled soil were 1.30, 0.56 and 0.38 MPa in 1989. In each of the three years the average length of marketable carrots was 3.3, 2.8 and 2.6 cm longer from zone tilled soil than from non-zone tilled plowed soil. Marketable carrot yields were improved each year do to reduction in the percent of small or cull carrots. In 1990 total carrot yields were improved 25 percent by zone tillage, and the percent of marketable carrots increased from 74 to 87 percent. Although compaction was shown to decrease the rate of onion root and top growth zone tillage had little effect on onion yields in 1988. In 1990 total and marketable onion yields were significantly improved by zone tillage.

549
RESPONSE OF MICROIRRIGATED VEGETABLES TO SOIL AND FOLIAR-APPLIED BIOSTIMULANTS IN FULL-BED MULCH CULTURE.
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Soil, foliar and the combination of soil and foliar-applied biostimulants, containing cytokinins and essential mineral nutrients, were applied to vegetables in a sequential cropping system. Vegetables were grown on raised, mulched beds with microirrigation. Bell pepper, cv. Bell Captain, and tomato, cv. Summer Flavor 5000; were grown from Aug-Dec 1989, followed by cabbage, cv. Bravo and cauliflower, cv. Snow Crown Hybrid, from Dec 1989 to Mar 1990, then by cucumber, cv. Dasher II, and squash, cv. Lemondrop, from Mar to June 1990. The original plastic mulch and microirrigation tubes were used for all 3 crop sequences. Combination of soil and foliar-applied biostimulants increased ($P \leq 0.1$) marketable yields of bell pepper over the water treated control and soil treatment alone. Tomato yields were similar with all treatments. Combination of soil and foliar biostimulants also increased cabbage and squash yields over control when bell-peppers were the first crop. Cucumber yields were similar with all treatments but yields were higher after cauliflower than after cabbage when bell peppers were the first crop.

550
EVALUATION OF EIGHT CUCUMBER PLANTING SYSTEMS UNDER DRIP IRRIGATION.
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Field investigations were conducted during two successive growing seasons to determine the response of cucumber, 'Dasher II', grown both with and without the presence of methyl bromide, black plastic, and staking under drip irrigation. Treatments were arranged in a split-split plot design with four replications. Harvested area was two beds wide, 10 x 1.80 m.

In year one, no interactions among treatments were observed. Total fruit number, marketable fruit number, total and marketable yield were greater for the methyl bromide treatments. Staking had an adverse effect on total yield, but a positive effect on marketable yield. All other variables were non significant. Greatest economic return was produced with methyl bromide without black plastic or stakes and methyl bromide with stakes, but without black plastic. Two years of combined data will compare the above mentioned variables plus earliness to harvest.

551
EFFECT OF ROW COVERS ON WINTER HARDINESS AND SEED YIELD OF 'BRUNSWICK' AND 'GOLDEN ACRE' CABBAGE *(BRASSICA OLERACEA* L. VAR. *CAPITATA* L.)
Rita L. Hummel* and Wilbur C. Anderson. Washington State University-Puyallup, Puyallup, WA 98371-4998 and Washington State University-Mount Vernon, Mount Vernon, WA 98273-9788.

Cabbage seed production in western Washington is at risk from freeze damage in the months of November to February. During the 1987-1988, 1988-1989 and 1989-1990 winters, the cold protection efficacy of 5 floating row covers (Agryl P17, Dewitt N-sulate, Reemay 2014, DuPont Typar, VisQueen Porous Row Cover) and straw was tested on field-grown cabbage. Air temperature in the cabbage crown, Tk_{50} of cabbage leaves, plant winter survival and seed yield were measured. During a severe freeze in February 1989, an average temperature of -11.1 °C was recorded in the uncovered controls while temperatures under the row covers were -6.7°C, -6.8°C and -8.4 °C under the N-sulate, VisQueen and Agryl covers, respectively. When compared to controls in June of 1989, row covers increased the survival of the more cold hardy 'Brunswick' plants but did not significantly increase seed yields. The duration and severity of the February 1989 freeze was such that all of the less cold hardy 'Golden Acre' plants were killed.

552
TRIPLOID WATERMELON EVALUATION
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A protocol for evaluation of triploid (seedless) watermelons was developed that included measurements of seedling emergence, individual fruit weight, total marketable yield, soluble solids, hollowheart, internal color, frequency of mature seeds, and a description of the fruit. Thirty commercial or experimental triploid hybrids were evaluated at Bradenton, Leesburg, Live Oak, and Quincy, Florida using these criteria. Seedling emergence varied from 35 to 100%. Emergence of seedling from commerical hybrids was generally higher than that from experimental hybrids. 'Tiffany' and 'Ssupersweet 5344' were the earliest maturing cultivars. Highest total yields were produced by 'HMX 7924', 'Crimson Trio', 'Ssupersweet 5344' and 'CFREC 90-2'. Average fruit weight was highest for 'CFREC 89-10', 'CFREC 89-11'. 'CFREC 88-4', 'Ssupersweet 2532, and 'Ssupersweet 5032'. 'Tiffany' consistently had high soluble solids. Entries with the best overall performance were 'HMX 7924, 'Crimson Trio', 'Tiffany', 'CFREC 88-4', 'CFREC 89-11', 'CFREC 89-10', 'Ssupersweet 2532 and 'Ssupersweet 5032'.

553
POTATO RESPONSES TO FERTILIZER AND INDIGENOUS SOIL PHOSPHOROUS
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Single-plant microplots of 'Russet Norkotah' potatoes *(Solanum tuberosum* L.) were grown outdoors in a 5 X 5 factorial RCBD of indigenous phosphorous level (200, 325, 450, 575, 700 kg·ha^{-1} Bray-Kurtz Pl extractable; McBride sandy loam) and banded triple super phosphate (0, 50, 100, 150, 200 kg P_2O_5/ha). Disease in the low P soil that was used to create the four lower P soil blends completely confounds response of the plants across indigenous P levels and might have accentuated responses within levels. Plants responded to fertilizer P with tuber yield increases of 100, 70, 40, and 10 percent within the 200, 325, 450, and 575 indigenous P levels, respectively. Fertilizer P also increased marketable yield and tuber P concentration. Neither indigenous nor fertilizer P altered tuber specific gravity.

Companion studies compare the responses of corn (Zea mays L.) and potato to indigenous soil P levels and quantify P uptake among potato cultivars in solution culture.

111 ORAL SESSION (Abstr. 554-561) Tree Fruit: Roots and Rootstocks

554
CONTROL OF ROOT ENVIRONMENT BY DRIP FERTIGATION FOR OPTIMAL PRODUCTION OF TREE FRUITS
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The characteristic low rate of water emission by drip irrigation enables irrigating at the rate of consumptive use. This can de achieved by maintaining a constant soil water potential in the root zone. A computerized irrigation system consisting of soil moisture sensor and a suitable valve system provides means for a continuous and accurate control of the SMP and thereby on the volume of the irrigated soil where most root activity takes place. Data obtained in field experiments conducted in deciduous and evergreen orchards show improved productivity as well as fruit quality Increased number of fruits without a measurable reduction in fruit size was found in irrigation treatments where low irrigated soil volume was combined with high fertilizer concentration in the root zone, Physiological root restriction effects, high water availability combined with sufficient aeration and efficient mineral uptake seem to be the major causes for the improved productivity.

555
EFFECT OF PLANTING SOIL, ROOTSTOCK, AND PHYTOHORMONE SPRAYS ON PEACH TREE SURVIVAL IN FIELD MICROPLOTS
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A planting of 72 'Redhaven' peach *(Prunus persica* (L) Batsch) trees on Lovell and Nemaguard peach seedling rootstocks, was established during spring 1984 using in-ground 55-gallon microplots. Planting soils (from short-life and non-short-life sites) as main plots were replicated three times. Two trees per plot for 2 rootstocks and 3 phytohormone treatments [abscisic acid (ABA) and gibberellic acid (GA_3) at 100 µg ml^{1} plus H_20 as control] were randomized within main plots. During 1984 - 1987, trees were sprayed bi-annually with phytohormones. The experimental planting was maintained using conventional cultural practices. Observations for tree survival were recorded in December each year. Throughout the period of this investigation, a trend of greater peach tree survival was found in the microplots with non-short-life soil than in those with short-life soil from old site. However, the differences were significant only during 1987 and 1990. Starting in 1987, survival was significantly greater on Love11 than on Nemaguard rootstock. Survival of ABA-treated trees did not differ from either GA_3-treated or control trees. Nevertheless, beginning in 1988, those trees treated with GA_3 had markedly lower survival than controls.

556
Rootstock Induced Differences In Flower Bud Growth Of Peach
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Spring flower bud growth in peach *(Prunus persica* (L.) Batsch cvs Redhaven, Rio-Oso-Gem, Loring, and Encore) was monitored in 1989 and 1990 to determine the bloom delaying potential of different rootstocks. 'Redhaven' buds on 'Halford', 'Siberian C', or self-rooted trees reached 75% pink (P75) 2 days later than buds on GF 677, or Damas. Buds on 'Bailey' and 'Lovell' reached P75 1 day later than buds on Damas. 'Loring' buds on 'Tzim Pee Tao' and 'Citation' reached P75 3 days later than buds on 'Bailey', 'Lovell', 'Sinung Chumi', H7141137, H7141064, H7338001, and H7338013. Buds on H7141049 reached P75 2 days later than buds on H7338013. 'Rio-Oso-Gem' buds on H7338013, H7141049, and H7141064 reached P75 4 days later than buds on 'Sinung Chumi'; buds on H7338013, and H7141049 reached P75 3 days later than buds on 'Citation', and buds on H7338013 reached P75 3 days later than buds on H7141041. 'Encore' buds on 62325 reached P75 3 days later than buds on B81150, C25165, RR53117, RR5345, RR5354, RR70288 or Lovell cuttings, and buds on 'Okinawa × Cardinal' reached P75 2 days later than buds on C25165, RR53117, RR5345, RR5354, RR70288 or 'Lovell' cuttings.

557
EFFECT OF PEACH INTERSTEMS ON SCION PHENOLOGY
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Severe spring freezes during the 1980s significantly reduced peach production in the southeastern United States. In an attempt to reduce the risk of flower mortality from cold temperatures, an experiment was initiated in 1987 to observe the effects of peach interstems on phenology in two early blooming peach varieties. Scion varieties 'Junegold' and 'Loring' were budded to both a 50-cm interstem of P.I. 101667 (P. persica) and virus-free 'Lovell' (=control). Both interstems had been previously budded to virus-free 'Lovell' seedlings. Trees were planted in 1988 in a split-plot, replicated design with interstem the main plot and variety the subplot. Trees were trained to an open center form with a single branch left on the interstem. Date of full bloom on 'Junegold' and 'Loring' trees with the P.I. interstem averaged 10 and 15 days later than those on the 'Lovell' interstem during an unusually early spring in 1990. After three years, varieties with a P.I. 101667 interstem grew 6 and 12 percent less in height and basal diameter, respectively, than did those on 'Lovell' interstems. No incompatibility was observed in the four interstem combinations.

558
GROWTH, GAS EXCHANGE, AND WATER RELATIONS OF SEEDLING- AND CUTTING-PROPAGATED PEACH AND CITRUS ROOTSTOCKS.
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Lovell and Nemaguard peach *(Prunus persica* L. Batsch.) rootstocks, and Carrizo citrange (Citrus sinensis L. Osb. × *Poncirus trifoliata* L. Raf.) and sour orange *(C. aurantium* L.) citrus rootstocks were propagated by seed and semihardwood cuttings to investigate the mechanism of differential stress responses observed previously between trees propagated by these methods (Couvillon et al., 1989 Acta Hort. 243:221). Peach seedlings had higher root/shoot ratios, less biomass in roots ≤ 1 mm in diameter, less biomass in leaves, but similar total dry weights than cuttings. Differential growth responses between peach seedlings and cuttings were not paralleled in citrus, indicating that responses may have been specific to peach, and not a result of propagation method *per se.* Leaf nitrogen contents were lower for cuttings than seedlings of all cultivars, despite equal or greater N uptake per unit root weight for cuttings. Seedlings of all cultivars had higher rates of carbon assimilation (A), and in all cases except Carrizo, seedlings maintained positive A to lower water potentials than cuttings. Root hydraulic conductivity did not differ between cuttings and seedlings for all cultivars, but was generally higher for peach than citrus.

559
CHERRY ROOTSTOCK ROOT DISTRIBUTIONS IN TWO MICHIGAN SOILS
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Root distributions of Mazzard, Mahaleb, Colt and MxM 2 rootstocks growing in 2 different soils were determined using the trench profile method. The orchards used were 1980 NC-140 sour cherry rootstock plantings at Clarksville (CHES), a Kalamazoo loam, and Traverse City (NWHES), a Leelanau loamy sand, with 'Montmorency' as the common scion. Two additional rootstocks, MxM 14 and MxM 60, where studied at CHES. Roots were counted on exposed profiles, 1.2 m deep X 2 m wide, parallel to the tree row, 1.4 m for the trunk in a weed-free herbicide strip. Roots counts were recorded in 3 size classes: < 2 mm, 2 to 5 mm and > 5 mm in diameter. At both sites, root numbers decreased with depth for all rootstocks. There were rootstock differences in the A horizon at both sites. In the A horizon, Colt had the most fine roots at NWHES and MxM 2 the most at CHES. Mazzard and Colt had more large roots at NWHES and Mazzard had the most large roots at CHES. Mazzard, Mahaleb and MxM 2 had more roots at CHES. Colt had fewer roots. At NWHES, there were no differences between rootstocks in the B horizon, but at CHES there were. Rootstock response to soil physical conditions will be discussed.

560
PERFORMANCE OF TART CHERRY CULTIVARS ON EIGHT SELECTION OF MAHALEB ROOTSTOCK.
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Mahaleb seedlings are the main rootstock for tart cherries. Eight clones from different parts of the world selected for concentration of maturity, uniformity of stand in the nursery or superior seed germination were evaluated with Montmorency and Meteor to determine their effect on yield, vigor, fruit size, quality and leaf chemical composition. Accumulative yield (kg/tree) for 1982-1990 crop years was significantly higher for Montmorency than Meteor. For this period Glendale #1 (GD#1) had the highest and Glendale #3 (GD#3) the lowest cumulative yield and yield efficiency index. No difference was measured for vigor either for cultivars or rootstocks. Irrespective of roots, the pooled mean fruit weight was higher for Meteor than Montmorency (1986 to 1990). GD#1 and 3 exhibited the largest and MS#6 and Turkish clones the smallest

fruit size. Fruit total soluble solids (SS) was higher for Montmorency and no difference was observed between cultivars for acidity (% malic acid). Rootstocks affected SS but not acidity. Leaf K, Ca and Mg was higher for Montmorency but Meteor exhibited higher N (1987 to 1990). The rootstocks responded uniformly to N but K, Ca and Mg levels were different among the clones.

561
EARLY PERFORMANCE OF FOUR APPLE CULTIVARS ON 'MARK' AND OTHER ROOTSTOCKS
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In 1985, a study was established to compare the growth and fruiting of 'Cortland', 'Empire', 'Delicious' and 'McIntosh' apple (Malus domestica Borkh.) on Mark and MM.111 rootstocks. 'Delicious' and 'McIntosh' on M7A and M.26 were also included in the trial, with ten replications of each cultivar/rootstock combination arranged in a randomized complete block design. Tree survival for the first six years has been 90% or greater for all combinations except 'Empire'/MM.111, 30% of which died as a result of winter injury. Occurrence of burr knots was rated as horticulturally significant for all cultivar/rootstock combinations except McIntosh/MM.111. Early flowering was highest on 'Empire' and 'McIntosh' on Mark. M.26 also induced early flowering, while M.7A induced early flowering with 'Delicious' but not with 'McIntosh'. Cumulative yield was highest with 'McIntosh' on Mark and M.26 and with 'Cortland'/Mark. Conversely, the lowest cumulative yields were recorded for Empire/MM.111 and for 'Delicious' regardless of rootstock. Tree leaning was severe for trees on Mark and on M.26, and tumor-like malformations have been observed on all trees on Mark in this study.

112 ORAL SESSION (Abstr. 562468) Viticulture

562
THE EFFECTS OF COOL NIGHT TEMPERATURE AND POTASSIUM UPTAKE ON GROWTH PARAMETERS OF SEYVAL GRAPEVINES
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Seyval blanc grapevines were grown in a controlled environment (greenhouse) with differential night temperature, potassium concentration and crop load as experimental variables. Experimental design was a randomized split plot consisting of 2 night temperatures, 4 potassium levels and 2 crop loads. Growth and nutritional data were collected during the 1988 and 1990 seasons from leaf, stem and berry analysis. Fruit quality data indicated differences in accumulation of sugars, acids and pH. Vegetative growth, characterized by shoot length and number of leaves, was reduced under the cooler night temperatures, but leaf area and weight of leaves were similar. Both low (19.5 ppm) K and high (293 ppm) K concentrations consistently gave lower, and often significantly lower, values for growth than the intermediate concentrations (40 and 120 ppm K).

563
ROOTSTOCK GROWTH AFFECTED BY CROPPING LEVEL UNDER LOW SOIL-MOISTURE CONDITIONS IN SEYVAL GRAPEVINES
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Both berries and roots of grapevines are powerful carbohydrate sinks. However, during periods of soil-moisture stress, the relative strength of these two sinks is not known. This experiment was conducted to evaluate interrelationships between differing crop loads on carbohydrate partitioning for above and below-ground tissues. Root development, depth, and rate of turnover were determined by quantifying root images from video recordings taken to depths of 75 cm at two week intervals throughout the growing season. Two-year old own rooted Seyval grapevines, and Seyval grafted to 5-BB and Seyval, were grown under a rain exclusion shelter and provided with 10 or 2.5 liters of water/plant/week. Treatments were cropping level, either 0 or 6-clusters/vine. Shoot length, number of mature nodes, and dry leaf weight of vines under high cropping level were significantly reduced compared to vines growing under the low cropping level; so was root number and depth of root penetration. These data suggest that conditions of low soil moisture result in carbohydrate partitioning in favor of the clusters at the expense of the roots.

564
DROUGHT AND CROP REMOVAL EFFECTS ON CONCORD GRAPEVINE PHYSIOLOGY AND COLD HARDINESS
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Nearly all Concord grown in Washington are irrigated and, therefore, susceptible to periodic drought stress. This may occur for more than one season if the snow pack is limited in consecutive years. In 1988 a study was initiated to determine the effects of consecutive years of drought stress on vine growth and physiology. The possible beneficial effect of fruit removal shortly after fruit set was examined to see if it might contribute to better vine cold hardiness and survival. Three years of data clearly show that withholding irrigation has significantly affected vine water potential, photosynthesis, and stomatal conductance. Crop removal from either fully irrigated or drought stressed vines had little effect on these physiological factors. Leaf area development on both a cane and vine basis showed the same response to both irrigation and crop removal. Cold hardiness of bud and cane tissues showed only minor differences between irrigated and stressed vine during the dormant season also lacked any significant differences. Additional data for the third year of stress will be presented and discussed.

565
FIELD EVALUATIONS OF MICROPROPAGATED VERSUS ROOTED CUTTINGS OF MUSCADINE GRAPE
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Muscadine grape *(Vitis rotundifolia)* plantlets were propagated in vitro using axillary shoot proliferation (Lee and Wetzstein, 1990). Field performance was compared to conventionally propagated plants obtained from cuttings rooted under mist. Plants have completed two growing seasons in the field. Tissue-cultured plants showed no signs of rejuvenation. No differences were observed between the two propagation types in terms of leaf area, leaf dry weight or leaf morphology. Micropropagated plants exhibited enhanced performance, with significantly greater numbers of flowers, inflorescences, and yield than conventionally propagated plants.

566
WEED CONTROL, IRRIGATION, PRUNING, AND NITROGEN FERTILIZATION INFLUENCE THE GROWTH OF NEWLY PLANTED NIAGARA GRAPEVINES.
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The rate of establishment of a vineyard has major economic importance. The impact of four factors (weed control, nitrogen fertilization, irrigation and pruning) and their interactions were evaluated in regard to the first year growth of Niagara grapevines. Weed growth in a 30" wide band surrounding the vines significantly reduced growth for all factors measured. Pruning at the start of growth to two primary shoots significantly reduced leaf number, leaf area, leaf dry weight and root dry weight in comparison to unpruned vines. Irrigation significantly increased shoot length and shoot and root dry weight accumulation. Nitrogen fertilization had no significant direct influence on the growth factors measured but it did exhibit significant interactions with weed control, irrigation and pruning. None of the treatments significantly affected bud hardiness at nodes 3, 4 and 5. The results suggest that weed control, nitrogen fertilization and irrigation enhanced the establishment of Niagara grapevines in their first year of growth but pruning inhibited the establishment.

567
EFFECTS OF MEPIQUAT CHLORIDE (N,N-DIMETHYLPIPERIDINIUM CHLORIDE) ON GROWTH, YIELD, AND QUALITY ATTRIBUTES OF CONCORD GRAPES
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Mepiquat Chloride (N,N-dimethylpiperidinium chloride) was applied at .28 and .56 kgs ai/ha to mature Concord (Vitis labruscana B.) vineyards at first bloom in the Spring of 1990. Daminozide at 1000 mg/liter was used as a comparative treatment to determine relative effectiveness of the Mepiquat Chloride. Experimental design was a randomized complete block with a basic unit of 4 to 6 vines per plot. Clusters on vines treated with either daminozide or Mepiquat Chloride produced an increased berry set which resulted in a yield increase. Berry weight and soluble solids decreased as yield increased. Differences between the .28 and .56 kg Mepiquat Chloride rates were generally not significant. The .28 kg/ha Mepiquat Chloride and 1000 mg/liter daminozide did result in some differences.

568
ANATOMY OF CHLOROTHALONIL-INDUCED GRAPE BERRY RUSSET
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Clusters of Vitis labruscana cv. Concord were grown either in full sun or canopy shade, and either not sprayed or sprayed with 3.4 Kg/Ha chlorothalonil every 2 wk from pre-bloom to veraison. Only sun-exposed, sprayed fruit produced skin russeting. Clusters of the very susceptible V. vinifera cv. Rosette were grown in direct sun, sprayed with chlorothalonil 4 times from bloom to veraison, in the presence or absence of purported anti-russeting agents. Heavy russet occurred in all treatments. Russet initiation was similar in the 2 cvs.: epidermal cells first died beneath spray residue in full sun, a phellogen then arose in the hypodermis, followed by periderm. Epidermal death began in 'Rosette' within a wk of the bloom spray, but in 'Concord' only after 2-3 wk post bloom and 3 sprays. 'Concord' russet generally appeared as patches or scabs, whereas 'Rosette' russet ranged from freckles, welts, scabs to large smooth burnished areas. In both cvs., unbroken russet consisted of uniform layers of phellum. New, deeper periderm initials arose beneath checks and cracks which formed as fruit enlarged. In 'Concord', but not 'Rosette', the daughter cells of each such initial were often enclosed in the original cell wall. In all cases of russet, cell walls in the periderm were suberized and sometimes lignified. Cells also contained much phenolic material.

113 ORAL SESSION (Abstr. 569476) Woody Ornamentals: Culture and Management

569
MONTE CARLO SIMULATION OF CONTAINER MEDIUM SYSTEMS
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A new application for Monte Carlo simulation techniques to artificial media is presented. A Fortran program was written which simulates the distribution of two different geometric particle sizes in a container of fixed size and shape; particles are shaken at random and allowed to settle under the influence of gravity. We study the resultant shrinkage of the system, the particle configurations, and the channels for the movement of water which remain. The configuration of the system can be followed by graphical visualization either on a computer screen or on a hard copy output. Possibilities for future work involving even more complex, multicomponent systems will be discussed.

570
SEED GERMINATION OF PIERIS FLORIBUNDA: INFLUENCE OF LIGHT AND TEMPERATURE
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Seeds of Pieris floribunda (Pursh ex Sims) Benth. and Hook. (mountain andromeda) were germinated at 25C and an 8 hour/16 hour thermoperiod of 25/15C with daily photoperiods of 0, l/2, l/2 twice daily, 1, 2, 4, 8, 12, and 24 hours. In seeds exposed to light, germination at 25C began between 3 and 6 days compared to 6 to 9 days at 25/15C, but the delay did not influence cumulative germination. With the exception of seeds not exposed to light, 30-day germination for equivalent photoperiods at both temperatures was similar. Without light, 30-day germination at 25C and 25/15C was 38% and 52%, respectively. Daily photoperiods as short as l/2 hour increased cumulative germination to 90% at 25C and 25/15C. The remaining light treatments yielded 88 to 95% germination. High germination percentages were due in part to rigorous seed grading prior to initiation of the study.

571
PLANT ENVIRONMENT THERMODYNAMICS IN INDIVIDUAL CONTAINERS AND IN A CLOSED, INSULATED PALLET SYSTEM
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Thermodynamics in two production systems (traditional, open, spaced container compared with the closed, insulated pallet system) were evaluated by continuous recording of temperatures in twenty-two locations within the plant environment (foliage. root matrix, ambient, underlying soil or container bed, reservoir) over a year-long production cycle initiated in October. The effects of the rates and extremes of daily and seasonal temperature changes of the two production systems on the survival and growth of 16 woody plant species were evaluated.

During a summer week of high temperatures and high solar radiation, the root matrix temperatures within the pallet were relatively constant (18-23°C) while the temperature in the exposed. individual container varied from 12-36°C. the ambient air temperature fluctuated from 6-36°C. During a winter 4-week, low temperature period when ambient air temperature ranged from 8.9-15.5°C the root matrix temperatures in individual containers under structureless. clear polyethylene winter-protection covers ranged from 0-4.4°C; root matrix temperatures within the closed. insulated pallet ranged from 2.3-6.7°C. Temperatures in the roof matrix within the closed, insulated pallet were consistently more stable and favorable for root growth.

572
PREDICTION OF AIR/WATER RELATIONS OF PINE BARK-SAND POTTING MEDIA FROM ANALYSES OF COMPONENTS
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Mathematical equations which estimate water retention of pine bark-sand potting media at four moisture levels (0-, 10-, 50-, 100 cm water tension) were formulated and tested. The equations are a weighted sum of water retained attributed to each component for each moisture level. The equations are batch-independent and can be used to estimate total pore space, air space, easily available water, and water buffer capacity by analyzing only medium components. No differences were detected between regression equations which describe estimated water retention and those which describe measured water retention.

573
PRIMARY PLANT NUTRIENT STUDY ON FIELD-GROWN JUNIPER AND TAXUS
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The effectiveness of 5 rates of nitrogen (56, 112, 224, 336, and 448 kg ha^{-1}) without applied phosphate and potash and 2 rates of nitrogen (56 and 224 kg ha^{-1}) with 2 rates of phosphate and potash (56 and 112 kg ha^{-1}) were investigated on a silt loam soil which tested very high in available phosphorus and high in available potassium at the beginning of the study. Well rooted Juniperus andorra 'compacta' and Taxus densiformis were field transplanted in the middle of June and then fertilized with half the annual nitrogen rates and all the annual phosphate and potash treatments the following October and again in October of the next 2 years. The second half of all nitrogen treatments were applied in June for the next 2 years. Yield data were taken in June, 3 years after transplanting. High rates of nitrogen had a significant detrimental effect on taxus growth while the lower rates of nitrogen had a significant beneficial effect on the development of juniper. The application of phosphate and potash on this initially high testing silt loam soil had essentially no effect on the growth of taxus and juniper. Soil test results will also be discussed.

574
PRE-TRANSPLANT GROWTH AND POST-TRANSPLANT ESTABLISHMENT OF ILEX X ATTENUATA ASHE. 'EAST PALATKA'
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A two year study was conducted in Florida to ascertain the effects of production in plastic containers, directly in the ground and in fabric containers on pre-transplant growth and post-transplant establishment of 'East Palatka' holly (Ilex X attenuata Ashe. 'East Palatka'). Container-grown trees had more shoot dry weight and total leaf area than other production methods. Harvested root balls of fabric container-grown trees had 65% and field-grown trees 55%. respectively, of the surface area of the entire root system. The root system of container-grown trees had more small diameter roots and more root surface area within the root ball than other production methods. Production in fabric containers resulted in higher root densities in harvested root balls when compared to trees grown in the field.

Fabric container-grown 'East Palatka' holly transplants had more negative xylem pressure potential and lower net carbon exchange rates than other production methods immediately after transplanting, and when irrigation was subsequently withheld. Differences in dry weight of regenerated roots 14 weeks after transplanting were not evident among production methods.

575
THE ESTABLISHMENT AND WEED SUPPRESSION ABILITIES OF SELECTED DECIDUOUS WOODY GROUNDCOVERS
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Dormant rooted cuttings of 4 deciduous woody groundcovers *(Diervilla sessilifolia* Buckl., *Forsythia x intermedia* Zab. 'Arnold Dwarf', *Rosa* L. 'Nearly Wild', and *Symphoricarpos x doorenbosii* 'Magic Berry') were used in 3 experiments in order to evaluate their abilities to establish and quickly cover a site, suppress weeds, and tolerate a wide range of soil reactions. All plants were planted at either 15, 30, or 45 cm on center. Those planted on 15 cm centers produced greater than 85% canopy cover by September, while those at the 30 and 45 cm spacings produced 48 to 80% and 19 to 46% cover respectively. In their second year of growth, half of the plots were treated with a preemergent herbicide (Scotts OH-2 [oxyflourfen + pendimethalin]) and half were left untreated. Results showed that all species suppressed significant weed growth without the herbicide at the 15 and 30 cm spacings, while diervilla was the only species to effectively suppress weed growth at the 45 cm spacing. When grown in a primarily soil-based medium with pH values ranging from 5.6 to 7.3, no significant differences in biomass were shown among any of the pH ranges except for *R.* 'Nearly Wild', which showed lower total biomass when grown in pH values above 6.7.

576
Hydration-Dehydration Advancement of Kentucky Bluegrass and Perennial Ryegrass Cultivars.
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Hydration-dehydration seed treatments, in which seeds are hydrated with aeration and then air dried, were investigated in Kentucky bluegrass *(Poa pratensis* L.) cultivars (cv) 'Glade,' 'Baron,' 'Monopoly' and 'Ram I' and perennial ryegrass *(Lolium perenne)* c.v. 'Palmer,' 'Pennfine,' 'Citation II,' 'Manhattan II,' and 'Derby.' Seeds of Kentucky bluegrass and perennial ryegrass cultivars were hydrated with aeration (36 h), dried at ambient temperature (48 h) and placed in a germination chamber at 25° C (8 h light) -15° C (16 h dark) or 15° C (8 h light) - 6° C (16 h dark). Bluegrass and ryegrass hydrated, then dehydrated, germinated more rapidly than untreated seeds at 25° - 15° C, bluegrass failed to germinate during the duration of the experiment when subjected to 15° - 6° C temperatures. Ryegrass germination was unaffected by hydration-dehydration at the lower temperatures. Treated Citation II and Manhattan II ryegrass germinated better than other cultivars during the first 3 days whereas Monopoly was the best germinating bluegrass during days S-12.

114 ORAL SESSION (Abstr. 577-584) Floriculture: Nutrition and Media

577
THE EFFECT OF FERTILIZATION, NUTRIENT CHARGE AND IRRIGATION METHOD ON EARLY VEGETATIVE AND ROOT GROWTH OF POINSETTIA 'V-14 GLORY'
William R. Argo* and John A. Biernbaum, Department of Horticulture, Michigan State University, East Lansing, MI 48824.

Rooted cuttings of poinsettia 'V-14 Glory' were grown in 15 cm pots using 2 different fertilization schedules, 2 different starting charges, and 2 methods of irrigation. The constant application of 28.6 mMol N $liter^{-1}$ liquid fertilizer caused a significant decrease in plant and root growth after both 3 weeks and 8 weeks compared to a gradual weekly increase in applied fertilizer from 0 mMol N $liter^{-1}$ to 28.6 mMo1 $liter^{-1}$ over a 5 week period. The additional incorporation of 270 grams N m^{-3} to Metro mix 510 prior to planting had no effect on fresh weight or dry weight accumulation. Irrigation by either top watering with 33% leaching or by subirrigation had no significant effect on growth. High levels of nutrients moved out of the root zone to the top 2.5 cm of the pot with both types of watering. When the root media surface was covered by an evaporation barrier, high levels of nutrients in the media stayed in the root zone, which significantly reduced the shoot dry weight and leaf area. The evaporation barrier had the greatest effect in subirrigated pots since the movement of nutrient salts, either from leaching or from movement upwards to the top layer, could not occur.

578
LEACHING AND FERTILIZER CONCENTRATION EFFECTS THE QUANTITY OF NITROGEN LEACHED, MEDIA NO_3-N CONCENTRATION, AND VEGETATIVE GROWTH OF POINSETTIA.
Mark V. Yelanich* and John A. Biernbaum, Department of Horticulture, Michigan State University, East Lansing, MI 48823.

Poinsettias grown in 15 cm pots, were fertilized with one of three concentrations of NO_3-N and K (7/3, 14/6 and 28/12 mol m^{-3} N/K), applied at every irrigation with one of five leaching volumes (0.00, 0.25, 0.50 0.75 and 1.00 container capacities leached (CCL)). The leachate was collected and evaluated for NO_3-N and EC. After 71 days the plants were measured for height, leaf area and number, shoot fresh and dry mass. The quantity of N leached increased with increasing NO_3-N applied and increased leaching volume and ranged from 501 kg ha^{-1} a^{-1} (7 mol m^{-3}, 0.25 CCL) to 7975 kg ha^{-1} a^{-1} (28 mol m^{-3}, 1.00 CCL). Media NO_3-N concentration increased with decreased leaching and increased NO_3-N applied. For example with 7 mol m^{-3} N applied, NO_3-N in the media decreased from 27.1 mol m^{-3} with 0.00 CCL to 8.6 mol m^{-3} with 1.00 CCL. Shoot height and dry mass were not affected by the treatments. Leaf area increased from 1578 to 1935 cm^3 as fertilizer concentration decreased.

579
THE EFFECT OF NITROGEN CONCENTRATION ON THE NITROGEN BUDGET AND GROWTH OF 'CELEBRATE 2' POINSETTIA IN A SUBIRRIGATION SYSTEM
Mary Ann Rose*, Michael Chaplin, and John White, Department of Horticulture, The Pennsylvania State University, University Park, PA 16802.

Euphorbia pulcherrima 'Celebrate 2' was grown in Metro-Mix 350 and subirrigated with 5 rates of N in a saucer system with no leaching. The 5 nitrogen treatments, 0, 25, 50, 100, and 200 mg $N \cdot l^{-1}$, received a total of 3.1, 3.3, 3.5, 3.6, and 3.9 liters of solution, respectively, from potting to anthesis.

Shoot dry weights increased significantly with increasing N rate, but root dry weights did not. Shoot, root, and media % N increased with increasing N rate, ranging from a low of 1.2, 0.9, and 0.1% for these values in the 0 mg $N \cdot l^{-1}$ treatment, to 3.7, 2.6, and 0.3% in the 200 mg $N \cdot l^{-1}$ treatment. The percent of applied N taken up by the plant was 60, 85, 69, and 55% for the 25, 50, 100, and 200 mg $N \cdot l^{-1}$ treatments. Total N recovered in the plant or media exceeded 88% for all treatments.

Plant and bract diameter, leaf and bract area, and Minolta SPAD leaf chlorophyll values increased with increasing N. The number of breaks and bract color as measured by the Minolta Chroma Meter were not affected by N rate. Plant height was greatest in the 50 and 100 mg $\cdot N\ 1^{-1}$ treatments, but these plants were of lower quality than the 200 mg $\cdot N\ 1^{-1}$ treatment.

580
CONTROLLED-RELEASE FERTILIZER USAGE AND NUTRIENT RELEASE RATES INFLUENCE EBB AND FLOW PRODUCED POTTED CHRYSANTHEMUM PRODUCTION AND POSTPRODUCTION QUALITY
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Three studies were conducted to evaluate the effect of controlled-release fertilizers with different nutrient release rates and/or different application rates on production and postproduction quality of potted chrysanthemum. In the first study, Osmocote 14N-6.2P-11.6K and Nutricote 14N-6.2P-11.6K Type 100, both at 0.5, 1, and 2 times the recommended rates, were evaluated with the chrysanthemum cultivar 'Bright Golden Anne'. No differences in floral or foliar longevity were observed. In the second study, Osmocote 14N-6.2P-11.6K with a release rate of 90 to 120 days was compared to 2 "special request" Osmocote 14N-6.2P-11.6K formulations with release rates of 40 to 60 and 70 to 90 days, all applied at 0.5, 1, and 2 times the recommended rate to the cultivars 'Spirit' and 'Iridon'. Nutricote 14N-6.2P-11.6K Types 40, 70, and 100 at 0.25, 1, and 4 times the recommended rate were evaluated in the last study using the cultivars 'Spirit' and 'Iridon'. Results of all the studies will be discussed.

581
CALCIUM AND NITROGEN NUTRITION OF ALSTROEMERIA
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The effects of calcium and nitrogen & flower 'production of *Alstroemeria* were determined in two separate greenhouse experiments. Calcium was supplied as $Ca(NO_3)_2$ and $CaCl_2$ at 0, 1, 2, 4, 8 and 12 mM, and N was supplied as KNO_3 and $Ca(NO_3)_2$ at 0, 3.5, 7, 14, 28.5 and 57 mM. Nutrient solutions were applied at 7 or 10 day intervals to plants growing in soilless medium in 2.6 or 5.5 dm^3 pots. Flowers were harvested when the primary florets opened. Total nitrogen concentration was measured in tissue samples comprised of the uppermost 8 leaves of flowering stems. Calcium supply had no effect on flower production in *Alstroemeria*. Flower production increased with N supply to 28.5 mM, but declined at 57 mM. Linear regression of cumulative flower production as a function of time showed that during the linear phase of production, plants supplied with 28.5 mM N produced about 2.25 stems day^{-1} $plant^{-1}$. During the flower production period, N concentration was maintained at about 4.4% dry wt in plants supplied 28.5 mM N. In plants supplied 57 mM N, tissue N increased from about 4.8% to 5.6%, while concentrations less than 4% were obtained with N supply 14 mM or lower.

582
EFFECT OF A POT COVER ON IRRIGATION AND FERTILIZER REQUIREMENTS AND MEDIA NUTRIENT STRATIFICATION
John A. Biernbaum*, William Argo and Mark Yelanich, Department of Horticulture, Michigan State University, East Lansing, MI 48824.

In production of flowering potted plants in peat based media, soluble salts accumulate in the surface layer of root media with subirrigation, hose and breaker or drip watering systems. This salt accumulation is due to evaporation of water from the media surface which can account for 30 to 60% of total water loss. In experiments with Easter lilies and poinsettias, pot covers reduced water and fertilizer requirements by 25 to 50%. Root zone nutrient concentrations in covered pots were higher with less fertilizer applied than in uncovered pots because there was less migration of fertilizer salts to the upper layer of the root zone. Pot covers can also be designed to distribute and control the rate of application of surface applied water and therefore reduce runoff. With a pot cover, water loss of flowering Easter lily and poinsettia in interior post production conditions was reduced by 30 to 50% and the time to wilt was nearly doubled in one experiment with poinsettias. Water loss was not reduced nearly as much with the pot cover designed for use with five chrysanthemum cuttings in a 15 cm pot.

583
MICRONUTRIENT TOXICITY IN SEED GERANIUM PELARGONIUM x HORTORUM BAILEY
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Micronutrient toxicity symptoms of *seed* geranium (Pelargonium x hortorum Bailey) 'Ringo Scarlet' were experimentally induced by using 9 different concentrations of B, Cu, Fe, Mn, Mo and Zn in the fertilizer solution. Plants of 3-4 true leaf stage grown in peat-lite mix were constantly fed for 5 weeks with nutrient solutions containing 0.25, 0.5, 1, 2, 3, 4, 5, and 6 mM of each micronutrient. The control solution contained 20 uM B, 0.5 uM Cu, 10 uM Fe, 10 uM Mn, 0.5 uM Mo and 4 uM Zn. Visible foliar toxicity symptoms developed when the nutrient solution contained 2, 0.5, 5, 1, 0.25, and 0.5 mM, respectively, of B, Cu, Fe, Mn, Mo, and Zn. Reduction in dry matter yield was evident when 1 mM B, 2 mM Cu, 3 mM Fe, 2 mM Mn, 0.5 mM Mo, and 1 mM Zn were used in the fertilizer solution. Leaf chlorophyll contents decreased as Cu and Mn levels increased. Elevated levels of Fe increased tissue chlorophyll contents.

584
SHREDDED PINECONE AND PINEBARK AS GROWTH MEDIA FOR ORCHIDS, CATTLEYA SP.
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Orchid Cattleya sp. plants grown for 12 months in 40 or 100% shredded pinecone or 40 or 100% pinebark (0.6-1.3 cm) media produced a similar number of pseudobulbs and total plant dry weights as plants grown in 40 or 100% silva fir orchid bark. Plants grown in 100% pinecone medium ranked first in pseudobulbs and dry weight production. Plants grown in 2:2:1 (v/v/v) nikkle bark (western red bark), sphagnum peat moss and perlite ranked last in both these growth parameters. Analysis of the media at the end of the experiment revealed that the media differed in pH, P, K, Ca, and Mg. The highest and lowest pH were found in 100% orchid bark and nikkle bark, respectively. Pine cone media generally contained the most K and Mg, whereas 100% pine bark ranked first in P content and 100% orchid bark ranked first in Ca Content. Nikkle bark (100%) generally contained less P, K, Mg and Ca than the other media. Media containing 0.6-1.3 cm pine bark or sphagnum peat moss were physically degraded (shrinkage, compaction and decomposition).

115 ORAL SESSION (Abstr. 585-591A) Miscellaneous Environmental Stress

585
CHARACTERIZATION OF VELOCITY AND TURBULENCE EFFECTS ON PLANT DEVELOPMENT
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Experiments were conducted to measure the effects of velocity and turbulence on plant development. Specialized growth chambers were designed and built to provide a range of airflow velocities from 0.25 to 2.00 m/s. These chambers were modular in construction to allow modification of velocity profiles and addition of devices to control turbulence. Experiments were conducted to measure the force and effects exerted by 0.5, 1.00 and 1.50 m/s airflow on Chrysanthemum (Chrysanthemum × morifolium Ramat) and soybean (Glycine Max L. Merrill) parameters. Measurements of stem diameter and modulus of elasticity were used to determine plant response to wind-induced stress. Plant height, width, stem diameter, node number, and dry weight of leaves, stems, and roots were measured to determine plant morphological adaptation to differences in heat and mass transfer caused by different velocity regimes.

586
ASSESSMENT OF ENVIRONMENTAL STRESS IN RELATION TO SINK DEMAND AND DEVELOPMENT OF PRUNUS PERSICA.
Gary W. Stutte* and Mike Newell, Department of Horticulture, University of Maryland, College Park, MD 20742

The limitations of non-destructive, near infrared (NIR) assessment of canopy stress in 'Redhaven' peach was determined with respect to sink demand, stage of development and inter-plant competition under orchard conditions. Spatial

variability of intra-canopy stress was detectable under conditions of heavy sink demand at the onset of Stage II, but not during Stages I or II of fruit development when sink demand was low. There was no interaction between stage of reproductive development and relative canopy stress however. It was possible to determine variability of intra-orchard stress early in fruit development when sink demand was high, but the intra-canopy interactions between sink demand and enviromental-stress during sink development precluded reliable estimations of canopy productivity.

587

EFFECTS OF ALUMINUM ON BIOCHEMICAL CONSTITUENTS OF PEACH SEEDLINGS

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Experiments were conducted to assess the effects of several aluminum concentrations on the biochemical composition of peach *[Prunus persica* (L.) Batsch] rootstocks. Seedlings of 'Nemaguard' and 'Lovell' were irrigated daily with l/4 strength Hoagland's solution containing 0, 25, 50, and 100 ppm aluminum supplied as $AlC1_3 \cdot 6H_20$. Plants received a 16-hour photoperiod under HID lights at 250 µmol $m^{-2} s^{-1}$ PPF. Increasing aluminum concentrations significantly reduced root lignin concentrations in both cultivars. Soluble protein and total sugar concentrations were significantly reduced in 'Nemaguard' but were unaffected in 'Lovell' seedlings. Changes in cell wall polysaccharide composition will be discussed.

588

OSMOTIC ADJUSTMENT AND CARBOHYDRATE METABOLISM IN APPLE LEAVES OF DIFFERENT AGES UNDER WATER STRESS

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Greenhouse grown, 4-year-old, potted apple trees were subjected to water stress during August to October. Water potential (Ψ w), osmotic potential (Ψ_s) and soluble carbohydrates in young and mature leaves were measured. A total adjustment of 1.0 MPa in August and 1.5 MPa in October was observed in mature leaves, of which only 0.8 MPa in October was due to active solute accumulation. Sorbitol concentration increased as Ψ_w fell to -2.2 MPa and accounted for the primary carbohydrate associated with active osmotic adjustment. Sucrose level decreased in response to water stress in most cases. All soluble carbohydrate levels declined when Ψ_w was below -2.2 MPa, suggesting that other solutes are involved during severe stress. Highly negative correlations between the percent sucrose and sorbitol (r^2=0.85), glucose (r^2=0.90) and fructose (r^2=0.67) were observed. Concentrations of sorbitol, glucose, fructose and sucrose declined in young leaves as Ψ_w became more negative and no active osmotic adjustment was detected.

589

ROLE OF TEMPERATUPE AND OXYGEN REGIMES IN CHILLING ACCLIMATION OF CUCUMBER SEEDLINGS.

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Resistance to chilling at 2°C was induced by holding cucumber seedlings at (12°C) for 48 hrs followed by a warming period at 25 C. Chilling resistance developed up to 24 hours warming and decayed afterward. During this time sub-ambient oxygen levels arrested where supra-ambient O_2 levels (60%0_2) enhanced the chilling resistance. Also, the total lipid fraction in the hypocotyls became enriched in linolenic acids, while other fatty acids declined, and this process was stimulated by 60% O_2 and arrested by oxygen depletion. We concluded that lipids desaturation is initiated by cooling and develops during the warming period and that the activity of oxygen, a cofactor in lipid desaturation, may account for the oxygen role in chilling resistance. Inhibition of protein synthesis by cycloheximide had little or no effect on the temperature and the oxygen regulation of chilling resistance suggesting that lipids desaturation is due to pre-existing rather than the synthesis of lipid desaturases. Our results support the view that (membrane) lipid desaturation contributes to chilling resistance.

590

Growth Response of Tomato to the Anti-ozonant EDU and Ozone.

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Ethylene diurea (EDU) acts systemically to prevent tropospheric ozone (O_3)-induced visible folir lesions and has enhanced yield of various field grown crops exposed to 0_3. Insufficient research data are available to ascertain its effects in the absence of O_3, on growth and yield and, therefore its suitablility for use in the field to survey 0_3-induced crop losses. This study was conducted to quantify the effects of EDU, alone and in interaction with O_3 on biomass accumulation in tomato, *Lycopersicon esculentum*, Mill, 'New Yorker', in the field and controlled environment. In 1988, potted young tomato plants received soil drench treatments of aqueous solutions of 0.000, 0.015, 0.150, and 1.500 g L^{-1} EDU and were exposed to filtered air or filtered air plus O_3 in outdoor open top exposure chambers. similar plants raised in controlled environment were treated with 0.000 0.005 0.015 0.050, 0.150, and 0.500 g L^{-1} EDU and exposed to four levels of O_3 in indoor Continuously Stirred Tank Reactors. Measurements included leaf area fresh and dry weights, number of flower buds, stem height, and number of abscised leaves. Results indicated that EDU prevented 0_3-induced reductions in biomass and foliar lesions and delayed leaf abscission. At high EDU concentrations, visible symptoms of EDU toxicity were noted as characteristic interveinal chlorosis and marginal inrolling. Concentrations of EDU above approximately 0.300 g L^{-1} outdoors and 0.100 g L^{-1} indoors were toxic. Low concentrations may have stimulated growth. Internal concentrations of EDU, critical to plant response, probably result from the interaction of the applied EDU dose and plant size.

591

PLANT MOISTURE STRESS - AND NUTRITION-MEDIATED CHANGES IN FEEDING OF HOMALODISCA COAGULATA, A VECTOR OF DISEASES INDUCED BY XYELLA FASTIDIOSA

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The leafhopper Homalodisca coagulata (Say), which feeds on xylem fluid of 100 different host plant species, is a major vector of diseases caused by Xyella fastidiosa (i.e. phony peach disease, plum leaf scald, Pierce's disease, etc.). Previous research has indicated that both leafhopper feeding preference and feeding rate were correlated with the chemical profile of xylem fluid. Our objectives were to examine diurnal, stress and nutritional effects on xylem fluid of Lagerstroemia indica L. and Prunus persica (L.) Batsch, and subsequent effects on leafhopper feeding. Feeding rate and the concentration of amino acids and organic acids in xylemfluid were higher for irrigated plants. Feeding and xylem fluid tension were maximum during midday; feeding did not occur at night. Glutamine, which represented ca. 50% of the amino acid pool for L. indica, was the constituent best correlated to insect feeding. Physical determinants predominated over chemical determinants with increasing stress. Feeding was precluded at a xylem fluid tension of 1.5 to 2.0 MPa.

591A

IRON OXIDATION IN HANDWARMER IMPROVES FREEZE PROTECTION OF YOUNG CITRUS TREE WRAPS.

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The purpose of this study was to see if handwarmers inserted inside an insulating tree wrap could benefit young citrus trees during freezes. The handwarmer, a packet containing iron particles and charcoal, releases heat when exposed to air because of rapid iron oxidation. Tests were carried out in a freeze chamber and during a severe advective freeze in Dec. 1989. In freeze chamber tests to -7°C, handwarmers improved trunk temperature for over 19 hours with warming of 5 to 14°C. Under field conditions, minimum trunk temps were significantly higher with handwarmers (-4.2°C) than both the wrapped or non-wrapped controls (-5.9° and -7.5°C). Handwarmers were effective for only one night and did not improve temperature during the second or third night of this freeze. For one-night freezes, handwarmers may provide some benefit to young trees.

121 ORAL SESSION (Abstr. 592-599) Cell and Tissue Culture: Cell and Suspension Culture

592
CALCIUM CHLORIDE EFFECTS ON PROLIFERATION, OIL YIELD, AND TERPENOID PRODUCTION OF ROSEMARY IN VITRO
Azza A. Tawfik*, Paul Read, Dept. of Horticulture and Susan Cuppett Dept. of Food Science and Technology, University of Nebraska, Lincoln, NE 68583-0724

The effect of macro- or micro-nutrients on the growth of rosemary (Rosmarinus officinalis L.) and its essential oil yield in vitro has not been reported. Shoot tips and leaf segments of R. officinals var. Lockwoodii were used in this study. Induction callus medium supplemented with six concentrations of Ca^{2+} was used. Murashige and Skoog medium was used as a control. Data were taken on fresh and dry weight for callus produced from both shoot tips and leaf segment explants. Essential oil yield and GLC analyses of tissue extracts were also investigated. The lower concentrations of Ca^{2+} produced dark green and compact calli, while the higher concentrations produced light green friable calli. The essential oil (containing some monoterpenes) has been detected in undifferentiated callus cultures. Ten peaks were identified from the oil extract from the parent plants. Only eight peaks were found in the oil extracted from the undifferentiated callus produced from leaf segments. The Ca^{2+} ion supplementation significantly affected the oil yield, camphene, cymene, linalool and borneol acetate. No significant effect on the other four components was observed.

593
EFFECT OF SUCROSE ON CALLUS INDUCTION , OIL YIELD AND TERPENOID PRODUCTION OF ROSEMARY *IN VITRO*
Azza A. Tawfik, Paul E. Read, Department of Horticulture, and Susan Cuppett, Food Science and Technology, University of Nebraska, Lincoln, NE 68583-0724

The influence of sucrose concentrations on the proliferation and essential oil yield of rosemary *Rosmarinus officinalis L.* grown *in vitro* has not been investigated. Shoot tips and leaf segments of two genotypes of rosemary, *R. officinalis 'Prostratus'* and *R. officinalis* var. *Lockwoodii* were cultured on callus induction medium used in our previous study. The medium was supplemented with sucrose at four concentrations (10, 20, 30, and 40 g/L) to determine the effect of sucrose on the proliferation of rosemary and its essential oil yield . Data were taken on fresh and dry weight, essential oil yield and GLC analysis of tissue extracts. Sucrose concentration significantly affected the fresh weight of both genotypes and the texture of callus. Compact dark green callus was obtained when 20 g sucrose /liter was used. Ten peaks were identified in the oil extracted from tissues. Sucrose significantly affected some constituents of the oil extracted from both genotypes.

594
OPTIMIZING CALLUS INITIATION USING STOLON NODAL SEGMENTS OF BUFFALOGRASS NE84-609 AND A RESPONSE SURFACE DESIGN
Ronald W. Moore*, K.M. Eskridge[1], P.E. Read and T.P. Riordan, Departments of Horticulture and Biometry[1], University of Nebraska, Lincoln, NE 68583-0724

The concept that greater callus mass will induce competence was investigated. The second most immature nodal segments were removed from heavily fertigatcd greenhouse grown plants. Shoots initiated from those nodes were only cut back to one-third their total length. They were subjected to the following treatments: (1) dicamba from 1µM to 5µM in increments of 1.0; (2) B5 medium salt concentrations from 1/3x to 5/3x in increments of 1/3; (3) sucrose levels from 2% to 10% in increments of 2; (4) casein hydrolysate from 0 to 200mg/l in increments of 50. The experiment consisted of twenty-five different treatment combinations in a central composite rotatable second order design. Explants were placed in continuous cool white fluorescent light at 26°C.

Dicamba, B5 salts, and sucrose had significant effects on callus mass ($p<.12$), while casein hydrolysate had no notable effects on callus mass ($p \geq .57$). It was determined that optimum response occurred at 5/3x concentration of B5 salts, 10% sucrose, and 5.0µM dicamba. White, compact calli were observed in treatment combinations that yielded callus fresh weights of two-hundred milligrams or higher.

595
EFFECTS OF INITIAL AMOUNT OF SUGAR IN THE MEDIUM ON THE GROWTH OF *CYMBIDIUM* PLB IN VITRO
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Sugar concentration in the medium is one of the major factors affecting the heterotrophic growth of cultures since sugar is the only carbon and energy source for the growth. The initial amount of sugar in combination with the initial sugar concentration in the medium may affect the time courses of the sugar concentration in the medium and dry weight increase of cultures.

In the present experiment, protocorm-like bodies (PLB) of *Cymbidium* were cultured in vitro under different conditions of concentrations and amounts of glucose in liquid l/2 MS medium. The glucose concentrations in the media decreased with time in all the treatments. The fresh and dry weights of PLB were greater under higher glucose concentration conditions. It should be noted that the mean relative growth rate (RGR) of PLB for the entire culture period was similar when the initial amount of sugar per fresh weight of PLB was the same, regardless of the sugar concentrations of the media.

596
CARBOHYDRATE SOURCE AND LIGHT EFFECTS ON GROWTH OF EUCALYPTUS SUSPENSION CULTURES
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Eucalyptus tereticornis suspension cultures were studied to determine how growth was affected by carbohydrate source and light. Cultures were grown in MS-based media containing sucrose, glucose or fructose (3%) and 1 mg/l 2,4-D (inoculum of 0.5 g fresh weight of cells60 ml of media). Cells were harvested every 48 hrs. for 14 days. Maximum growth was obtained with sucrose (7.5 g final fresh weight/flask), compared to glucose (4.9 g fresh weight/flask). There was little growth with fructose (0.7 g final fresh weight/flask Cell doubling times in media containing sucrose, glucose and fructose were 3.5, 4.1 and 22.4 days, respectively. To determine light effects, cells were cultured under continuous fluorescent light (125 µE $m^{-2}s^{-1}$) or in the dark in glucose- or sucrose-containing media. In a preliminary experiment, cells cultured under light grew and cells cultured in the dark did not grow, regardless of carbohydrate source.

In conclusion, sucrose and glucose were satisfactory carbohydrate sources, and fructose was not. Light may be needed for growth of Eucalyptus suspension cultures.

597
EFFECT OF CULTURE CONDITIONS AND CYTOKININS ON ROOT ORGAN CULTURE OF BUDDLIEA ASIATICA.
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Factors affecting root growth and shoot regeneration from root organ cultures (ROC) of Buddliea asiatica were investigated as part of an ongoing attempt to develop a micropropagation system based on root organ culture. Stock ROCs were established by excising adventitious roots from axillary shoot cultures and transferring them to liquid MS medium without hormones on an orbital shaker at 100 rpm. These grew rapidly and initiated adventitious buds throughout several subcultures. In the first experiment the effect of 2 light treatments (darkness vs. ca. 5 µmoles/m^2/sec for 16 hr/d), 2 aeration levels (50 vs. 100 rpm), and 3 flask/medium volumes were tested in a complete factorial. Only lighting significantly promoted root elongation, and neither lighting, agitation nor culture volume had a significant effect on root dry weight or bud development. In a second experiment in the light, the cytokinins BAP significantly promoted dry weight of meristematic green masses consisting of green callus and numerous small shoot primordia.

598
GROWTH AND NUTRIENT DEPLETION IN *IN VITRO* CULTURES OF WATERMELON
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Watermelon *(Citrullus lanatus* [Thunb.] Matsum. & Nakai) tissues were proliferated in liquid medium with Celgard raft membrane and in agar-solidified medium. Tissues in liquid medium accumulated more fresh weight than those in agar-solidified medium. Fresh weight gain declined

after 14 and 21 days in agar-solidified and liquid medium, respectively. The largest fresh weight gain was obtained within 7 to 14 days and 14 to 21 days in agar-solidified and liquid medium, respectively. The total dry weight after 5 weeks was greater in liquid than in agar-solidified medium. The relative dry matter content, however, was 36.17% greater in agar-solidified medium than in liquid medium. Nutritive ion analysis of the liquid medium indicated rapid depletion of NO_3^- and NH_4^+. The ions available in the medium at the end of the experiment were 85.08%. 68.63%, 29.23%, and 1.16% of the initial concentrations of Ca^{++}, K^+, NO_3^-, and NH_4^+, respectively. Moreover, 72.28% of the initial sucrose was still in the medium after 5 weeks.

The shoots from agarless medium were watersoaked and inferior to those obtained from agar-solidified medium. Novel medium formulations will be discussed as they pertain to improvement of shoot quality.

599

RESPONSE OF APPLE MESOPHYLL CELLS TO CULTURE FILTRATE OF PHYTOPHTHORA CACTORUM

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The effect of culture filtrate (CF) of P. cactorum on apple cell membranes was monitored by measuring changes in fluorescence of cells stained with Merocyanine 540 (MC-540), a" optical probe of changes in transmembrane potential (PD). The ability of this probe to monitor PD changes in apple cells was confirmed by measuring changes in fluorescence emission induced by valinomycin and gramicidin. Compared with cells incubated in control solution, MM.106 (susceptible to P. cactorum) cells in CF showed an immediate fluorescence increase followed by a decrease after 3 and 24 hr. M.26 (moderately resistant) showed the same initial increase then after 3 hr stabilized at the level of the control. Smaller differences were observed with Mark (moderately resistant) cells, while no difference occured with MM.111 (resistant) confirming its higher level of resistance. These results provide evidence for the role of a toxic metabolite of P. cactorum in disease development and for the feasibility of using-540 fluorescence of apple cells as a screening system for identifying rootstocks resistant to P. cactorum.

122 ORAL SESSION (Abstr. 600-607) Vegetables: Culture and Management II

600

EFFECT OF PLANTER FLAT TYPE AND CELL SIZE ON ROOT GROWTH OF BELL PEPPER TRANSPLANTS

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Planter flat type affected root development of pepper (Capsicum annuum L. 'Jupiter') transplants grown in flats with comparable root cell volumes. Six-week-old plants grown in TODD 100A flats had more lateral roots than plants grown in either Grow-Tech 200 or Growing Systems 135 flats but the number of basal roots and total root dry weight were unaffected. After growing for 8 days in pots of sand, plants from GS 135 flats still had fewer lateral roots than plants from the other flats but there were no differences in root dry weight. Root mass increased with increasing cell size but total root number was decreased only in small flats. Plants grown in TODD 80A and 100A flats had fewer basal roots than those grown in TODD 175 flats but lateral root number was greatest in plants from TODD 100A flats. The dry weight, but not the number, of basal roots was less on plants grown in TODD 80A flats as compared to TODD 100A flats. After 8 days in pots of sand, the number of roots developed did not differ among the TODD flats, but differences in dry weights persisted.

601

AGE AND N-NUTRITION OF SPANISH ONION TRANSPLANTS IN THE GREENHOUSE

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A study was conducted to determine the effect of seedling age and N nutrition of Spanish onion transplants grown in the greenhouse on onion yield and quality in the field. Three Spanish onion cultivars, 'Sweet Sandwich', 'Yula', and 'Vega', were seeded in 200-cell trays at 12, 10, or 8 weeks before transplanting. The seedlings were fertilized with 75, 150, or 225 ppm N every week starting at 2 weeks after seeding. Time to maturity in the field was not affected by seedling age, but was reduced with higher N rate. Both greater age and higher N rate resulted in larger onions at harvest. Total marketable yield was highest with 10- and 12-week-old transplants and with 150 and 225 ppm N. All cultivars responded similarly.

602

HEIGHT CONTROL OF TOMATO TRANSPLANTS

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The use of cultural height control techniques can provide adequate control to produce a marketable tomato transplant without the use of any growth regulators. The cultural practices of DIF (difference between day and night temperatures), drought stress, and seismo stress (shaking) were used to quantify their effect when used in combination for height control. An additive effect was seen with respect to height control as multiple control methods were employed. A maximum height reduction of 41 percent was obtained when -DIF, drought stress, and seismo stress were used in combination. The plants were planted into field plots and observed. There were no apparent effects on transplant survival or fruit development.

603

RESPONSE OF TOMATO PLANTS GROWN IN LIMITED NUTRIENT SOLUTION TO APPLIED HUMIC ACID

P. P. David*, P. V. Nelson, and D. C. Sanders, Dept. of Horticultural Science, North Carolina State University, Raleigh, NC 27695-7609.

The effects of humic acid (HA) on nutrient accumulation and growth of tomato seedlings was evaluated in a solution of limited nutrient availability in a greenhouse. HA additions were made to the nutrient solution at rates of 640, 1280 or 2569 mg/l.

The addition of 1280 mg/l HA produced significant increases in accumulation of all plant nutrients as well as fresh and dry weights of shoots and roots. Effect of adding 640 mg/l HA was less beneficial. Increased nutrient accumulation was found to be due to the chelating action of HA rather than the nutrients it contained.

Root volume and electrolyte leakage, as an indication of membrane permeability, did not differ as a consequence of HA additions; however. there was a clear trend toward increases in both with HA additions. Also, electrolyte leakage correlated positively with HA rate. There were no effects of a shift in solution pH from 5.8 to 7.0 nor of the interaction of pH and HA on nutrient accumulation or growth of tomato seedlings.

604

PRETRANSPLANT CONDITIONING OF WATERMELON

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At transplanting vine length was greater for 'Mirage' (diploid hybrid) than 'Queen of Hearts' (triploid) watermelon subjected to pretransplant nutrient conditioning and/or cyclic cold stress, and vine length increased significantly as nutrient level increased. However, vine lengths were similar for both cultivars eight days after transplanting and influence of pretransplant nutrient level was less evident than at transplanting. 'Mirage' outyielded 'Queen of Hearts' on the first of two harvests, and total weight of 'Mirage' was greater than 'Queen of Hearts' for combined harvests. Production of >8.1-10.8 kg melons was similar for both cultivars and

comprised the primary percentage of melon wights. Most small fruit (5.4-8.1 kg) were produced by 'Queen of Hearts' and most large fruit (>10.8 kg) by 'Mirage'. Compared with other treatments, yield generally increased when seedlings received high fertility and cold stress prior to transplanting.

123 ORAL SESSION (Abstr. 608-615) Crop Protection: Vegetables/Fruit

605
PLASTIC MULCH, PLANT SPACING AND NUMBER AFFECT YIELD, FRUIT SIZE AND ECONOMIC RETURN IN WATERMELON

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One of 2 plants per site of 'Prince Charles' and 'Royal Jubilee' watermelon were grown with drip fertigation and with/without plastic mulch in 5 environments during 4 seasons. Plant sites were spaced from 0.45 to 1.5 m in rows centered 1.5 m. Plastic mulch increased yield 10 to 200% depending on spacing and environment. Two plants per site reduced yield, and average fruit size. With plastic, mulch yield of large fruit (>9 kg) was greatest at 0.6 to 0.9 m in row, while marketable yield (>5 kg) was greatest at 0.45 m. Without plastic, the yield of large andmarketable fruit increased as in-row spacing increased from 0.45 to 1.5 m. Net return was increased by plastic mulch and closer in-row spacing. If all fruit >5 kg can be marketed, greatest returns can be obtained from a single plant at in-row spacings of 0.45 to 0.9 m grown on plastic.

606
BEE ATTRACTANTS INEFFECTIVE FOR IMPROVED CUCUMBER AND WATERMELON YIELD

Jonathan R. Schultheis[*1], John T. Ambrose[2] and Stephen B. Bambara[2], Depts of Horticulture and Entomology, North Carolina State University, Raleigh, NC 27695-7609

Several compounds are commercially available to attract bees for improved pollination in horticultural crops. The objective of these studies was to test the effectiveness of bee attractant by evaluating the number of bee visitations to cucumber and watermelon blossoms and their effect(s) on yields and crop profitability. In 1989, Bee-Scent® was tested in two commercial pickling cucumber fields. In 1990, watermelon plots were sprayed with Bee-Scent® and Bee-Line® and compared with a nontreated control. Data collected were the number of bee visitations, fruit quality, and yields. For both cucumber and the watermelon test, increases in bee visitation were not observed. There were no significant differences in cucumber or watermelon yields between bee attractant treatment(s) and the control. These studies demonstrate that there is no increase in bee visitation, yield, or economic benefit with either product.

607
SET-UP OF ON-FARM TRIALS AND EVALUATION OF RESULTS

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Demonstration trials comparing an accepted practice to a new idea or practice is not new. However, more producers are asking for more information about specific production problems addressing specific challenges confronting them on their farms. Therefore, the producer must claim greater partnership in generating the knowledge required. In on-farm trials, the producer provides the practical knowledge and experience with the land as well as the human and physical resources for the conduct of the trial and most importantly assesses the relevance of the results.

In on-farm trials objective must be straight forward and single embracing the least number of treatments possible with one of the treatments being the current standard practice.

Meaningful results are only obtained when treatments are randomly applied and replicated. This makes possible the valid use of simple statistics such as averaging, analysis of variance, and paired comparison testing. The agricultural agent or specialist provides good experimental control and assurance that data analysis is valid.

608
THE EFFECT OF ONE, TWO, AND THREE MONTH WEED-FREE PERIODS ON YIELD OF LATE SEASON TOMATOES

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Weed control by cultivation was done until July 1, August 1, and September 1 in addition to full season weed control by chemical methods in a late season tomato planting. The chemical control consisted of using metribuzin and sethoxydim applications on an as-needed basis. Yields were highest in treatments in which weed control measures ceased on August 1. Yields from this treatment were 33% higher than the next closest treatment. Plots in which only chemical weed control methods were used resulted in the second lowest yields - 62% of the August 1 treatment. No weed control resulted in 10% of the yield produced by the August 1 treatment. A combination of weed control methods until mid-summer appears to have been the best combination for producing desirable yields.

609
COMPETITION FOR LIGHT BETWEEN PROCESSING TOMATOES AND NIGHTSHADES (SOLANUM NIGRUM AND S. PTYCANTHUM)

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Black and eastern black nightshade were established during 1989 and 1990 at densities between 0 and 4.8 plants m^{-2} in irrigated 'Heinz 6004' tomatoes. Tomato yield, either as number or weight of fruit was reduced more by eastern black nightshade than black nightshade. Eastern black nightshade overtops tomatoes, reducing light penetration. The photosynthetically active radiation (PAR) reaching the top of the tomato canopy was negatively correlated with eastern black nightshade density. Black nightshade remained shorter than tomatoes throughout the season and did not affect light penetration or tomato yield. Increasing densities of eastern black nightshade reduced the vegetative and berry weights of the weed. Black nightshade did not compete intra-specifically.

610
INFLUENCE OF CLOMAZONE RATE ON WEED CONTROL AND TOLERANCE IN SELECTED COLE CROP SPECIES

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Clomazone [2-(2-chlorophenyl)methyl-4,4-dimethyl-3-isoxazolidone] is a selective herbicide for weed control in soybeans and pumpkins and is currently under investigation for use in other horticultural crops. Field studies were conducted in 1989 and 1990 at Lexington and Quicksand, KY on a Maury silt loam and a Pope silt loam with 3 or 5% OM, respectively. Clomazone was applied PPl at 0.0, 0.42, 0.84, 1.68 and 3.36 kg ai/ha. 'Solid Red hybrid 781' red cabbage, 'Bravo' green cabbage, 'Green Comet' broccoli, 'Snow Crown' cauliflower and 'Joi Choi' pak choi were transplanted after application. Clomazone provided good to excellent weed control at rates above 0.84 kg/ha. Field evaluations indicated significant differences in the tolerance of various cole crops to clomazone as chlorosis was evident in certain treatments. All crop species exhibited severe phytotoxicity to clomazone at rates of 1.68 and 3.36 kg/ha. Moderate chlorosis was also observed when 0.42 and 0.84 kg/ha clomazone was used, but marketable yields were not significantly reduced in comparison 10 the control, with the exception of green cabbage and pak choi. Less injury was observed in all crops at the Quicksand location due to the increased soil organic matter content. Broccoli and cauliflower exhibited the greatest tolerance to clomazone in these studies followed by red cabbage, green cabbage and pak choi.

611
WINTER COVER CROPS INFLUENCE INSECT POPULATIONS IN SUSTAINABLE CANTELOUPE PRODUCTION
Kathryn E. Brunson[1*], Sharad C. Phatak[1], Laurence D. Chandler[2] and Richard B. Chalfant[1]. [1]University of Georgia and [2]USDA-ARS, Coastal Plain Experiment Station, Tifton, GA 31793

Winter cover crops were evaluated to determine their influence on densities of insects in sustainable canteloupe production. Eight cover-cropping regimes, including a weedy fallow control, were tested in a replicated trial. Thirteen different insects, both pest and beneficial, were recovered from visual observations and crop shake samples. Polyculture, Crimson Clover, Mustard and Vetch supported higher densities of Lygus lineolaris, Geocoris punctipes, Chrysomelids, stink bugs, loopers, plant hoppers, aphids and predacious flies. There was no significant differences in densities for Coccinellids, Orius sp., lacewings or whiteflies. The fallow control showed low densities for all insects. Wireworm densities for Conoderus rudis and Conoderus scissus were highest in Polyculture and Mustard. No differences in densities of Conoderus falli were observed but Vetch had the highest means.

612
CANOPY MANAGEMENT FOR TOMATO BLACKMOLD CONTROL
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First year field experiments at the University of California, Davis, demonstrated blackmold fruit rot of tomatoes caused by *Alternaria alternata* could be influenced by canopy management. Both wider spacings between clumps of plants within the row or between adjacent rows reduced the incidence of blackmold. The reduction of rot was comparable to fungicide treatments. Further field tests are planned.

613
INFLUENCE OF FERTILIZER ON PATHOGENICITY OF COLLETOTRICHUM ORBICULARE ON CUCUMIS SATIVA.
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A study was conducted to investigate the influence of fertilizer on anthracnose disease of cucumber, caused by Colletotrichum orbiculare. The cultivars H19 and SMR-58 were used. Treatments included four fertilizer rates (Peters NPK-20 20 20) at 50, 100, 150, and 200 ppm, and a water control. The experiments were set up as a completely randomized block design with five replications and three plants per replication. The experiment was conducted with several isolates. A spore concentration of 8 x 10^4 spores/ml was used to inoculate plants at the four true leaf stage. Plants were incubated for 24 hrs in a dew chamber at 21 C after which they were transferred to the greenhouse. True leaves were scored for disease on a scale of 0 (no disease) to 5 (dead) 4 to 8 days after inoculation. H19 was more resistant than SMR-58 at all treatments. In general, disease severity increased with increasing fertilizer rates for both cultivars and all isolates tested. Fertilizer may be an important variable when trying to standardize pathogenicity tests with Colletotrichum orbiculare on cucurbits and thus, may influence race designations.

614
CULTURAL ALTERNATIVES FOR AVOIDANCE OF LETTUCE INFECTIOUS YELLOWS VIRUS (LIYV)
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The occurrence of LIYV has a substantial economic impact on winter lettuce production in the California and Arizona desert districts. The disease is vectored by the sweet potato whitefly, Bemisia tabaci, and reduces both yield and quality of winter lettuce with the earliest plantings impacted more severely. Avoidance of whitefly, either by later planting or protection of the young plants (transplants produced in whitefly-free areas or shielded from attack with row covers) may greatly reduce both the incidence of infection and disease development. At the Yuma Valley Ag Center, 3 direct-seeded planting dates were at two-week intervals beginning August 16; row covers were installed prior to irrigation and final removal coincided with transplant placement for the respective planting date. Heat stress reduced early stands and high whitefly counts resulted in severe LIYV infection and no marketable yield in the first planting. The efficacy and economic feasibility of non-chemical cultural procedures as alternative control methods will be discussed.

615
REDUCING PESTICIDE USE IN ORCHARDS THROUGH ENVIRONMENTAL MONITORING FOR PEST PROTECTION
Mahmoud K. Ali*, Mark L. Gleason. Paul A. Domoto and Michael D. Duffy, Department of Horticulture, Iowa State University, Ames, Iowa 50011

Five spray strategies for control of three major pests (apple scab, codling moth and apple maggot) were compared in a Red Delicious apple orchard at the Horticulture Research Station, Ames, Iowa, during 1989 and 1990. Three IPM-based treatments, incorporating weather and pest monitoring, were compared to a traditional spray schedule and a control (no fungicides). A partial budget technique was used to compare economic data from all treatments. IPM-based treatments saved an average of six pesticide sprays per year compared to the traditional treatment, with equivalent pest control efficacy. Yield of IPM-based treatments was comparable to or greater than yield of the traditional treatment. The IPM-based treatments were comparable in cost to the traditional treatment. However, the IPM-based treatments had an increasing cost advantage as orchard size increased.

124 ORAL SESSION (Abstr. 616-623) Floriculture: Growth and Development

616
TEMPERATURE INFLUENCES TELOSMA FLOWERING
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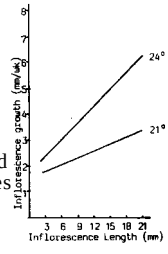
The flowers of Telosma cordata, known in Hawaii as Pakalana, are strung together to make fragrant leis for all occasions. These flowers are not available during winter months when demand is high. We have previously reported that Telosma is a LDP. In this-experiment, the effect of temperature on rate of flower development is reported. Four 30 cm tubs of well-grown, vegetative Telosma vines were placed in each of 3 growth chambers. Daylength was set for 16 hours light/8 hours dark. The temperatures of the chambers were constant 18, 21, and 24C 1°. Inflorescence buds were evident after 3 weeks at 21 and 24C with first anthesis at 24C 32 days after the treatment began; the majority of inflorescences required @ 42 days to reach anthesis. Inflorescence initiation at 18C had not occurred by this time while buds at 21C were developing, albeit at a slower rate and had not yet reached anthesis (Figure). Flower bud & pedicel length increased more rapidly with age. Commercial pakalana producers could stimulate winter crops where the temperatures do not fall much below 21C.



617
A NEW FORCING TECHNIQUE FOR PRODUCTION OF LILIUM.
Mark S. Roh, U.S. Department of Agriculture, Florist and Nursery Crops Laboratory, Beltsville, MD 20705.

Small bulblets of Lilium longiflorum, 'Nellie White' and bulbils of L. elegans hybrids were subjected to various temperatures to-investigate the effects on flowering and production of pot plants. Bulblets 390 mg in weight and with an average of 6.5 scales that received 2 wk of 2.5C, 2 wk of 15C, 2 wk of 2.5C, and 2 wk of 15C, produced plants that flowered in 15 months with 2.6 flowers on a stem of 29 cm with 60 leaves. When 300 mg bulbils of L. elegans hybrids received sequential 5C, 20C, and 5C temperature treatment, plants produced 2 to 3 flowers on strong 63 cm long stem in 7 months. These procedures eliminate the bulb production phase in the field. Lilium bulblets or bulbils can produce quality plants after exposure to alternating temperatures prior to planting.

618
COLD STORAGE OF BEDDING PLANT PLUGS
Nathan E. Lange* and Royal D. Heins, Department of Horticulture, Michigan State University, East Lansing, MI 48824-1325

Plug sheets (406 size) of Impatiens wallerana 'Accent Orange,' Viola tricolor 'Majestic Yellow,' and Petunia x hybrida 'Ultimate Red' were placed at 6 different temperatures ranging from 0.0C to 12.5C (2.5C increments) with a PPF of either 0, 1, 5, or 10 µmol·m1·s^{-2}. Irradiance levels were

provided by cool white fluorescent bulbs with a 24 hour photoperiod. Impatiens and Petunia plants were removed weekly for 6 weeks from each plug sheet in each temperature/irradiance treatment. Viola plants were removed biweekly for 16 weeks. The average number of days to flower from transplanting and the percentage of plant survival were recorded for each treatment. All Impatiens plugs held at 0.0C died after one week of storage. Storing Impatiens at 2.5C for more than 2 weeks or 5.0C for more than 3 weeks resulted in severe chilling injury and subsequent plant death regardless of irradiance. Impatiens satisfactorily tolerated 7.5C storage at all irradiances, including darkness, for 6 weeks. Satisfactory treatments were defined as treatments when no more than 1 out of 10 plants died after storage and flowering was not delayed by more than 5 days compared to non-stored control plants. Viola plugs satisfactorily tolerated 16 weeks of storage in the dark at 0.0C and 2.5C, and up to 6 weeks at 10.0C. When exposed to a PFF of 1 $\mu mol \cdot m^{-1} \cdot s^{-2}$, Viola plugs satisfactorily stored for 16 and 10 weeks at 10C and 12.5C, respectively. Petunia plugs stored satisfactorily in the dark for 6 weeks at temperatures ranging from 0.0C to 5.0C.

619

CONTROL OF FLOWER INITIATION IN *PRIMULA VULGARIS* BY TEMPERATURE AND DAY LENGTH

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Flower initiation in *Primula vulgaris* 'Dania Lemon Yellow' was studied under photoperiods of 8, 11 or 14 hours, and temperatures of 8, 12, 16 or 20C. Instantaneous photosynthetic photon flux (350, 300 or 250 $\mu mol \cdot m^{-2} s^{-1}$) was selected to provide 10 $mol \cdot m^{-2} day^{-1}$ at the different day lengths. Early seedling development occurred at 16C. The seedlings were transplanted into 750-ml pots filled with a peat-lite medium, 30 days after sowing and placed under one of the selected environments. The transition of the meristem to a reproductive stage was determined using scanning electron microscopy. After transplanting, 30 to 50 days were required before a transition of the meristem could be observed in plants grown at the different photoperiods and temperatures. Flower initiation was detected earlier in plants grown under long photoperiods (14 hours) compared to 11 or 8 hours day length. Temperatures of 12 or 16C resulted in an earlier noticeable change in the apical meristem than 8 or 20C.

620

IMPROVING PRIMULA SEED GERMINATION BY CHEMICAL TREATMENTS

David C. McNertney* and David S. Koranski, Department of Horticulture, Iowa State University, Ames, IA 50011

Priming, scarification, stratification, GA and KNO_3 were used to improve germination rate and percentage of *Primula acaulis, P. obconica* and *P. polyanthus.* Priming treatments consisted of PEG and KH_2PO_4 as the osmoticants. PEG from 150 to 400 g/L with increments of 50 g/L and KH_2PO_4 from 0.05 to 0.25 M with increments of 0.05 M were used in aerated columns for 9, 12 and 15 days at 18C. Stratification was conducted at 1C for 1 to 9 weeks. Scarification involved using 98% sulfuric acid for 0.5, 1 and 2 min. GA treatments involved soaking for 8 and 72 hours in solutions of 10, 100. 300, 400, 500 and 600 ppm. Seeds were treated with KNO_3 at 0.1, 0.3, 0.5, 0.7 and 0.9 M either as an 8 hr soak or applied to the germination media. Priming with PEG or KH_2PO_4 always resulted in root tip damage and lower germination percentage as compared to controls. GA was the most effective treatment for improving germination.

621

EFFICACY OF UNICONAZOLE ALTERED BY APPLICATION METHODS

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In a series of experiments, uniconazole was applied seven days after planting to single-stem, vegetative *Dendranthema grandiflora* grown in 12.5-cm pots. Plant heights were determined at treatment and 14 to 21 days later, and results are expressed as stem elongation during this period. Uniconazole reduced elongation when applied as a drench, a whole plant spray, or to only the stems, but not when applied to only the leaves. Plants were given a whole plant spray of uniconazole at 10 or 20 ppm, and half the plants had the media covered to prevent spray solution entering the media. Plants with covered media had greater stem elongation than noncovered ones, and the effect was greater at the higher concentration. Uniconazole and daminozide were applied using spray volumes from 100 to 400 $ml \cdot m^{-2}$. Elongation decreased with increasing volume more with uniconazole than daminozide. For uniconazole, media cover had no effect at 100 $ml \cdot m^{-2}$, but the effect increased with higher spray volumes.

622

INTERACTION OF UNICONAZOLE AND GA_{4+7}, ON HIBISCUS GROWTH

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Hibiscus, *Hibiscus rosa-sinensis* cv Jane Cowl, received a soil drench of uniconazole at 0.2 mg/ 2.6-liter pot. Plants were pruned, allowed to grow, and then treated foliarly with GA_{4+7} at 0, 7.5 (once or 4 times every two weeks), 15 (once or twice four weeks apart), or 30 µM. One application at 30 µM, two applications at 15 µM and four applications at 7.5 µM were more effective in partially restoring stem elongation than other treatments. GA_{4+7}, regardless of concentration, had no effect on stem diameter which was small on all plants receiving uniconazole. Multiple applications of GA_{4+7} stimulated flowering, without affecting the flowering date. GA_{4+7} at 15 and 30 µM and four applications of 7.5 µM increased the rate of leaf production and total leaf area, but promoted the abscission of lower leaves. The size of individual leaves increased following GA,,, application. However, multiple applications of GA,,, were needed to maintain large leaf area on the uniconazole treated plants. Foliar treatment with GA_{4+7} (7.5 to 30 µM) had no effect on plants which did not receive uniconazole, except slightly increased leaf area at 30 µM.

623

INTERACTION OF PLANTING DATE AND GROWTH REGULATORS ON TWO POINSETTIA CULTIVARS.

Gary J. Wilfret*, Gulf Coast Research and Education Center, IFAS, Univ. of Florida, 5007 60th St. E. Bradenton, FL 34203

Poinsettia cvs Gutbier V-14 Glory and Gross Supjibi were grown in a shaded house (25% light exclusion). Rooted cuttings were panned on 8/23, 8/30, land 9/6/90, and pinched to 6 nodes on 9/6, 9/13, and 9/20, respectively. Supplemental lighting was provided at night from 9/15 to 10/5. Growth regulators chlormequat (2000 ppm) + SADH (1000 ppm), paclobutrazol (60 ppm), and uniconazole (5, 10 or 20 ppm) were applied. on 10/2, 10/9, and 10/16, respectively, at 204 ml m . Control plants of Glory were 44.1, 40.9, and 38.1 cm While Supjibi plants were 45.9, 42.3, and 35.4 cm tall with respect to planting date. Although hts. of untreated plants were similar, Supjibi exhibited a greater response to the pgrs than 'Glory.' optimum ht (30-35 cm) of Glory was attained in the 1st planting only with uniconazole at 20 ppm; in the 2nd planting, uniconazole at 10 or 20 ppm was needed; and all pgrs except uniconazole at 20 ppm produced acceptable plants in the 3rd planting. Supjibi required only 10 ppm of uniconazole in the 1st planting; 5 ppm uniconazole or the CCC + SADH combination in the 2nd planting, and 5 ppm uniconazole in the 3rd planting to yield plants within the optimum range.

125 ORAL SESSION (Abstr. 624-630) Root Environment

624

THE RELATIONSHIP OF CONTAINER VOLUME AND MEDIUM COMPOSITION TO CONTAINER MEDIUM TEMPERATURE PATTERNS

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Supraoptimal root-zone temperatures in container media reduce plant growth and increase the time necessary for container plants to attain marketable size. Computer simulation was used to study the effect of container volume on temperature patterns in similarly-shaped containers tilled with pine bark or pine bark : sand growth media. Container medium temperature patterns were sinusoidal. Model data elucidated that container medium temperature patterns adjacent to the container wall were not affected by changes in container volume or media type. However, at the center position in the container medium, changes in container volume or media type caused a phase shift associated with the sinusoidal temperature patterns, and changed the container medium temperature amplitude. The temperature amplitude was lower and occurred later in the day as container volume was increased, and was higher and occurred earlier in the day as the sand content in the container medium was increased. Simulation results suggest that the time necessary for plants to attain marketable size might he shortened when containers walls are exposed to solar radiation, if nursery operators minimize container medium sand content and shift plants to larger container volumes earlier in the production cycle than usual, or start plants in the container volume which they will be marketed.

625
INFLUENCE OF HIGH TEMPERATURE AND EXPOSURE TIME ON NITRIFICATION IN A PINE BARK MEDIUM
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Pine bark-filled containers periodically fertilized with a $(NH_4)_2SO_4$ solution were heated from 21°C to one of 5 temperatures (28°, 34°, 40°, 46°, or 52°C) for a daily exposure duration of 1, 2, 4, 6, or 24 hours. Medium solution extracts were analyzed for NH_4-N and NO_3-N every 5 days for 20 days. Treatment temperature of at least 40°C and a daily exposure duration of 24 hours was necessary to inhibit nitrification, thereby increasing NH_4-N concentration in the medium solution. Similar increase in NH_4-N was found for a 2 hr/day exposure to 46°C, with further increases in NH_4-N at longer exposure times. By day 10, the maximum level of NH_4-N concentration in medium extracts was found after a 1 hr/day exposure to 52°C. Decreases in medium solution NO_3-N concentration generally coincided with the increases in NH_4-N. Results indicate that high container temperatures may increase the ratio of NH_4-N to NO_3-N in the medium solution of plants fertilized with predominantly ammoniacal N.

626
COMPOSTING SEWAGE SLUDGE WITH WOODCHIPS
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This experiment was designed to examine the feasibility of composting sewage sludge with yard wastes. Yard waste (mostly prunings) were removed from the Provo, Utah garbage dumps, ground, and mixed with either 0, 20 or 40% digested sludge from the Provo sewage treatment facility. The first study utilized 1 year-old sludge and was placed in piles of approximately 1 m^3. The second study utilized fresh sludge and consisted of the products mixed and placed in windows 80 cm high. The temperature in the piles in treatment 1 failed to go above 35° C and in the second treatment only got to 55° C. Larger piles with different organic materials have achieved higher temperatures. Mineral analysis and plant growth data will be presented.

627
INFLUENCE OF SUPRAOPTIMAL ROOT-ZONE TEMPERATURES ON RUBISCO ACTIVITY, CHLOROPHYLL AND CAROTENOID LEVELS IN 'ROTUNDIFOLIA' HOLLY
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High root-zone temperatures have been shown to affect photosynthate partitioning, respiration, nitrogen nutrition and growth of 'Rotundifolia' holly. The loss of chlorophyll and protein in shoots of other plants in response to high root-zone temperatures has been documented. Therefore, the objectives of this research were to look at the effects of supraoptimal root-zone temperatures on RUBISCO activity, leaf protein and photosynthetic pigment levels.

Soluble protein levels in leaves increased linearly as root-zone temperature increased from 30 to 42 C. RUBISCO activity per unit protein and per unit chlorophyll responded quadratically to root-zone temperatures. Total chlorophyll, chlorophyll a & *b*, and carotenoid levels decreased linearly with increasing root-zone temperature. It is possible that 'Rotundifolia' holly was capable of redistributing nitrogen to maintain RUBISCO activity for photosynthesis.

628
RHIZOBIAL DIVERSITY OF BLACK LOCUST
Janet McCray Batzli* and William R. Graves, Department of Horticulture, University of Maryland, College Park, MD 20742
Peter van Berkum, USDA-ARS, SARL, Beltsville, MD 20705

Nitrogen fixation in legumes is enhanced by inoculating the host with more efficient strains of rhizobia. The objective of this study was to characterize the rhizobial diversity of black locust *(Robinia pseudoacacia* L.) for the selection of strains that are superior for nitrogen fixation. Seedlings were inoculated with soil samples collected from the root zones of legume trees throughout the United States. Bacteria were isolated from the nodules, subcultured and verified to be rhizobia. The antibiotic resistance, pH reaction, carbohydrate utilization, NaCl tolerance, enzyme activities, mean generation times, and protein profiles of the 189 isolates in the collection varied significantly between and within locations. Most of the isolates showed intermediate antibiotic resistance, high carbohydrate utilization, neutral to acid pH reaction, and generation times from S to 7 hr. The strains were grouped using numerical taxonomy techniques, and seedlings were inoculated with representative strains from each group. Nitrogen fixation, total nitrogen content, and plant growth varied significantly among seedlings inoculated with strains from the different groups.

629
WATER RELATIONS RESPONSE PLOTS OF LEAVES OF MYCORRHIZAL ROSA HYBRIDA L. IN DRYING SOIL
Robert M. Auge*, Ann J.W. Stodola and Xiangrong Duan, Dept. of Ornamental Horticulture. University of Tennessee, Knoxville, TN 37901

Past water relations studies (including ours) of mycorrhizal plants report various characteristics at one or two measures of soil moisture. Here we have constructed response plots over a range of soil water potential (Ψ_s) for leaves of mycorrhizal (M) and nonmycorrhizal (NM) rose plants. Such plots permit identification of breakpoints, zero points, etc., and more clearly depict treatment responses. In unacclimated plants, stomatal conductance (Cs)/ Ψ plots were similar for M and NM treatments until -1.0 MPa, below which M plants maintained slightly greater Cs. Cs of M plants was also usually higher at Ψ_s near 0 MPa. Both Cs and leaf water potential (Ψ_l) began declining at about -0.5 MPa Ψ_s; Ψ_l did not vary between M and NM plants. Drought acclimation (exposure to several drying cycles) succeeded only in increasing Cs variability in M and NM treatments and did not materially affect Ψ_s/ Ψ_l relationships. NM leaves typically had greater absolute and relative water content (WC) than M leaves. Ψ_l at zero conductance, near -2.8 MPa, was unaffected by mycorrhizae. Ψ_l at zero conductance was about -1.9 and -1.1 MPa for M and NM plants?, respectively. Cs began declining at similar Ψ_l in unacclimated M and NM plants. To summarize, there were subtle differences between M and NM treatments, such as greater Cs in M plants at very high and very low Ψ_s, yet plots relating Cs, Ψ_l, and Ψ_s were mostly similar. Leaf WC plots varied considerably between M and NM plants, hut it is difficult to speculate what advantage this might hold for either treatment.

630
AMMONIUM ACCUMULATION AND ETHYLENE EVOLUTION BY TOMATO INFECTED WITH ROOT-KNOT NEMATODE
Allen V. Barker* and Bert M. Zuckerman, University of Massachusetts. Amherst. MA 01003

Shoots of tomato plants (Lycopersicon esculentum Mill. 'Heinz 1350') infected with root-knot nematode (Meloidogyne incognita) accumulated ammonium and evolved ethylene. Ammonium accumulation and ethylene evolution increased as foliar symptoms of infection increased. Ammonium accumulation was higher in infected roots than in uninfected roots, but accumulation in roots was related inversely to symptoms appearing on shoots. Ammonium accumulation appears to precede ethylene evolution which may lead to symptomatology of the infection.

138 ORAL SESSION (Abstr. 631-638)
Cell and Tissue Culture: Somatic Embryogenesis & Organogenesis

631
SOMATIC EMBRYOGENESIS IN CARNATION
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Somatic embryogenesis was induced from internodal callus of 'Scania', 'Improved White Sim', and 'Sandra' carnation (Dianthus caryophyllus L.). The optimum protocol was to initiate callus in liquid basal medium based on MS salts and vitamins with 3 % sucrose and supplemented with 3.0 µM 2,4-D. Cell suspensions were sieved (pore size = 1mm) and filtrate was washed and subcultured in 2,4-D-free liquid basal medium for 60 days with one change after 2 days. Somatic embryos originated from single cells and early development proceeded conventionally (globular, heart-shaped, and torpedo stages), but clearly defined apical or root meristems were not always formed. Some embryos developed into seedlings and were acclimatized to ex vitro conditions.

632

INDUCTION OF SOMATIC EMBRYOS AND ADVENTITIOUS ROOTS FROM IMMATURE ZYGOTIC EMBRYOS OF JUGLANS CINEREA L.

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Forest populations of native Butternut trees are rapidly being depleted as a result of Butternut canker disease, incited by the fungus, Siroccocus clavigignenti-juglandacearum Propagation of existing selections will provide valuable germplasm for forest tree improvement. Open-pollinated fruits from a single specimen of J. cinerea were collected weekly in June and July 1990. Immature cotyledons were excised and placed on a modified Driver and Kuniyuki medium, with or without growth regulators, in the dark at 26°C. Somatic embryos developed directly on cotyledons collected 7-8 wk post-anthesis, and cultured for 3 wk on medium containing IBA, BA, and kinetin at 0.05, 4.4, and 9.3 µM, respectively; prior to transfer to basal medium. Non-embryogenic callus formed on some explants. Explants collected 8-10 wk post-anthesis failed to initiate somatic embryos, but adventitious root formation occurred. Explants initially cultured on medium lacking hormones also produced adventitious roots. Although somatic embryos were produced at low frequency, this study demonstrated that immature Butternut cotyledonary tissue is amenable to somatic embryo production.

633

THE EFFECT OF AUXIN TYPE ON INDUCTION OF SOMATIC EMBRYOGENESIS IN PECAN

Adriana M. Rodriguez* and Hazel Y. Wetzstein, Department of Horticulture, Plant Science Building, University of Georgia, Athens, GA 30602.

Somatic embryos were induced in cultures of immature pecan *(Carya illinoensis)* zygotic embryos. Explants were pulsed for one week on WPM nutrient media with either NAA or 2,4-D at 2, 6 or 12 mg/l. Cultures were then transferred to basal medium and maintained with monthly transfers to fresh medium. Observations were made of callus form and quantity, embryogenic frequency, and embryo morphology. Overall callus proliferation was more extensive in cultures induced on 2,4-D versus NAA. Repetitive somatic embryogenesis was obtained with all auxin treatments. However, somatic embryo morphology was affected by auxin type: embryos induced on NAA were more normal and more closely resembled zygotic embryos than those induced on 2,4-D. Higher levels of 2,4-D increased the occurrence of abnormal embryos.

634

ORGANOGENIC CALLUS INDUCTION AND SHOOT MORPHOGENESIS IN COMMON BEAN

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Induction of organogenic calli and shoot morphogenesis from undifferentiated callus in Phaseolus vulgaris (P.v.) has not been reported. Shoot tips and inflorescence bud initials were excised from 5 P.v. genotypes and placed on Gamborg's B_5 or Murashige and Skoog (MS) medium with 2 or 4% sucrose. Thidiazuron (TDZ) was used in the media at 0.5 mg/l with 0, 0.125, 0.25 or 0.5 mg/l Indoleacetic acid (IAA), or at 1 mg/l with 0, 0.25, 0.5 or 1 mg IAA/l. The basal media (OB_5 & OMS) were used as controls. Cultures were incubated at 25 C in darkness for one week followed by 5 weeks under 16-hr photo-period with 25µ Mol $s^{-1}m^{-2}$ from cool-white fluorescent tubes. Green compact regenerable calli were induced for 2 genotypes only from inflorescence explants. Percentages of explants producing calli ranged from 0 to 60. Callus pieces (40-50mg) were transferred to fresh induction media. After 3 weeks, proliferating calli were transferred to either maintenance or shoot differentiating media. Ten to 40 shoot primordia were observed per 40-50 mg callus after 3 weeks on differentiation media. Calli on maintenance media continued to proliferate and were still regenerable after 4-6 months.

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GIBBERELLIC ACID PROMOTES SPINACH REGENERATION

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Gibberellic acid (GA_3) is considered a non-essential compound for *in vitro* culture. A recent study, however, has shown that GA_3 was necessary for shoot regeneration of spinach *(Spinacia oleracea* L.). The present study was conducted to determine the minimal level of GA_3 required and to observe whether an increase in concentration further promotes regeneration. Callus was derived from leaf disks of 'High Pack' on MS medium supplemented with 0.5 mg L^{-1} 2,4-D, and 2 or 4 mg L^{-1} kinetin in the dark at 20±3C. The callus was transferred onto regeneration medium containin the corresponding concentration of kinetin (2 or 4 mg L^{-1}, 0.01 mg L^{-1} 2,4-D, and 0.0, 0.1, 0.25, 0.5, 1.0, or 2.5 mg L^{-1} GA, The cultures were exposed to a 10-h photoperiod (65 µE $m^{-2}s^{-1}$). Percentage of callus forming shoots was influenced by the concentration of GA_3 in the regeneration medium. regeneration ceased on a GA_3-free medium and was most predominant on a medium containing 2.5 mg L^{-1} G A_3 The higher kinetin concentration produced more callus proliferation but had minimal effect on shoot regeneration.

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SHOOT ORGANOGENESIS ON COTYLEDONS OF WATERMELON

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Cotyledons from seedlings of Jubilee II and small-seeded Dixielee were plated on MS medium with 3% sucrose and 0.7% T.C. agar. A factorial combination of BA at 0, 5, 10 and 20µM with at IAA 0, 0.5 and 5µM was tested to determine the best medium for shoot organogenesis. Shoots formed only on cotyledons incubated on media with BA The addition of IAA to the medium increased callus production and decreased shoot formation. Green meristematic protrusions, which resembled apical meristems, were observed on the base of enlarged cotyledons 9 to 12 days after initiation on medium with 10 or 20µM BA These protrusions subsequently formed shoots that could be rooted on MS medium with or without auxin. The effect of seedling age and dissection method on shoot organogenesis was also tested. The percentage of explants with shoots was greatest on cotyledons collected from 5-day-old seedlings. Cotyledons taken from older seedlings (10, 15 and 20 days), or removed directly from ungerminated embryos, displayed a reduced organogenic potential. The number of explants with shoots was also increased by dissecting cotyledons lengthwise compared to cross-section. The effects of kinetin and thidiazuron on shoot organogenesis were also investigated.

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PERENNIAL EMBRYOGENIC CELL CULTURES OF GRAPE

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Development and manipulation of grape *(Vitis* spp.) embryogenic cell cultures are described. Embryogenic cell lines are induced from anthers, ovules, pistils, leaves or zygotic embryos cultured on solidified MS or Nitsch's medium containing the plant growth regulators benzyladenine and either 2,4-D or NOA. Alternatively, the plant growth regulators GA and IAA are utilized for fertilized ovule explants. White or pale yellow embryogenic cell clusters are isolated from resulting calli for culture on basal media lacking plant growth regulators and transferred every six weeks. MS medium modified with 6% sucrose, 1/4 MS nitrogen salts and 0.2% charcoal is suitable for maintaining the cell lines. Culture growth is enhanced by utilizing low light, high medium-to-headspace volume ratios in culture vessels and careful discrimination of embryogenic cell type during transfers. Established cultures are composed of groups of homogenous, small, isodiametric cells (proembtyonal complexes) that give rise to somatic embryos. Such cultures have been maintained in this manner for over 6 years and are, therefore, distinguished as being perennial. This methodology has been successfully applied to both *Euvitis* and *Muscadinia* species.

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SOMACLONAL VARIATION IN STRAWBERRY: EFFECT OF HORMONE CONCENTRATION AND CALLUS AGE

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Effect of hormone concentrations and ageing of callus on the extent and nature of variation among callus culture regenerants of strawberry cv. Redcoat was examined. Plants regenerated from callus culture had reduced plant vigour, shorter petiole length and smaller leaf size, but more leaves and runners under greenhouse conditions. These responses appeared to be a physiological influence of growth hormones. No distinct phenotypic variants were observed at hormone concentrations in the range of 1 -10 µM each of BA and 2,4-D combination, but the highest concentration (20 µM each) of this combination produced a high frequency (10%) of dwarf type variants. The dwarf nature of these variants was maintained in the runner plants produced by the primary regenerants. The plants regenerated from 8 week-old calli did not show any distinct morphological variants. However, a significant proportion of deformed leaf shape (613%) and yellow leaf (21-29%) variants was obtained among plants regenerated from 16 and 24-week-old calli. The primary regenerants of leaf shape variants were established as chimeras. The chimeric plants produced runner progeny with normal plants and plants with completely distorted leaf morphology. Both leaf shape and yellow leaf variants remained stable through runner propagation. The isozyme analysis failed to distinguish any of the variants from the standard runner plants. The flow cytometric analysis indicated the aneuploid nature of leaf shape variants but it could not distinguish dwarf and yellow leaf variants from standard runner plants.

139 ORAL SESSION (Abstr. 639-646) Postharvest Physiology: Fruit

639
RELATING PREHARVEST FACTORS TO ENDOGENOUS ANTIOXIDANTS AND SUBSEQUENT SCALD DEVELOPMENT IN APPLES
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Scald susceptibility is greatly influenced by environmental conditions and may be related to the levels of endogenous antioxidants in the peel. Accumulation of these antioxidants may also be affected by preharvest factors. In 1989 and 1990 we studied the effects of maturity, light and preharvest temperatures (<10°C) on endogenous antioxidant levels at harvest and scald development after long term storage. Maturity differences were created by spraying Cortland apple trees with ethephon. Effects of light were determined by bagging apples 1 mo. prior to harvest. Samples from other trees were harvested after exposure to different numbers of hours <10°C. Preharvest hours <10°C were negatively correlated to scald development. Ethephon treatment decreased scald incidence and shading increased it, The total lipid-soluble antioxidant activity increased with increased hours <10°C and with ethephon treatment. Bagging slightly decreased levels. Ethephon treatment increased anthocyanin content but not that of total flavonols. Bagging decreased total flavonols and to a greater extent decreased anthocyanin. Other antioxidants are being determined.

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ATTEMPTING TO ADJUST SCALD CONTROL PRACTICES FOR APPLES FROM HARVEST-TIME PREDICTIONS OF SCALD POTENTIAL
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We have found that post-storage development of scald on Cortland and Delicious apples can be predicted from either OD 200 measurements of hexane extracts of apple surfaces at harvest, or from accumulation of hours below 10°C before harvest. However, use of weather records may be compromised by occurrence of long periods of temperatures continuously above 10°C after some temperature below 10°C already has been experienced.

We have investigated the capability to adjust the concentrations of DPA used for scald control, based on our predictions of scald susceptibility at harvest. Cortland and Delicious apples were harvested after experiencing different numbers of hours below 10°C. At each harvest. fruit were dipped in 500 to 2000 ppm of DPA. Results suggest that DPA concentration needed to control scald may be adjustable according to predictions of scald susceptibility.

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INDUCTION OF BITTER PIT-LIKE SYMPTOMS ON APPLES BY INFILTRATION WITH MG^{+2} IS ATTENUATED BY Ca^{+2}
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Golden Delicious apples (Malus domestica, Borkh) were vacuum infiltrated with various concentrations of Mg^{+2} and Ca^{+2} alone and in combination at concentrations ranging from 0.01 to 0.4 M as the chloride salt with 0.4 M sorbitol. Fruits infiltrated with Mg^{+2} alone and stored for 2 weeks at 20°C developed bitter pit-like symptoms that were positively correlated with Mg^{+2} concentration infiltrated. Infiltration with Ca^{+2} induced no bitter pit-like symptoms. Bitter pit symptoms induced by Mg^{+2} were decreased, or did not develop when Ca^{+2} was included in the infiltration medium. The native (endogenous) Ca concentration (ppm dwt.) of individual fruits was inversely related to the number of lesions induced by Mg^{+2} infiltration. Experiments are in progress to determine if Mg^{+2} infiltration can be used to predict susceptibility of apples to bitter pit in storage.

642
RETENTION OF CAPTAN ON APPLE AS AFFECTED BY FRUIT SURFACE CHARACTERISTICS
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Fruit of six apple cultivars were subjected to a 10 second dip in a dilute Captan solution to study the effects of cuticular variability on Captan retention. The effect of the fruits' environment and developmental stage on retention was assessed by repeating the experiment 3 times over the growing season. Cultivars differed significantly in their ability to retain Captan on their fruit surfaces. Five of the six cultivars significantly decreased over the season in their ability to retain the compound. One cultivar remained unchanged. The ranking among cultivars for retention changed dramatically with date, implying that environmental and/or developmental changes strongly influenced retention of Captan. Morphology and composition of cuticular waxes and their influence on surface wettability will be discussed.

643
ASSAY OF ACETYL CoA ALCOHOL TRANSFERASE IN 'DELICIOUS' APPLES
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Acetyl CoA alcohol transferase catalyzes the condensation of acetate and alcohols and is responsible for synthesis of esters important for flavor and odor perception in apples. Traditional methods of assay involve use of gas chromatographic techniques, a time-consuming, cumbersome procedure. Use of 5,5'-dithiobis-(2-nitrobenzoic acid) to react with free CoA generated from the esterification reaction results in a method for spectrophotometric assay of ester formation in cell-free extracts of 'Delicious' mesocarp tissues. Results of the assay are comparable to those obtained via gas chromatography. It is uncertain whether the enzyme responsible for catalysis is substrate-specific. The procedures described here could provide a useful tool for ascertaining the capacity for ester (hence flavor) biosynthesis in fruit tissues of differing genetic origin and developmental stage. Substantial differences in ester-forming activity are seen in apples held in different environments, as well as between strains of the 'Delicious' apple.

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AN ASSESSMENT OF RIPENING QUALITY IN PEACHES IMPORTED FROM CHILE
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A study was conducted to measure the capability of imported Chilean peaches to ripen during the 1990-1991 shipping season. Samples were taken weekly from the Port of Philadelphia. On each sampling date, a random sample of 24 fruits of each of three cultivars were taken. Fruits were brought to the postharvest laboratory in College Park for evaluation. After one day at 20°C ethylene evolution rate was measured on each individual fruit, in a static system. Ground color, overcolor, dehydration, firmness, soluble solids and physiological disorders were also measured. A subsample of 12 fruits were measured again after holding at 20°C for 7 days. A wide range in shipping quality was observed among peach cultivars. Correlations between ethylene evolution and the other measured variables were calculated. A general overview of peach maturity on arrival and peach quality after ripening will be presented.

645
PHYTOTOXIC RESPONSE OF TANGERINE FRUIT TO HOT MOIST AIR QUARANTINE TREATMENT FOR MEXICAN FRUIT FLY
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Tangerines grown in Mexican fruit fly (Anastrepha ludens Loew) infested areas require disinfestation prior to marketing in fly free areas. Early season, degreened tangerines (Citrus reticulata Blanco) were size graded and subjected to experimental hot air treatments at 45, 46, and 48C for periods of one, two, three, and four hours. Phytotoxic responses of fruit to heat treatments were evaluated immediately after treatment and at weekly intervals during three weeks post treatment. Heat treated and non heat treated fruit were evaluated for

total soluble solids, titratable acidity, total sugars, ascorbic acid, fruit weight, juice yield, flavedo color, and sensory attributes. Percent mortality of nonfeeding, third instar larvae was measured for each time temperature combination with water baths simulating the heating and cooling profiles of heat treated fruit. A darkening of the flavedo and a change in flavor was observed at prolonged, higher temperatures. A lower incidence of storage decay was observed in heat treated fruit.

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USE OF SEMPERFRESH AS COATING OF CITRUS FRUIT

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With increasing health concerns worldwide, this study aims to compare Semperfresh (SF), a polysaccharide ester, to commercial wax coating on lemon fruit. Three concentrations of SF (1, 2 and 4%) were used and compared to a recommended standard wax concentration. Assessment period was 30 and 60 days of storage at 20°C. After 30 days of storage, fruits treated with SF at 4% were greener than all other treatments. However, no differences in fruit color were observed after 60 days. Rind firmness, acid content and total soluble solids were not affected by either treatment but fruit quality was better than that of non-treated fruit. Fruit weight loss was significantly reduced by wax and 1 and 2% of SF. However, fruits treated with SF at 4% showed more weight loss. Percent fruit decay was significantly higher for waxed and non-treated fruit. In conclusion, SF may have a potential use as coating material for citrus.

140 ORAL SESSION (Abstr. 647-654) Genetics and Breeding: Germplasm II

647

PEDIGREE®: A PROGRAM TO TRACE AND DRAW FAMILY TREES BY MICROCOMPUTER

Shahrokh Khanizadeh*, Michel Lareau and Deborah Buszard, Agriculture Canada, St-Jean-sur-Richelieu, Que. Canada J3B 3E6 and McGill University, Que, Canada H9X 1C0

Breeders often wish to know the pedigree of known cultivars which have potential as parents. Family trees, and listings of plant and fruit characteristics are usually done manually, which is labor and time-consuming. A special software package, 'Pedigree®', has been developed for professional breeders and those who desire records of the known cultivars. Pedigree® is written for a strawberry breeding program but can be readily adapted to other small fruits since several characteristics, incorporated in the data file, are common to all. In its present form Pedigree® can be applied to apples. pears, cherries and peaches. Although some of the characteristics in the program may not be pertinent, the program is easily modified to accomodate these horticultural crops. Pedigree® allows the user to select one of the 18 crops in the data file. Functions include add, delete, modify, search, print and draw for any genotype file. More than forty characteristics can be entered for each genotype. Pedigree® is available for IBM/PC/XT/AT/PS and compatible machines that have 512K memory (ROM) and a hard disk. A 80286/386 processor is recommended for data files having more than 1000 records. A diskcopy of Pedigree® can be obtained from the author (SK) for $50.00.

648

MULTIVARIATE ANALYSES OF MORPHOLOGICAL TRAITS USED TO DISCRIMINATE AMONG SPECIES, INTERSPECIFIC HYBRIDS AND CULTIVARS OF IMPATIENS

Virginia D. Lerch * and Timothy Ng, University of Maryland, Department of Horticulture, College Park, MD 20742.

An Impatiens collection grown at the U of MD, College Park was evaluated for thirty-two morphological characteristics. The collection consisted of two replications of forty putative species collected in the 1970 plant expedition co-sponsored by USDA-ARS and the Longwood Foundation (Kennett Square, PA), nine putative interspecific hybrids, nine New Guinea breeding lines and five progeny selected from crosses among these lines. Quantitative data were collected on plant height and width, stem length, leaf length and width, petiole length, flower and eye zone diameter, and spur length. Qualitative data included: plant habit; stem, leaf and flower color; flower type and location; spur shape; type of leaf margin; leaf apex and base form; and leaf arrangement. A discussion of the usefulness of these characteristics to discriminate among Impatiens species, interspecific hybrids and cultivars based on cluster and other multivariate analyses will be presented.

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PROGRESS IN THE DEVELOPMENT OF A *MENTHA* GERMPLASM COLLECTION

Henrietta L. Chambers*, Barbara M. Reed, Joseph D. Postman and Kim Hummer, USDA/ARS NCGR, 33447 Peoria Rd., Corvallis, OR 97333

Approximately 450 accessions representing 40 taxa from around the world, including 77 advanced breeder selections and 54 F1 hybrids are maintained at the repository in Corvallis. Most of the clones came from the collection of M. J. Murray of the A. M. Todd Company, Kalamazoo, MI. Others were received from the former USDA/ARS mint breeding program in Corvallis which ended in 1981. Data on origin, morphology, pedigree, oil analysis, fertility and chromosome number was provided with many of the accessions. We have confirmed the identity of the clones utilizing many of these features. We are actively seeking unrepresented germplasm. Chromosomes from pollen mother cells or root-tip cells are currently being counted. Nomenclature changes reflecting recent research have been made. Many clones have been indexed for viruses. Infected clones are treated with thermotherapy and meristem culture to produce virus-negative replacements. An in vitro backup collection is maintained in cold storage. Iniation of in vitro cultures has been complicated by internal bacterial contamination in some clones. Research to eliminate this problem is in progress. Cuttings and in vitro cultures of *Mentha* germplasm are available to researchers worldwide.

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CRANBERRY GENETIC RESOURCES

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About 100 to 150 cranberry cultivars, *Vaccinium macrocarpon* Ait., have been developed during the last 150 years. Less than 10 of these were obtained from controlled hybridizations of cranberry breeding programs. The remainder were selected directly from wild North American populations. At the USDA/ARS Germplasm Repository in Corvallis, Oregon, 39 cultivars and 16 selections from wild populations in 7 states are being established in an upland, dry-harvest field collection. Additional cultivars and native selections will be acquired. Native material of *V. oxycoccos* L., little cranberry, from 6 locations in Maine, Alaska, and Scandinavia, and 29 accessions of *V. vitis-idaea* L., lingonberry, from 8 countries are in the collection. Evaluation of this germplasm for flowering, fruiting and other characteristics will be reported. The genome of *V. macrocarpon* has been described as small and relatively undifferentiated, similar to that of blueberry. Thus far we have observed fruit shape differences and a yellow-fruited-mutant which demonstrate examples of genetic diversity within this taxon.

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EVALUATION OF *RUBUS* GERMPLASM FROM THE ECUADOREAN ANDES M. M. Thompson*, USDA/ARS NCGR, 33447 Peoria Rd., Corvallis, OR 97333

Seeds and herbarium specimens of 47 accessions from 11 *Rubus* taxa native to the Andean Region of Ecuador were collected in October and November 1990 and deposited at the USDA/ARS Germplasm Repository in Corvallis, OR. Plants will be grown from these seeds and evaluated for taxonomic identity and potential breeding value. Characteristics of the plants will be discussed. Taxa obtained include: *R. adenothallos* Focke, *R. acanthophyllus* Focke, *R. bogotensis* Kunth, *R. coriaceus* Poiret, *R. glabratus* H.B.K., *R. glaucus* Benth., *R. robustus* C. Presl., *R.* roseus Poiret, *R. urticifolius* Poiret. These taxa will contribute unique genes to the improvement of *Rubus* crops by breeders throughout the world. Seeds may be requested from the curator, USDA/ARS NCGR-Corvallis.

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GENETIC VARIABILITY IN TOTAL AND AVAILABLE IRON CONTENT OF *AMARANTHUS* SPECIES

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Iron deficiency anemia is one of the most prevalent nutritional deficiencies affecting the world's population, especially among women and children of lesser developed countries. Green leafy vegetables have been described as good sources of Fe due to their high total Fe content. However,

research has demonstrated that high total Fe does not always correspond with high biologically available Fe. The purpose of this study was to examine genetic differences in total and available Fe within a genus of green leafy vegetable. Amaranth was chosen based on its popularity as a green vegetable in many LDCs. Forty lines of vegetable type *Amaranthus,* surveying 12 species, were chosen from the collection at the plant introduction station at Ames, Iowa. These lines were direct-seeded at the MSU Horticulture farm. 18 were harvested three times, on day 28, 35, and 42 from seeding, and the other lines were harvested only on day 35. The leaves were rinsed, frozen, lyophilized and ground. Total Fe content was determined by atomic absorption spectroscopy. An invitro assay simulating gastrointestinal digestion was utilized to estimate diffusible, available Fe. Changes in availability over the three harvest days as well as differences between and among species for Fe availability were determined.

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ISOZYME VARIATION IN CULTIVATED EXACUM AFFINE AND EUSTOMA GRANDIFLORUM GERMPLASM.

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Genetic diversity among cultivars and breeding lines of Exacum affine and Eustoma grandiflorum was investigated using starch electrophoresis to detect isozyme variation. Variation in banding patterns for diaphorase (DIA), esterase (EST), isocitrate dehydrogenase (IDH). malate dehydrogenase (MDH), phosphoglucomutase (PGM), 6-phosphogluconate dehydrogenase (PGD), and phosphohexose isomerase (PHI) has been found. For Exacum, at least 2 distinct banding patterns occur for DIA, IDH, MDH, PGM, PGD, and PHI and for Eustoma, 3 banding patterns for DIA and 2 patterns for EST, IDH, and MDH have been found. Isozyme variation can assist in cultivar identification during early seedling stages and should be useful for genetic marker studies of Exacum and Eustoma.

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EVALUATION OF PRUNUS CERASUS GERMPLASM FOR COLD RESISTANCE

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Genetic variability for cold resistance in stems and dormant buds was characterized using differential thermal analyses and visual browning. Collection occurred over nine months from, mid-August to mid-April, for 36 cultivars and seedlings of the Michigan State University Prunus cerasus (sour cherry) germplasm collection. High temperature exotherms (HTEs) and low temperature exotherms (LTEs) were detected over time in the stems and buds of each sample. Genetic variability was observed in tissue susceptible to freeze injury throughout the season. Vegetative buds and xylem were the most susceptible in mid-winter; however, the phloem/cambium region was the most susceptible during acclimation in almost all samples. The cortex remained the most resistant throughout the season. Median LTEs were closely correlated to xylem lethal temperature scores (LTs) derived from visual browning following temperature/survival freezing tests. Genetic and seasonal variability existed in initiation time, magnitude, end occurrence temperature for LTEs. HTEs exhibited variability in magnitude and occurrence temperature.

141 ORAL SESSION (Abstr. 655-662) Vegetables: Establishment and Management

655

OSMOTIC PRIMING LEEK SEEDS TO IMPROVE GERMINATION AND EMERGENCE AT HIGH TEMPERATURE.

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Leek (Allium porrum L.) cv. Verina seed germination is drastically reduced at temperatures above 25°C. Seeds of leek were osmotically primed in aerated solutions (-15 bars, 10 days at 15°C) of D-mannitol, polyethylene glycol-8000 (PEG_s), KNO_3, and a non-aerated solution of PEG-8000 (PEG_{na}). The seeds were dried-back before sowing. The treatment effects were assessed under different environmental conditions. Significant negative correlation between germination and temperature was observed in all the treatments and control on a germination table. At constant temperature (30°C) in a growth chamber, mannitol, PEG_s and PEG_{na} treatments increased emergence over a control. These same three treatments had a significantly higher coefficient of velocity (CV) compared to the control and KNO_3 treatments. In a growth chamber with alternating day/night temperatures (38/28 or 32/22 C, 14/10 hrs respectively), primed seeds had significantly higher emergence and CV compared to the control. In a greenhouse with alternating day/night temperature (34/25 C), the emergence of primed and non-primed seeds was not significantly different; however mannitol, PEG_s, and PEG_{na} had significantly higher CV compared to the control or KNO_3 treatments.

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GROWTH AND YIELD OF PEPPER TRANSPLANTS AND DIRECT-SEEDED PLANTS

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Daniel J. Cantliffe, University of Florida, Gainesville, FL 32611

Pepper cv. 'Jupiter' plants were field-grown from containerized transplants produced with either overhead (SPl) or sub-flotation (SP2) irrigation, or from direct seeding, in 3 years. Shoot and root growth were measured at frequent intervals. At planting, SPl transplants had larger basal root length and numbers than SP2 transplants. At the end of the growth period, basal, lateral, and taproot dry weights accounted for 81, 15, and 4% of the total for transplants, and 25, 57, and 18% of the total for direct-seeded plants. The coordination of growth (linear logarithm relationship) between root and shoot, changed after fruit set only in transplants. Over all seasons, transplants exhibited significantly higher yields than direct-seeded pepper plants.

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EFFECT OF SEED TYPE AND WITHIN-ROW SPACING ON STAND ESTABLISHMENT AND YIELD OF 'YUKON GOLD' IRISH POTATO

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The effect of two 'Yukon Gold' potato *(solanum tuberosum* L.) seed types (whole and cut of comparable weight) and within-row spacing (WRS) of 15, 20, and 25 cm on stand establishment and yield were evaluated in 1990. The seed-type x WRS interaction was not significant for all measurements reported. 'Yukon Gold' stems emerged earlier and more uniformly and total tuber set and marketable yield were higher from whole-tuber seed than from cut seed pieces. Total tuber set and marketable yield were higher at 15 cm than at wider WRS.

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EFFECT OF SEED TUBER (SOURCE) ON POTATO PRODUCTION IN GEORGIA

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The objective of this study was to compare the performance of potato crop produced from tubers produced in Georgia and Maine. A split-plot experiment with 10 genotypes and 3 seed-tuber sources (S1 = tubers produced during spring-summer in Georgia, S2 = tubers produced during summer-fall in Georgia, and S3 = tubers produced in Maine), was conducted from 12 March to 2 July 1990 at Fort Valley, Georgia. The genotypes were arranged in main plots whereas sub-plots consisted of tuber sources. At 60 days after planting (DAP), the S3 recorded highest tuber yield (28.9 MT/ha) which was significantly greater than S1 and S2. At 100 DAP, the mean tuber yield of S1 (31.2 MT/ha) and S3 (32.3 MT/ha) were not statistically different. The percent dry matter was not affected by the tuber source whereas S1 and S3 had greater number of tubers per plant as compared to S2. The interaction between seed tuber source and genotype was significant for tuber yield. These results indicate that locally produced tubers may possibly be used to plant the next crop, thus eliminating the usually high cost associated with import of seed tubers from northern states.

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RELATIONSHIP BETWEEN DRY MATTER ACCUMULATION, NUTRIENT UPTAKE AND YIELD OF SWEETPOTATO.

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It is difficult to predict or estimate the storage root yield of sweetpotato (Ipomoea batatas) because there appears to be so much variation among cultivars. A study was initiated to investigate the relationship between early dry matter accumulation, nutrient uptake and storage root yield in three sweetpotato cultivars, "Jewel', 'Georgia Jet' and 'Carver II'. Vine dry matter at 90 and 120 days as well as leaf dry matter at 90 days after planting were positively correlated with total and marketable yields in 'Carver II'. Vine dry matter was also

significantly correlated to storage root yield in 'Jewel' at 120 days after planting. Leaf nitrogen content was negatively correlated with storage root yield in 'Georgia Jet' and 'Carver II' at 60 days, and in 'Jewel' at 90 days after planting. Leaf phosphorus content was negatively correlated with storage root yield in 'Georgia Jet' and 'Carver II' at 60 days, but positively correlated at 90 days after planting. The N:K and N:P ratios were negatively correlated with storage root yield in 'Jewel' and 'Georgia Jet' at 90 days. It would appear that storage root yield of 'Jewel' and 'Georgia Jet' sweetpotato cultivars can be predicted using leaf N:K and N:P ratios.

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INTERCROPPING TOMATO AND SWEET POTATO AT DIFFERENT PLANTING METHODS
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A comparative study of different planting methods in intercropping of tomato and sweet potato was conducted at BAR1 during November, 1989 to April, 1990. Tomato was planted within sweet potato rows, between two rows of sweet potato in single row and tomato + sweet potato in paired row methods. A spacing of 60×40 cm was maintained for both the crops except in paired row method where the spacing was 30×30 cm. Sweet potato as mono crop produced the highest tuber yield 22.93 followed by 20.25, 17.65 and 16.74 t/ha when tomato was grown in sweet potato in paired row method, between rows and within row respectively. Tomato as sole crop produced highest yield 36.56 followed by 31.96 and 28.0 t/ha where it was planted between rows and within row respectively. Highest land equivalent ratio (LER) 1.64 and net return with benefit cost ratio 2.60 were recorded when tomato was planted between rows. It indicated that planting tomato between sweet potato rows was better compared to other methods.

661
FACTORS INFLUENCING FUNGICIDE RESIDUES ON RAW PROCESSING TOMATOES AND IN TOMATO PRODUCTS
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Field studies were conducted to determine fungicide residue accumulation using several crop management strategies on processing tomatoes (Lycopersicon esculentum Mill.) Residues of EBDC, ETU, chlorothalonil, and anilazinc on raw, unwashed, unpeeled tomatoes and tomato juice were quantified. Data from Ohio studies indicate that maximum tomato fungicide residues arc only 20-25% of EPA tolerance levels and Nat'l Acad. of Sci. estimates. Residues can be further reduced by (1) alternating fungicides, (2) substituting disease resistant cultivars, (3) using weather-based disease forecasting systems (TOM-CAST) to reduce total fungicide applications and (4) using decreascd fungicide rates in early stages of plant development. Decreasing fungicide rates resulted in a 33 to 53% fruit residue reduction without influencing tomato yield or quality. (TOM-CAST) reduced total season sprays from 10 to 4 with no change in yield or anthracnose (Colletotrichum coccodes) infected fruit. Results indicate that it is the total fungicide amount applied per growing season rather than the interval from final spray to harvest that determines residue on raw processing tomatoes.

662
LEVELS OF DIMETHYL SULFIDE AND ITS PRECURSOR IN SWEET CORN AS INFLUENCED BY GENOTYPE AND HARVEST MATURITY
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Dimethyl sulfide (DMS) has been identified as the compound responsible for the characteristic odor and flavor of cooked and processed sweet corn. In the attempt to improve the flavor potential of sweet corn, thirty-one genotypes were surveyed to determine the level of DMS in the kernel, and its relationship to harvest maturity. DMS contentvaried significantly with genotype and harvest maturity. In each case, DMS was observed to decrease with maturity of the kernel. Values obtained ranged from 3.0 to 20.6 µg DMS/g sample. Based on their DMS content, six genotypes were selected for measurement of the heat-labile DMS precursor S-methyl methionine (MMS), along with methionine (Met). Kernels contained from 53.0 to 397.5 µg MMS/g sample, and from 32.8 to 108.9 µg Met/g sample. Similar to DMS, MMS and Met levels in kernels differed significantly among genotypes and decreased as kernels matured. DMS levels were closely correlated with MMS (r^2=0.84) content, and to a lesser degree (r^2=0.42) with Met.

142 ORAL SESSION (Abstr. 663-669) Tree Fruit: Propagation

653
A VERSATILE NEW TACTIC FOR FRUIT TREE MICROGRAFTING
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Micrografting is an effective technique for elimination of viruses, early diagnosis of grafting incompatibilities, rejuvenation of mature tissue, and bypassing the juvenile phase in fruit trees. Current micrografting procedures are difficult, impractical, expensive, and generally result in an inefficient rate of successful graft production. In order to alleviate some of these limitations, a unique apparatus was designed to splice the in vitro-derived scion and rootstock together during the micrografting process. The dual-layer device was constructed with a pliant outer layer to facilitate manipulation during the grafting of micro-scale plants, and a delicate, absorbent inner layer to cushion the plant tissue and retain hormones and other compounds. These chemicals are slowly released at the grafting zone to alleviate oxidation and enhance callus formation at the cut surface of scion and rootstock. After healing, it is easy to remove the grafting apparatus from the grafted plant without damaging the tissues. This apparatus may be used to unite a scion and a rootstock with different stem diameters. Shoot-tip cultures of 'McIntosh' and 'M-7' apple and 'North Star' sweet cherry, and in vitro seedlings of lemon, orange and grapefruit were used as a source of in vitro scions and rootstocks. Successful graft unions were developed, and the grafted plants were transplanted into the greenhouse environment Micrografted plants were sectioned to determine the anatomical characteristics of the graft union.

664
ANATOMICAL OBSERVATIONS OF ADVENTITIOUS ROOT FORMATION IN *MALUS DOMESTICA* MICROCUTTINGS
James F. Harbage* and Dennis P. Stimart, Department of Horticulture, University of Wisconsin, Madison, WI 53706.

Correlations were made between physiological and anatomical studies on adventitious root formation in micropropagated *Malus domestica*. Root formation was examined in response to water, 1.5 µM 1H-indole-3-butyric acid (IBA), 48.3 mM sucrose (S), and IBA + S. Root formation was also studied in relation to duration of inductive treatment using 0, 24, 48, 72, and 96 hrs. Rooting percentage and root number after 2 weeks post induction development were highest with IBA + S, low in S, end absent in IRA or water treatments. Similarly, 10 um paraffin embedded sections had 10-12 root primordia (RP) per microcutting when induced in IBA + S, and l-3 per microcutting induced in S only. Microcuttings induced in water or IBA alone had no RP. In l-2 µm epoxy embedded sections, RP development was complete within 4-5 days. Prior to induction treatment, essentially all living cells in the basal l-3 mm o microcuttings were tilled with a central vacuole. First response to induction medium occurred within 24 hrs of incubation as evidenced by occasional secondary phloem parenchyma cells with densely staining cytoplasm, numerous small vacuoles, and visible nucleoli, By 48 hours most phloem parenchyma was active with tangential and radial divisions evident. By 72 hours areas of localization, RP, were evident. By 96 hours most dividing cells were organized into primordium developing through the cortex. Implications of the time course of anatomical events in relation to common rooting procedures will be discussed.

665
'STEM BANDING ENHANCES ROOTING AND SUBSEQUENT GROWTH OF M.9 AND MM.106 APPLE ROOTSTOCK CUTTINGS
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Softwood shoots of apple rootstocks M.9 and MM.106 were banded with Velcro for up to 20 days prior to propagating cuttings. Percent rooting and root number of cuttings were significantly improved by banding for 10 20 days both with and without 1H-indole-3-butyric acid (IBA) application. Stem banding resulted in earlier budbreak, a higher survival rate and longer new shoot growth of transplanted cuttings of M.9 after 4 months. Percent budbreak and new shoot growth were highly correlated with root number of cuttings. The effects of Velcro stem banding on budbrcak and subsequent growth of the cuttings were largely due to the enhanced rooting of cuttings.

666
INCREASING BRANCHING OF ORNAMENTAL PEAR TREES WITH PROMALIN AND DIKEGULAC-SODIUM
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One-year-old trees of 'Bradford', 'Aristocrat' and 'Redspire' pear on 'OHxF 97' were treated in a nursery with foliar sprays of Promalin at 750 and 1500 ppm and dikegulac-sodium (Atrimmec) at 8000

and 16000 ppm in June of 1989. While untreated trees of all three cultivars averaged less than 1 lateral per tree at the end of the season, those treated with Promalin at either concentration averaged over 10. Dikegulac also promoted branching of all three cultivars but, unlike Promalin, it reduced height growth and resulted in unacceptably narrow crotch angles.

163 ORAL SESSION (Abstr. 670-677)
Vegetables: Postharvest Physiology

667
REGULARITY AND MODIFICATION OF SEX EXPRESSION IN MONOECIOUS PERSIMMON
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With 4 monoecious persimmon cvs., Fujiwara-gosho, Zenji-maru, Toh-hachi, and Hana-gosho, one-year woods which bore staminate or pistillate flowers were tagged respectively and the sex of flowers on the shoots developed from those woods were investigated in the following spring. In all cvs.. there was an obvious tendency that shoots arising from staminate bearing woods bore staminate flowers predominantly, especially with Fujiwara-gosho, whereas shoots from pistillate bearing woods produced pistillate flowers preferably. Trials to convert staminate to pistillate flowers by treatment with BA at 1000ppm were conducted at earlier stages after bud break with cvs. Zenji-maru, Shogatsu, and Seihakuji. By this treatment, the pistillode of staminate flower became functional and set a fruit. The effect was more pronounced in lateral than central flower of the cyme, indicating the importance of timing of the treatment.

668
GERMINATION OF ASIMINA TRILOBA AND A. PARVIFLORA
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A. triloba and *A. parviflora* seeds were stratified for 0 to 9 weeks followed by planting under shade of 0%, 30%, 55%, 80%, and 100%. Seeds were planted 4 Apr. 90 in the field in soil fumigated previously with methyl bromide. Factorial combinations of shade, species, and stratification were arranged in split-split-plots with the shade as main plots in a completely random design with 6 replications. Seedling emergence was evaluated at weekly intervals from 7 Jun. until 26 Nov. The percentages of seeds that germinated were 15%, 32%, 40%, 43%, and 44% for shade of 0%, 30%, 55%, 80%, and 100%, respectively ($p<0.1\%$). The corresponding average dates of germination were 12 Aug., 12 Jul., 11 Jul., 9 Jul., and 27 Jun. ($p \leq 0.1\%$). *A. triloba* germinated in higher percentages, 53% vs. 17% ($p \leq 0.01\%$) than *A. parviflora and* sooner, 26 Jun. vs. 19 Aug. ($p<0.01\%$). Percent germination and the average date of emergence were independent of stratification ($p > 5\%$), and all interactions were nonsignificant ($p>5\%$). The implications of these results will be discussed.

669
ROOTSTOCK SPROUTS RETARD EARLY SCION GROWTH OF CITRUS NURSERY PLANTS
Jeffrey G. Williamson*, Fruit Crops Department, University of Florida, Gainesville, FL 32611.

Experiments were conducted with Carrizo citrange *[Citrus sinensis* (L.) Osb. x *Poncirus trifoliata* (L.) Raf.] seedlings budded with 'Hamlin' orange [C. *sinensis* (L.) Osb.] to determine the effects of rootstock sprout number and location on scion growth of citrus nursery trees. In one experiment, 1, 2 or 4 rootstock sprouts per plant grew for 1, 2 or 4 weeks immediately following scion bud forcing. In another experiment, rootstock sprouts developed either above or below the bud union. No interaction was observed between sprout number per plant and the length of time sprouts remained attached to plants. Sprout development during the first or second scion flush reduced stem length, leaf area and dry weight of scions but did not affect root or whole plant dry weight. Reduction of scion growth increased with increasing sprout number and with increasing length of time that sprouts remained attached to nursery plants. Plants with sprouts above the bud union had reduced scion leaf number, scion leaf dry weight and total scion dry weight when compared to plants with sprouts below the bud union.

670
PEROXIDATION OF ISOLATED MICROSOMAL MEMBRANES TO SIMULATE POSTHARVEST STRESS RESPONSE.
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Peroxidation of membrane lipids has been implicated in postharvest disorders such as chilling injury and desiccation, but it is not clear whether peroxidation is a cause or an effect of the disorder. In an effort to better understand membrane stress response, microsomes were isolated from fresh cowpeas and cauliflower and challenged by peroxidative and hydrolytic conditions. Cauliflower microsomes were 12 times more susceptible to peroxidative attack than cowpea microsomes, but the cowpea microsomes were 5 times more susceptible to phospholipid hydrolysis than cauliflower microsomes. Preincubation with phospholipase A_2 enhanced susceptibility of cowpea microsomes to peroxidation by 33% but decreased susceptibility of cauliflower microsomes by 15%. The marked differences noted emphasize the complexity of degradation of lipids in plant membranes and provide excellent models to simulate and study stress response.

671
RESPIRATION AND ETHYLENE PRODUCTION IN BELL PEPPER AND CAULIFLOWER AS INFLUENCED BY PRIOR LOW-0_2 STORAGE
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The respiration and ethylene production of many commodities are decreased in response to low $p0_2$. In this study, bell pepper and cauliflower were examined to determine their respiratory/ethylene response to low $p0_2$. Continuous exposure of cauliflower to 3% 0_2 decreased CO_2 production by about 30%, whereas $CH_2=CH_2$ production was unaffected. upon return to air following 24, 72 or 120 hr, the CO_2 production rate attained values similar to those observed for the air-stored controls within 24 hr. In bell pepper fruit, storage under 4% 0_2 decreased CO_2 production by about 32%. Ethylene production was low (≤ 0.5 µl/kg hr) and unaffected by the low 0_2. Unlike cauliflower, the CO, production of bell pepper was significantly reduced (27%) after 24 hr low-0_2 storage followed by 24 hr in air. Thereafter, respiratory activity recovered slowly. Studies are underway to determine whether this residual low-0_2 effect is due to changes in mitochondrial oxidative capacity.

672
POSTHARVEST QUALITY OF SINGLE UNIT BROCCOLI
Lewis W. Jett*, Mosbah M. Kushad, and Ronald D. Morse. Department of Horticulture, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061-0327.

Broccoli *(Brassica oleracea L.* var. italica) has a relatively short postharvest life. This study was conducted to determine if shrink-film wrapping is as effective as top icing in preserving postharvest quality attributes of single unit broccoli (i.e. broccoli equivalent in mass to a single bunch of broccoli). After storage for 14 and 22 days, the wrapped single unit broccoli was compared to the top iced broccoli. Quality attributes evaluated were vitamin C (ascorbic acid), chlorophyll, fresh weight, and compactness. The top iced broccoli required continual icing during storage, while the wrapped single unit broccoli never received ice during storage. Wrapping maintained ascorbic acid and chlorophyll content, reduced fresh weight loss, and preserved hedonic attributes as effectively as top icing. Shrink-film wrapping is a potentially viable alternative to top icing for postharvest quality maintenance of single unit broccoli.

673
INFLUENCE OF POSTHARVEST CHEMICAL TREATMENTS, TIME OF IMMERSION AND PLASTIC FILMS ON RHEOLOGICAL PROPERTIES AND QUALITY OF ARTICHOKE BUDS.

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Artichokes (Cynara scolymus L.) buds were immersed in solutions of $CaC1_2$, ascorbic and citric acid. Immersion times:a) 10 hrs + 14 hrs out of sol. + 7 hrs b) 10 hrs. Stem length: 12 and 20 cm. Plastic film: perforated and low-permeability films. Storage conditions: 3 wks at 3 and 10°C, 80% R.H. $CaC1_2$ treated samples showed visible blackening, higher weight loss but a higher resistance to compression. Short stems resulted less firm and a-type immersion produced firmer buds. 10 ppm asc. acid resulted the best treatment to keep the quality as well as the perforated film (6 holes/in^2.). Logarithmic elaboration of deformation values versus l/applied load provided interesting results to define morphological and qualitative characteristics

674
PHYSIOLOGICAL MANIFESTATIONS OF CHILLING INJURY IN PROCESSING AND NON-PROCESSING TOMATO CULTIVARS

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Differences in sensitivity of 8 processing and 8 non-processing tomato cultivars to chilling injury packaged in sealed and non-sealed low density polyethylene bags were evaluated after 21 days at 7-8°C, 21 days at 7-8°C + 1 day at 30°C and 21 days at 7-8°C + 2 days at 30°C respectively. Parameters investigated were bioelectrical resistance, electrolyte leakage, in-package and in-fruit Co_2 and C_2H_4 production, firmness, percentage fresh weight losses, percentage decay-free and percentage marketable fruits. Among processing cultivars Advantage was least sensitive while Caraibe was most sensitive to chilling injury. Similarly, for non-processing cultivars Walters was least sensitive while Carnival was most sensitive to chilling injury.

675
IMPROVING POSTHARVEST KEEPING QUALITY OF VINE-RIPENED TOMATO FRUITS WITH A NATURAL LIPID.

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Ethephon application on tomatoes faces two problems: 1) Enhanced leaf senescence and defoliation that leads to sunscald damage to the fruit. 2) Increase in percentage of over-ripe fruits and decrease in their postharvest keeping quality. Vines of Heinz 7155 tomato were sprayed with lysophosphatidylethanolamine (LPE, 100 mg. $Liter^{-1}$) and fruits were harvested two weeks or 20 days later. LPE was able to accelerate tomato fruit ripening and increase the percentage of red tomato without defoliation. Fruits from the plants sprayed with LPE had better storability than from the control or ethephon sprayed plants whether the fruit was harvested at blush or at red stage. During the postharvest storage LPE treated fruits had lower respiration rate. The application of ethephon together with LPE mitigated the adverse influence of ethephon. Our results suggest: a) LPE has the potential to be used as a tomato fruit ripening agent without the adverse effects of ethephon b) LPE can improve the postharvest storability of tomato fruits, c) LPE can be used as a fruit ripening aid together with ethephon

676
ETHANOL INHIBITS RIPENING OF TOMATOES AT VARIOUS MATURITIES WITHOUT AFFECTING SUBSEQUENT QUALITY

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Ethanol, a natural compound produced by tomato fruit *(Lycopersicon esculentum* Mill.) under anaerobic atmospheres, reversibly inhibits the ripening of mature-green tomatoes. Exposure to ethanol vapors for 4 to 6 hr inhibits ethylene action and synthesis for 5 or more days before normal ripening continues. In this series of experiments we investigated the inhibitory effect of ethanol on ripening of tomatoes harvested at various stages of maturity. Fruit were exposed to 0, 2, or 4 ml ethanol/kg in a 20-L jar for 0, 2, 4, or 6 hr at 20C. Ripening was measured as changes in firmness, subjective color, and production of carbon dioxide and ethylene. Soluble solids content, pH and titratable acidity were measured at the end of the storage period when the fruit were red-ripe. The ripening inhibitory property of ethanol was not confined to mature-green fruit, but also inhibited the ripening of breaker, turning and light-pink tomatoes. Inhibited fruit subsequently ripened at 20C to the red-ripe stage after a 5 to 7 day delay with no reduction in quality. Treatment at 20C and holding at 15 or 12C prolonged the delay in ripening, and only marginally effected quality.

677
VIBRATION INJURY IN TOMATO FRUIT.

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Up to 80% of the retail value of produce can be attributed to postharvest operation. In turn, roughly 80% of postharvest operations are spent in the transport phase, mainly in truck trailers. Previous work by the USDA and others has shown that a specific vibration frequency causes injury to grapes and strawberries, while slight force in excess of 1G causes failure to tomatoes to ripen normally.

Mature green tomatoes were harvested and packaged in fiberboard cartons (10KG). Boxes were vibrated at 1.1G for 0 and 5 min in one test and for 0, 5, 10, 15, and 20 min in a second, then held at 20°C for 10 days. In the first test fruit exhibited uneven of "blotchy" ripening, where areas of the surface and subsurface remained green while the rest of the fruit ripened normally. In a second test, fruit exhibited increased C_2H_4 and CO_2 evolution with increased treatment time after 5 hrs. This was typical of a wound response. However, these elevated levels remained high throughout the 10 day holding period. In some treatments, fruit showed "blotchy" ripening similar to the first test, but results were not consistent. These results, in combination with microscopy and cellular leakage studies, will be discussed.

164 ORAL SESSION (Abstr. 678-684) Vegetables: Growth and Development

678
GROWTH OF A LETTUCE CROP IN NASA's BIOMASS PRODUCTION CHAMBER

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Lettuce (Lactuca sativa cv. Waldmann's Green) plants were grown in a large, tightly sealed chamber for NASA's Controlled Ecological Life Support Systems (CELSS) program. Plants were started by direct seeding and grown in 64 0.25-m^2 trays (six plants per tray) using nutrient film technique. Environmental conditions included: 23°C, 75% relative humidity, 1000 ubar (ppm) $C0_2$, a 16/8 photoperiod, and 300 umol $m^{-2}s^{-1}$ PPF from metal halide lamps. Although the chamber was typically opened once each day for cultural activities, atmospheric ethylene levels (measured with GC/PID) increased from near 15 ppb at 23 days after planting (DAP) to 47 ppb at 28 DAP. At harvest (28 DAP), heads averaged 129 g FW or 6.8 g DW per plant, and roots averaged 0.6 g DW per plant. Some tipburn injury was apparent on most of the plants at harvest. By 28 DAP, stand photosynthesis rates for the entire chamber (approx. 20 m^2) reached 17.4 umol $CO^2m^{-2}s^{-1}$, while dark-period respiration rates reached 5.5 umol $CO_2m^{-2}s^{-1}$. Results suggest that good yields can be obtained from lettuce grown in a tightly sealed environment.

679
CUCUMBER FRUIT GROWTH RATES

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Two cultivars of pickling cucumbers were measured for fruit growth rate. In order to predict the optimum time for mechanical harvest of pickling cucumbers, the relative growth rate of the fruit needs to be known. The two cultivars of cucumber used in this study were Calypso, a large leaf cultivar, and H-19 a little leaf cultivar. These varieties were chosen for the previously observed differences in fruit growth rates. Plants were grown in a

greenhouse. Selected flowers were hand pollinated, and fruit length and diameter were measured until the fruit diameter was greater than 57 mm. The treatments consisted of combinations of 1, 2, and 3 fruit on three adjacent nodes of a plant. The fruit growth rates for the single fruit were the greatest, while one fruit would be the dominant fruit in the combinations of 2 and 3 fruit. Fruit growth rates for H-19 were significantly slower than Calypso, however the competition from adjacent fruits was not as great. Fruit growth curves and growth rates will be presented.

680
INTERRELATIONSHIPS OF SEVERAL SEED GARLIC PHYSIOLOGICAL PARAMETERS ON CROP PRODUCTIVITY AND QUALITY
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Seed garlic grown in environment of higher elevation and lower temperatures resulted in larger bulbs than seed grown in lower elevation, Mediterranean climate. Regardless of seed source, relationship between seed clove size and resultant bulb size was positive and linear within seed clove sizes of lg. to 5g. Multiplication factor, however, was inverseley related to seed clove size. Total yield increased curvilinearly as a function of plant population within the range of 35,000/ha to 85,000/ha. Bulb size distribution was significantly influenced by population. Economic analyses are required in decision of "optimum" seed production system involving seed source, seed clove size and plant population.

681
RELATIVE ENVIRONMENTAL ADAPTATION OF BELL PEPPER CULTIVARS ACROSS THREE SOUTHEASTERN STATES
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Four commercially available bell pepper cultivars *(Capsicum annuum* L.) were evaluated for yield stability over a combination of 3 years. 3 planting dates, and 7 locations across the Carolinas and Georgia. Stability analysis is most frequently performed as a breeding tool with a large number of genotypes in relatively few environments and environments varying in only one respect, either years or locations. In this study, the reverse was emphasized in an attempt to evaluate the adaptation of commercially available cultivars to a broad geographic region. Although each cultivar (GatorBell, Hybell, Skipper, and Keystone Resistant Giant #3) was found to be responsive to environmental change, the stability of response was variable. An individual cultivar was characterized as having environmental stability if the weight of marketable fruit was above the average of all cultivars across all environments, both favorable and unfavorable with a minimal deviation between environments [a regression coefficient ≤1 and a coefficient of linear determination (R^2) value >50%].

682
TOMATO FRUIT CRACKING: CULTURAL, ENVIRONMENTAL, DEVELOPMENTAL AND GENETIC PIECES OF THE PUZZLE
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Fruit cracking in tomatoes is generally attributed to erratic watering, but can also occur where soil moisture levels are reasonably constant, as in irrigated, phytotron or greenhouse culture. The hypothesis that overwatering can cause cracking in these situations was examined in the greenhouse for 2 fall and 1 spring tomato crops. In fall '89 and spring '90, the treatment receiving the least water also had the least cracking, but differences were not significant for fall '90. Total fruit number and fruit weight were not significantly affected by watering treatments in any of the crops. Solar energy and temperature were tested for their effect on fruit cracking. In fall '90 when nighttime temperatures were maintained below 21C by airconditioners, % fruit cracking decreased significantly because total number and weight of fruit increased more than the number and weight of cracked fruit. A developmental pattern was also seen in that both fall and spring crops had a higher percentage cracking in the upper clusters. This pattern held up even though fruit number per cluster decreased through the season for the fall crop, but increased through the season for the spring crop. Significant differences between cultivars were also seen in most of the experiments.

683
DIURNAL FLUCTUATIONS IN SIZE OF TOMATO FRUIT
Juan Carlos Diaz-Perez* and Kenneth Shackel, Department of Pomology, University of California, Davis, CA 95616.

Tomato fruits showed diurnal fluctuations in size in addition to long-term irreversible enlargement. Diurnal fluctuations were highly related to the stage of fruit development. In all stages, the maximum relative growth rate occurred in the morning and the minimum RGR at midday. Midday depression of RGR became more severe as fruits developed. In young fruits, RGR was nearly constant over the day. A small depression in growth was observed only at midday. In more developed fruits, RGR was positive during the first half of the day, followed by near zero values in the afternoon, and a. recovery in early night. In mature fruits, overall fruit growth was minimum and RGR was positive only in the morning. Fruit shrinkage was often seen at midday in mature fruits.

684
ALTERNATIVE FRESH MARKET TOMATO PRODUCTION SYSTEMS: POSTHARVEST QUALITY AND ECONOMIC RETURN
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The objective of this study was to evaluate the productivity and economic performance of three distinctly different fresh market tomato production systems. These systems differed in level of inputs (cost of materials, labor and management) and pest control strategies. The high infrastructure/synthetic chemical (HC) system used more intensive inputs (eg. staking, plastic mulch, tickle irrigation, pest scouting) and a range of synthetic and biological materials to control pests when they reached the economic threshold. The high infrastructure/biological materials (HB) system also used the more intensive inputs including the incorporation of compost to provide N fertility and alter soil properties while using only biological materials to control pests. The low infrastructure/synthetic chemical (LC) system used less intensive inputs and synthetic chemicals to eradicate or prevent the establishment of pests. Yields from the HC, HB and LC systems were respectively, 80.5, 78.1 and 65.3 MT/ha total marketable yield and 42.3, 40.3, 39.8 MT/ha No. 1 fruits. Marked differences in fruit characteristics and storability from the three systems were also observed.

165 ORAL SESSION (Abstr. 685-692)
Small Fruit: Culture and Management

685
HORTICULTURAL. POTENTIAL OF VACCINIEAE INDIGINEOUS TO ANDEAN ECUADOR
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In the Andes of Ecuador, the Vaccinieae (tribe with inferior ovaries in the subfamily Vaccinioideae of the Ericaceae) has diverged into approximately 20 genera. In addition to Vaccinium, these include such genera as Cavendishia, Ceratostema, Macleania and Psammisia. Andean blueberry (Vaccinium floribundum) is extremely variable morphologically and occurs across a wide altitudinal gradient (900-3800+m). At higher altitudes, frost can occur any night of the year, so it is promising as a source of genes for frost resistance during bloom. Fruits are harvested for sale in local markets. It is also an attractive ornamental. Cavendishia, Ceratostema Macleania and Psammisia are components of shrub-paramo and/or cloud forest communities (800-3500m). Flowers are large, brightly-colored, often spectacular, and hummingbird pollinated. Experience with these genera at the NY Botanical Garden indicates they can often be trained as desirable plants for pot and/or hanging basket culture. Therefore the latter 4 genera have potential as new floricultural crops.

686
EFFECT OF NITROGEN SOURCE AND APPLICATION TIME ON HIGHBUSH BLUEBERRY PERFORMANCE
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A five year study was conducted in a mature planting of 'Bluecrop' bushes on a sandy loam soil in Grand Junction, MI. Treatments included an unfertilized control and urea (76 kg N/ha) applied once at bud break or in two applications (split) at bud break and petal fall. Other treatments included controlled release fertilizers (CRF) of two residual effects (Osmocote 3 mo., Osmocote 8 mo.) applied at 38 or 76 kg N/ha

at bud break. The effects of treatments on fruit yield, bush size (total cane cross-sectional area) and leaf N levels were monitored. Fertilized bushes were larger, produced higher yields and contained higher leaf N levels than unfertilized controls. Urea (single or split) resulted in similar leaf N levels, yields, and bush size as CRF at the same N rate. Bushes receiving split urea treatments contained higher leaf N levels during some years and produced slightly higher total yields than bushes receiving single urea applications. The duration of CRF (3 or 8 mo.) did not significantly affect yields, bush size or leaf N levels. Low rates (38 kg N/ha) of CRF products resulted in lower yields and leaf N levels and smaller bushes than high rates.

687
LOWBUSH BLUEBERRIES RESPOND TO DIAMMONIUMPHOSPHATE
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Nutrition surveys in Maine have indicated that most lowbush blueberry fields have P levels below 0.125%, the standard leaf tissue concentration. This study was conducted on a commercial field with a very low P leaf concentration (0.096%). Diammoniumphosphate (DAP) was applied preemergent to treatment plots at 0, 6.4, 12.8, 19.2, or 25.6 kg/ha P in 1987 and again in 1989 at 0, 22.4, 44.8, 67.2, or 89.6 kg/ha P. A RCB split block design used 6 blocks with pruning methods (flail mow or oil burn) split across fertilizer treatments. The highest DAP rates raised leaf P levels to 0.111% and 0.120% in 1987 and 1989, respectively. Stem length and number of flower buds per stem increased linearly with increasing DAP rate in 1987 and 1989. Yield increased linearly with DAP rate in 1990 but not in 1988. There were no interactions of fertilizer treatment and pruning method on nutrient levels, stem length or number of flower buds per stem in 1987 or 1989. Burned plots yielded higher than mowed plots in 1988 and 1990.

688
ICE DISTRIBUTION AND VASCULAR DEVELOPMENT IN BLUEBERRY FLOWER BUDS
Cindy L. Flinn* and Edward N. Ashworth, Department of Horticulture, Purdue University, West Lafayette, IN 47907

A relationship between the location of vascular tissues and the distribution of ice crystals has been noted in peach and forsythia flower buds. A similar hypothesis was tested with Vaccinium corymbosum 'Berkeley'. Vascular development was assessed by monitoring the movement of apoplastic tracers and the examination of fixed specimens. Individual florets were cleared using a NaOH/bleach protocol. Observations on xylem development were compared with ice crystal distribution in frozen sections and the location of voids in freeze-fixed bud tissue. Xylem vessels appeared to extend into reproductive tissues which were devoid of evidence of ice formation in anatomical studies.

689
BEE POLLINATORS OF CRANBERRY (VACCINIUM MACROCARPON AIT.) IN THE CAPE COD AREA OF MASSACHUSETTS
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Very little information is known about the native bee fauna of cranberry. This study was sent up to assess the diversity and abundance of bee pollinators of cranberry in the Cape Cod area of Massachusetts. Observations and collections were done on three different habitats: cultivated bogs, abandoned bogs, and natural sites. Numbers and species varied on different sites. Bumble bees were common on all three habitats, while honey bees were abundant only on cultivated bogs. Other bee species were of low abundance especially on cultivated fields. Bee diversity was highest on abandoned bogs. Implications of this work on the development of pollination schemes utilizing key native bee species will be discussed.

690
SEASONAL CHANGES IN PHOTOSYNTHESIS AND NONSTRUCTURAL CARBOHYDRATES IN FRUITING VS. VEGETATIVE CRANBERRY UPRIGHTS
Marianna Hagidimitriou* and Teryl R. Roper, Department of Horticulture, University of Wisconsin, Madison, WI 53706

Nonstructural carbohydrate content in cranberry (Vaccinium macrocarpon Ait.) tissue is highest early in the season and then decreases just before and during bloom. The low carbohydrate content observed during the early bloom and fruit set periods might be one factor responsible for low fruit set observed in cranberry. This study was undertaken to ascertain the differences in carbohydrate content between fruiting and vegetative upright shoots as well as older horizontal stems and roots. Carbohydrate content was always higher in uprights than stems. Starch content was higher in vegetative uprights than fruiting uprights at bloom but the differences in starch content declined as the season progressed. Soluble sugar content was similar in fruiting and vegetative uprights. Rates of net photosynthesis (Pn) in cranberry were measured in the field using an ADC LCA-3 infrared gas analyzer. Pn in cranberry increased early in the season, but was steady after canopy development. These data suggest that current season photosynthates are important for flower and fruit development in cranberry.

691
FIELD PERFORMANCE OF MICROPROPAGATED AND CONVENTIONALLY PROPAGATED RED RASPBERRY (RUBUS IDEAUS L.)
Ribo Deng*, Danielle Donnelly and Deborah Buszard, Department of Plant Science, Macdonald College of McGill University, Ste-Anne-de-Bellevue, Quebec, Canada H9X 1CO.

Micropropagated (MP) and conventionally propagated (CP) 'Comet' and 'Festival' red raspberry were examined in the field for two seasons (1989, 1990). MP plants established better than CP plants and were more vigorous than CP plants during the first but not the second growing season. Micropropagation had no effect on winter hardiness of either cultivar. MP plants produced more primocanes than CP plants, especially during the second growing season. No differences in primocane or floricane leaf photosynthesis were found. MP 'Festival' berry yields in the first fruiting season were 1/2-1/3 the yields of commercial plantings in the province while yields from CP 'Festival' and MP and CP 'Comet' were negligible. No variant plants were found in the MP plant population. Results indicated that the MP plants are superior to CP planting stock for both propagation and fruit production.

692
INFLUENCE OF GENOTYPE AND ENVIRONMENT ON YIELD COMPONENTS OF THREE PRIMOCANE-FRUITING RED RASPBERRIES.
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'Autumn Bliss', 'Heritage' and 'Redwing' cultivars were studied in 1989 and '90 at 6 locations ranging in latitude from 42°02' to 47°31' to determine environmental effects on their yield components. Vegetative (cane density, height, diameter, number of nodes), reproductive (length of fruiting section, number of fruiting laterals, flowers, berries, harvest dates) and environmental (solar, ppt, soil and air temp., nutrition) data were collected. In most instances, 'Redwing' had the greatest yield potential, i.e. greatest number of flowers per cane, but the greatest harvested yield was obtained with Autumn Bliss. 'Redwing' showed that greatest variability among locations and between years. 'Autumn Bliss' and 'Redwing' were unable to produce marketable yields in areas with lees than 2300 mean-annual corn heat units (CHU) while 'Heritage' required greater than 2600 CHU. In all instances, 'Heritage' was the least precocious cultivar.

166 ORAL SESSION (Abstr. 693-700) Genetics and Breeding: Disease and Insect Resistance

693
THE CONTROL OF GENETICALLY CAUSED DISORDERS IN REGISTRATION AND CERTIFICATION PROGRAMS
Dale E. Kester, Department of Pomology, University of California, Davis, CA 95616

Registrationand Certification programs for controlling viruses in vegetatively propagated cultivars rely on (a) single plant selection within the cultivar, (b) maintenance of foundation trees under controlled conditions to prevent reinfection, and (c) increase and commercial distribution from limited generations of sequential propagation. Viruses and other systemic organisms are identified by transmission and/or biochemical indexing tests as foreign bodies within plants of the cultivar. The potential for reproducing the correct cultivar and/or detecting latent somatic variants is not so readily assessed. Examples include noninfectious bud-failure (almond), nonproductive syndrome (almond), deep,

suture and crinkle (cherry), and rusty blotch (plum). Visual inspection and/or field performance are the only basic tools available for their detection. A distinction must be made between visual inspection of the source plant (phenotypic selection) and visual inspection of the progeny plants (genotypic selection). A program of "clonal" selection to control disorders in almond is described. Problems in terminology of the clone will also be discussed.

694

INHIBITION OF PROSTAGLANDIN ENDOPEROXIDE SYNTHASE AND LIPOXYGENASE BY ANACARDIC ACIDS.

R. A. Grazzini, D. Hesk, E. Yerger, C. C. Reddy, G. Hildenbrandt, J. Medford, D. Cox-Foster, R. Craig and R.O. Mumma*. Departments of Horticulture, Entomology, Biology and veterinary Science, Penn State University.

Anacardic acids, the allelochemicals responsible for small pest-resistance in geranium, inhibit two enzyme systems known to be involved in arthropod reproduction: prostaglandin endoperoxide synthase and lipoxygenase. Inhibition by anacardic acids results from the interaction of both the carboxyl and phenol portions of the anacardic acid molecule with the enzyme. The length and degree of unsaturation of the anacardic acid acyl chain are also involved in the inhibition response.

695

INHERITANCE OF MORPHOLOGICAL AND BIOCHEMICAL CHARACTERS ASSOCIATED WITH PEST-RESISTANCE IN GERANIUM.

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Small pest-resistance in geraniums results from the presence of omega-5 unsaturated anacardic acids in the exudate of glandular trichomes present on the epidermis. Exudate composition is under simple genetic control. A dominant allele at a single locus confers the presence of omega-5 unsaturation, and the resistant phenotype. A pair of complementary epistatic loci interact to modify the frequency of individual anacardic acids within the total exudate. A small number of loci appears to confer high densities of glandular trichomes. No linkage was observed between any of the biochemical and morphological characters examined.

696

THE EFFECT OF SELECTION FOR MULTIPLE DISEASE RESISTANCE ON CUCUMBER YIELD

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Cucumis bardwickii (CH) possess a sequential fruiting habit which is not present in commercial cucumber (C. *sativus* L.; CS). Preliminary experiments using resistant (R) and unselected-susceptible (S) paired CS x CH derived lines indicated that R lines were lower yielding than their S counterparts. Experiments were designed to determine whether selection for resistance to 3 pathogens reduces yield potential in CH derived lines. The yield potential (fruit number and weight) of 3R and 3S (unselected) sister F_4 CH derived lines were tested in Hancock, XI and East Lansing, MI in 1990 over 4 harvests under replicated conditions. The locations produced different results. In MI, all 3 of the U lines out-yielded their R counterparts based on weight (kg); 2 of the S lines produced more fruits per plant than the R lines. In WI, only 1 S line produced more fruits per plant than the R line. Results indicate that the parental line used in line development and the testing environment are important factors in yield expression of CH derived germplasm.

697

INHERITANCE OF RESISTANCE TO TOMATO SPOTTED WILT VIRUS IN A LYCOPERSICON ESCULENTUM CULTIVAR

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An F_4 population from South Africa of a cross made between 'Stevens', a reported tomato spotted wilt virus (TSWV) resistant cultivar and 'Rodade', a susceptible cultivar, was screened for resistance. Cuttings of 11 F_4 plants were inoculated twice with five isolates of TSWV originating from Arkansas, Hawaii, and Texas along with a mix of these isolates. Based on visual inspection and conformation with enzyme-linked immunosorbent assay (ELISA), these plants showed no infection. Susceptible checks, however, became severely infected. Four resistant F_4 plants were crossed with two susceptible advanced Arkansas breeding lines. Backcrossed (BC) and F_2 generations were produced from each of the F_4 x Arkansas lines. A total of 744 F_2's and 774 progeny of BC's were tested. All susceptible checks became severely infected according to ELISA. Chi-square testing indicated that the inheritance is a dominate single gene.

698

GENETICS OF THE NECROTIC REACTION TO LETTUCE MOSAIC VIRUS IN LETTUCE

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The gene *Momo* controls reactions to lettuce mosaic virus (LMV) in lettuce and its close relatives. Mo- produces a mottling reaction, while *momo* produces either a mild reaction or immunity, depending on the virus strain. Several cultivars react to LMV with necrotic lesions. Two crosses were made to study the inheritance of the necrotic reaction. Prizehead (nec.) x 86-197-2-l-4 (res.) gave F_2 and F_3 results indicating a single gene with necrotic dominant. Deer's Tongue (nec.) x Salinas (mot.) gave F_2 and F_3 results indicating a single gene with necrotic dominant. Only two phenotypes appeared in the the segregating generations of each cross, indicating an allelic series with necrotic > mottled > resistant.

699

SUSCEPTIBILITY OF VITIS GENOTYPES TO CROWN GALL

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Agrobacterium tumefaciens biovar 3 (AT3), the causal organism of crown gall in grapes, appears to enter vineyards through systemically infected nursery stock. Although AT3 can be eliminated from grapevines, an earlier study found that plants become rapidly reinfected in AT3 infested soils. With the goal of developing a rootstock to protect AT3 susceptible scion cvs. in infested vineyards, 25 Vitis genotypes were screened. Gall formation and development of systemic infection were evaluated after inoculations with each of five AT3 strains of diverse origins. Vitis genotypes varied widely in frequency of gall formation and ultimate gall size. 'Cabernet Sauvignon', 'Blanc du Bois', 'Tampa', V. cordifolia, V. yenshanensis, and V. tiliafolia formed galls of large size at virtually every inoculated site. One V. amurensis selection and the rootstock variety 101-14 Mgt produced galls at a low percentage of inoculated sites and resultant galls were small. All genotypes tested, including those previously reported to be resistant, formed galls at least occasionally. Development of systemic AT3 populations appeared to be highly variable.

700

VARIATION IN SUSCEPTIBILITY OF ENGLISH WALNUT *(JUGLANS REGIA)* TO WALNUT BLIGHT, AND THE RELATIONSHIP BETWEEN SUSCEPTIBILITY AND THE RETENTION OF OVERWINTERING PATHOGEN POPULATIONS.

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Walnut blight of English walnut *(Juglans regia)*, caused by *Xanthomonas campestris* pv. *juglandis (Xc juglandis)*, causes significant crop loss worldwide. Leaves and nuts of mature walnut cultivars were inoculated *in vivo* with *Xc juglandis* to determine if genetic variation in susceptibility to blight exists within the English walnut germplasm maintained in California. A two year study indicates significant differences in susceptibility, based on leaf and nut abscission following infection, lesion size and frequency, and the salability of infected nuts. Overwintering buds on branches that bore moderately infected foliage the previous season were more frequently infested than buds from lightly or severely infected branches. Results suggest that sufficient genetic variation exists to facilitate breeding for resistance to walnut blight.

175 ORAL SESSION (Abstr. 701-707) Woody Ornamentals/Landscape/Turf: Stress

701
EFFECTS OF ABA AND IRRADIANCE LEVEL ON PHOTOSYNTHESIS OF STAGE III *ARONIA ARBUTIFOLIA* MICROCUTTINGS
Wilfredo Colón*, Terril A. Nell and Michael E. Kane, Department of Environmental Horticulture, IFAS, University of Florida, Gainesville, FL 32611

Microcuttings of *A. arbutifolia* were grown for 30 days in woody plant medium supplemented with either 0, 2 or 4 mg·liter^{-1} abscisic acid (ABA) and 2 mg·liter^{-1} indole-3-butyric acid (IBA) before being transferred to a growth room providing irradiance levels of 450 (Low) and 650 (High) µmol $m^{-2}s^{-1}$. Leaf carbon exchange rates (CER) decreased proportionally with increased ABA levels after 30 days in vitro and 10 days after transfer. Under the high irradiance level, CER rates were lower than under the low irradiance level. At 20 and 27 days after transfer, all treatments had similar CER rates, ranging from 5.31 to 5.07 µmol $CO_2 m^{-2} s^{-1}$, respectively. Shoot length was reduced at each ABA level throughout the sampling period (0, 10, 20 and 27 days) in low and high irradiance levels. Total leaf area per plant was reduced up to 20 days after transfer, while total number of roots per plant were decreased with increased ABA levels at 0 and 10 days only. Microcuttings placed under the high irradiance level had a greater reduction in total leaf area per plant, shoot length and total number of roots per plant than plants at the low irradiance level. Stomatal density increased as ABA concentration increased after the 30 days of in vitro culture. However, stomatal density was similar in all treatments 27 days after transfer regardless of the ABA treatments or irradiance levels. Assuming in vitro applications of ABA cause a decrease in stomatal conductance, ex vitro establishment of microcuttings could possibly be enhanced by reducing transpiration rates.

702
ETHYLENE STIMULATION OF CELLULASE ACTIVITY AND TISSUE ABSCISSION: THE AFFECT OF ORGAN TYPE, TEMPERATURE, AND ETHYLENE CONCENTRATION IN CAMELLIA
Allan B. Woolf*, John Clemens, Julie A. Plummer and Edna Pesis, Department of Horticultural Science, Massey University, Palmerston North, New Zealand

Export of potted Camellia plants from the southern to the northern hemispheres necessitates manual removal of floral buds. We have shown that ethephon can be used to selectively remove floral buds from potted Camellia plants. This relies on utilizing the greater sensitivity to ethylene released from ethephon of floral buds relative to leaves. Using a range of ethylene concentrations, floral buds abscised at lower ethylene concentrations than leaves. Removal of applied ethylene resulted in cessation of abscission. Exogenous ethylene promoted ethylene production by the tissue. Temperature affected organ sensitivity to applied ethylene with an asymptotic response of ethylene concentration to time at 50% abscission for both floral buds and leaves. Cellulase activity increased in abscission zones of Camellia over the ethylene-stimulated abscission process. Cellulase activity of different plant organs and of different maturities is currently under examination.

703
TRANSPLANTING SUCCESS OF OVERGROWN SYCAMORE TREES GROWN IN FABRIC BAGS.
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Seedling trees were planted in the ground with or without fabric bags May 1987. Trickle irrigation was provided. March 1990, bag-grown plants were transplanted by hand and trees without bags were transplanted with a 1.1 m tree spade. A sample of bag-grown trees and trees without bags were dug with the tree spade and washed for root and shoot analysis. The objective of this study was to determine root growth and transplanting success of Eastern sycamore (Platanus occidentalis) field grown in fabric bags.

Caliper and height were not different between bag-grown trees and trees without bags. Bag-grown trees had 81% more root mass than trees without bags; however, bud break of the transplanted trees was delayed nearly 4 days for the bag-grown trees.

704
AN ANATOMICAL STUDY OF SPRING LEAF TATTER *IN ACER SACCHARUM*
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Spring leaf tatter in maple typically occurs in young, developing leaves. It is characterized by tip injury of lobe(s), often with a water-soaked appearance, and/or tearing in the intercostal area(s). Different cultivars of *Acer saccharum* exhibit varying degrees of tatter symptoms. In order to explain this variation, an anatomical study between less susceptible 'Legacy' and more susceptible 'Green Mountain' was begun in 1989. Leaves were sampled monthly at the research site in Wichita, Kansas, and subsequently fixed in FAA, dehydrated, embedded in paraffin and stained for observations using light microscopy. Using transverse sections, measurements were made of the cell layers of each sample and then compared between cultivars. Although the leaves of both cultivars were generally similar, those of 'Green Mountain' were markedly thicker overall (148.9 µm) and had a higher percentage of the leaf thickness (46.4%) occupied by spongy mesophyll. By comparison, 'Legacy' was thinner (126.9 µm) with less of the leaf (38.9%) occupied by spongy mesophyll. These differences may play a major role in explaining the greater susceptibility of 'Green Mountain' to spring leaf tatter.

705
CORRELATION OF IN VIVO AND IN VITRO HERBICIDE TOLERANCE OF ORNAMENTAL GRASSES
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Greenhouse screening tests were conducted to determine the tolerance of selected ornamental grasses to cyclohexanedione (sethoxydim) and aryloxyphenoxypropionate (fenoxaprop, fluazifop and quizalofop) herbicides. The four blue fescues tested were tolerant at the whole plant level, whereas Erianthus, Panicum and Pennisetum were sensitive to all herbicide treatments. Partially purified acetyl-coenzyme A carboxylase (ACCase), the proposed biochemical site of herbicide action, was assayed to quantify herbicide tolerance in vitro. Assays were conducted in the presence of fluazifop or sethoxydim to calculate I_{50} values. For the blue fescues the ACCase I_{50} values for fluazifop were 3,000 to 3,600 fold greater than Pennisetum (I_{50}=0.2 µM), and for sethoxydim were 1,200 to 2,100 fold greater than Pennisetum (I_{50}= 1.0 µM). Thus, tolerance at the whole plant level was correlated with tolerance at the enzyme level for the species tested.

706
WEED SUPPRESSION AND HERBICIDE TOLERANCE OF WOODY GROUNDCOVER SPECIES
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When planted on 15 cm centers, 6 woody groundcover species (Diervilla sessilifolia, Potentilla 'Longacre', Rhus aromatica 'Gro-low', Rosa 'Nearly Wild', Stephanandra incisa 'Crispa', Symphoricarpos 'Hancock' and Symphoricarpos 'Magic Berry') effectively reduced the numbers and dry weight accumulation of lambsquarters (Chenopodium album) 80 days after planting. The morphological and phenological characteristics of the plants which contributed to this suppression were, in order of importance: mean area per leaf, stem number per plant, and date of bud break. By the end of the growing season however, the lambsquarters significantly overgrew the groundcovers necessitating a one year weed free period of establishment before a full measure of weed suppression could be achieved. Oxadiazon at 2.2 kg ai/ha and a combination of 2% oxyflourfen and 1% pendimethalin at 3.3 kg ai/ha showed no phytotoxicity with any of the groundcovers and could provide for this weed free establishment year.

707
RELATIONSHIP BETWEEN FUNGAL HORMONE PRODUCTION AND ECTOMYCORRHIZAL INFECTION OF PINUS MUGO
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To test the hypothesis that phytohormone production is related to mycorrhizae formation 29 isolates of ectomycorrhizal fungi have been evaluated for production of ethylene and auxin in pure culture and for their ability to form ectomycorrhizae with Pinus mugo. The fungi tested included a series of monokaryotic isolates of Laccaria bicolor and dikaryotic isolates of Amanita muscaria, Hebeloma crustuliniforme, L. laccata, L. proxima, Pisolithus tinctorius, Rhizopogon ellenae, and R.

vinicolor. Inoculated root systems were rated for mycorrhizae formation, root/shoot ratio and root morphology. P. tinctorius isolates which formed abundant mycorrhizae produce no ethylene in vitro, but did produce the auxin IAA. L. bicolor isolates produced ethylene as well as auxins putatively identified as IAA, and IBA. Correlations between phytohormone production and mycorrhizogenicity will be presented.

176 ORAL SESSION (Abstr. 708-715) Genetics and Breeding: Morphological Characters

708
COMPARISON OF METHODS USED IN SELECTION OF STABLE SWEET CORN HYBRIDS FOR MARKETABLE EARS
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Three methods were compared in selection of stable sweet corn hybrids evaluated over a five year period. Tests included 30 sweet corn (commercial and experimental) hybrids. The yield alone method (YA) based on mean performance of hybrids, Kang's rank-sum (KRS) method, and Kang's modified rank-sum (KMR) method based on stability varience statistic. The number of selections made on the basis of YA, KRS, and KMR was 13. The YA, KRS, and KMR selected 8, 3, and 6 unstable hybrids, respectively. The yields (marketable ears) of selected hybrids were 3034 dz/ha for YA, 2945 dz/ha for KRS, and 3019 dz/ha for KMR. The mean yield of KRS - selected hybrids and KMR - selected hybrids was, respectively, 2.9% and 0.5% less than that of YA-based selections. However, the farmer would be able to choose more consistently performing hybrids on the basis of KRS than on the basis of KMR or YA. A fanner or researcher, who is oriented more towards yield than stability, may prefer to use the KMR method.

709
GROWTH RESPONSE OF SIX SEEDLING GREENHOUSE TOMATO GENOTYPES TO DIFFERENT LIGHT AND NIGHT TEMPERATURE CONDITIONS
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Greenhouse tomato germplasm was evaluated for growth and flower cluster development during December and January to identify a more energy efficient genotype. Three tomato inbreds (one advanced greenhouse line, Ohio ICR.9; one frost tolerant line, Ohio 4013-3; and one cold tolerant line, Ohio 4579) and their F1 hybrids developed over a 9 week period at 2 different night temperatures (17.2 C and 12.2 C) and light levels (natural light and 30% shade, 2 days/week). Regardless of the conditions, the 3 hybrids produced more leaf area and had higher dry weights for leaves, stems and roots than the inbreds. However, when photosynthesis measurements were taken at light intensities of 1000, 600 and 300 µmol/m^2/s, Ohio 4579 and Ohio ICR.9 had the highest net photosynthesis (13.3 and 13.0 umol CO_2/m^2/s, respectively) and Ohio 4013-3 had the lowest (7.1 umol CO_2/m^2/s). In flower cluster development there was no clear division between the hybrids and inbreds. The hybrid 4013-3X4579 was the first to flower (52 days) and it produced the most flower clusters (4) and the most flower buds on the first 2 clusters (8.3 and 9.4, respectively).

710
Internal Morphology of Type VI Trichomes on Leaves of *Lycopersicon* species
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Type VI trichomes consist of a basal cell, 2 stalk cells, and a 4-celled gland. Externally, glands of *L. hirsutum* are round but glands of most other species are 4-lobed. Microscopic examination of paraffin sections of leaves of *L. esculentum, L. hirsutum* f. *hirsutum,* and *L. hirsutum* f. *glabratum,* indicated these external differences of trichome morphology are related with a large extra-cellular cavity in the center of Type VI trichome glands of *L. hirsutum.* Phenols, sesquiterpenoids, and methyl ketones exuded by Type VI trichomes are associated with host-plant resistance to arthropods. Concentrations of these allelochemicals on leaflet surfaces are greater in summer than winter. Similarly, size of Type VI glands of *L. hirsutum* is greater in summer, as is cavity size and percent of gland filled by the cavity. These differences in trichome morphology may explain the differences in concentrations of allelochemicals among environments and may influence efficacy of host plant resistance in *Lycopersicon.*

711
GLANDULAR TRICHOME-SPECIFIC LIPID COMPOSITION OF GERANIUM.
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Unique lipid precursors to the allelochemicals (anacardic acids) responsible for small pest-resistance in geranium are absolutely localized to glandular trichomes, where they constitute more than 20 percent of the total lipid composition. When compared to other geranium tissues, glandular trichomes contain depressed levels of linoleic and linolenic acids, and elevated levels of stearic acid. The absolute trichome-specific localization of unique lipid precursors supports the hypothesis of a trichome-specific biosynthesis of anacardic acids.

712
PETIOLE STRENGTH VARIATION, LEAF SPOT COLOR AND VENATION PATTERN AND COLOR INHERITANCE IN Caladium x hortulanum Birdsey
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Differences in the apparent strength of Caladium x hortulanum Birdsey cultivars have been observed in the field. Analysis of data collected on aspects of petiole strength during the past two years on 12 experimental breeding lines validates the hypothesis of medium and darker pigmented petioles being significantly stronger and less prone to bending than lighter pigmented petioles. It has been postulated that petiole pigmentation may also serve as a marker of relative chill hardiness in these breeding lines. Progeny from self pollination of two commercial cultivars were utilized in a pedigree and backcross breeding program to delineate and prove a multi-allelic model for the mechanisms controlling spot and vein color inheritance as well as the inheritance of venation pattern.

713
CULTIVAR VARIATIONS IN LATERAL BRANCH DEVELOPMENT OF DENDRANTHEMA GRANDIFLORA. Richard Kent Schoellhorn*, James E. Barrett and Terril A. Nell, Department of Environmental Horticulture, University of Florida, Gainesville, FL. 32605.

Seasonal and environmental factors play a large role in determining the growth and number of flowering lateral branches in Dendranthema. Twelve cultivars. rated by growers as branching from very good to poor, were grown from unrooted cuttings under greenhouse conditions. All cuttings received a pre-plant dip of Daminozide, two weeks of mist, a soft pinch, and initiation of short days immediately after removal from mist. Two and three weeks after pinching, data was taken on total number of lateral branches and those exceeding two and five centimeters, respectively. At flowering, laterals were counted and graded as to those with buds showing color, those 75% of the length of the first flowering lateral and those flowering within one week of the first fully open flower. Branching response varied by cultivar from one to eleven branches per plant. Lateral branch measurements taken at three weeks were better indicators of final lateral development than measurements taken at two weeks. Those laterals that flowered within one week of first open flower were determined to be, commercially, the most significant. Correlations for number of laterals greater than 5 cm. at week three with laterals blooming within one week of first open flower and those with lengths 75% of first were highly significant with R^2 values of .80 and .91 respectively. Regression equations were response = .57 + .71(X) and response = .43 + .90(X), respectively.

714
GENETIC REGULATION OF ANTHOCYANIN ACCUMULATION IN PEACH AND POSSIBLE LINKAGE TO WEEPING GROWTH HABIT
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Three large F_2 populations (Sweet Melody x White Glory, 174RL x White Glory, and Rutger's Red Leaf x White Glory) each containing in excess of 600 individuals and segregating for growth habit (weeping vs. standard) and flower color (white vs. pink) were characterized. Deviation from an expected 9:3:3:1 dihybrid ratio was revealed in all crosses. Tests for linkage were significant, and a map distance of 33 cM was calculated. Preliminary biochemical analysis suggested that the basis for the white-flowered phenotype is due to a defective UDP-glucose:3-0-flavonoid glucosyl transferase (3GT) enzyme.

715
INHERITANCE OF A CHLOROPHYLL DEFICIENCY IN HAZELNUT
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Controlled crosses made as part of a hazelnut breeding program revealed segregation for a chlorophyll deficiency expressed as yellow leaf color. Segregation ratios approximated 3 green:1 yellow, indicating control by a single recessive gene for which the symbol c_1 is proposed. 'Barcelona', 'Butler'. 'Compton', 'Lansing', 'Willamette' , the ornamental selection 'Redleaf #3', and 20 numbered selections are heterozygous . Pedigree analysis strongly indicates that all heterozygotes inherited the recessive allele from 'Barcelona'. The yellow-leafed seedlings in these progenies are slightly less vigorous than their green siblings but can be maintained in the greenhouse. Upon transplanting to the field, their leaves become scorched and the trees die. They differ in appearance from the yellow-leafed ornamental C. avellana var. aurea. The cross 'Barcelona' x C. avellana var. aurea produced no yellow-leafed seedlings, indicating that the two chlorophyll deficiencies are controlled by different loci.

177 ORAL SESSION (Abstr. 716-722) Nutrition: Fruit/Nuts

716
ALTERNATIVE GROUNDCOVER MANAGEMENT SYSTEMS AFFECT ORCHARD SOIL FERTILITY AND APPLE LEAF NUTRIENT CONTENT.
I.A. Merwin* and W. C. Stiles, Dept. of Fruit and Vegetable Science, Cornell University, Ithaca, NY, 14853.

Eight groundcover management systems (GMS) have been evaluated since 1986 in an apple orchard replant site. Tree-row GMS have included post-emergence herbicide (glyphosate) "killed sods," pre-emergence herbicide (norflurazon + diuron) strips, a crownvetch "living mulch," hay-straw mulch, monthly cultivation, a close-mowed sod, and an unmowed, chemically growth-regulated (maleic hydrazide + 2,4-D) sodgrass. Soil organ&matter content, surface aggregate structure, and water infiltration have improved under vegetative groundcovers relative to herbicide treatments. Extractable soil N, K, P and B have increased under straw mulch. Except for K, foliar nutrient content (dry wt basis) has not been closely coupled with soil nutrient content. Leaf K, P and B contents have increased, while leaf N, Mg and Zn, have decreased in trees in sodgrass relative to herbicide GMS.

717
INFLUENCE OF SOIL FUMIGATION AND FUNGICIDES ON GROWTH, YIELD AND LEAF MINERALS OF APPLES REPLANTED IN AN OLD ORCHARD SITE
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Field trials were conducted to study the effect of pre- planting fumigation with methyl bromide and fungicides (metalaxyl, fosetyl-Al or thiabendazole) on tree growth, soil nematodes and leaf minerals of 6 apple stions (cultivar/rootstock combinations) planted in an old apple orchard site. The stions were; Gravenstein/MM106, McIntosh/EMLA-7, Granny Smith/MMlll, Jonagold/EM-26, Jonagold/EM-7A, and Jonathan/EMLA-26. Soil and leaf samples were analyzed during the 3rd year after planting. There were significant differences in growth (trunk cross sectional area) among different stions. Growth of all trees in fumigated plots was between 64% to 106% higher than that in non-fumigated plots. Trees in fumigated plots had a higher yield than those in the non-fumigated plots. Fungicides did not affect the tree growth either in the fumigated or non-fumigated plots. Soil samples from non-fumigated sites contained 6 times more lesion, 3 times more stubby root, 29 times more dagger and 87 times more ring nematodes than those from fumigated sites. There were differences in the leaf mineral content of trees in fumigated areas as compared to those in non-fumigated areas.

718
NITROGEN AND PHOSPHORUS FERTIGATION OF NEWLY PLANTED APPLE TREES
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Field experiments, commencing the year of planting, investigate the response of apple trees on dwarfing rootstocks to fertigation with various rates and forms of N and P. 'Summerland Red McIntosh' (Malus domestica Borkh.) on M.9 rootstock were drip irrigated with all combinations of 0, 17.5 and 35 g P/tree and 23.5 and 47.0 g N/tree, applied in 4 equal weekly doses during May 1988-90. Fertigated P was highly mobile in the sandy soils, increased leaf P in 2 of 3 yrs., and yield and trunk cross sectional area by yr. 2. However, a rapid acidification of soil occurred beneath the emitters in all treatments so that leaf Mn concentration was increased for 3 yrs., especially at high rates of N and P. The experimental block also had decreasing leaf K concentrations yr. 1 to 3 and an apparent P induced reduction in leaf cu. At another location, initial growth of Jonagold on M.26 rootstock was similarly increased by fertigated P relative to applications of the same amounts of granular P in the planting hole. The form of N applied affected nutrient uptake with leaf Mn concentration reduced and leaf Ca concentrations increased by fertigation of calcium nitrate.

719
METHODS FOR SUPPLYING COPPER TO APPLE ORCHARDS
Warren C. Stiles*, Department of Fruit and Vegetable Science, 120 Plant Science Building, Cornell University, Ithaca, NY 14853

The objective of these studies is to evaluate efficacy of alternative methods for supplying copper to apple orchards. Applications of fixed-copper fungicides or Bordeaux mixture foliar sprays at the green-tip to one-fourth inch green stage of bud development have not consistently increased copper levels of leaf samples collected during mid-summer and can result in significant fruit damage if the application is delayed beyond this stage of development. Combinations of post-harvest plus green-tip to one-fourth inch green sprays of alternative copper sources have not provided adequate improvement of leaf copper levels. Preplant incorporation of copper sulfate into the soil has resulted in significant leaf Cu increases. Mid-summer foliar sprays of EDTA-Cu at low rates have increased leaf Cu without causing significant injury to fruit.

720
EFFICIENCY OF NUTRIENT DELIVERY METHODS IN RASPBERRY
Regina L. Rieckenberg* and Marvin P. Pritts, Department of Fruit and Vegetable Science, 119 Plant Science, Cornell University, Ithaca, NY 14853

Foliarly applied macronutrients are often recommended for crop plants. Controversy exists, however, about how much, if any, of these sprays are absorbed by the leaf, or whether they are simply washed off the plant and taken up by the roots. The efficiency of foliar fertilization with nitrogen and potassium was evaluated, and compared to soil applications. 'Heritage' red raspberry plants were treated with 30 kg/ha and 70 kg/ha of N and K, respectively. 15-N labelled urea was used as a nitrogen tracer and rubidium was used as a potassium analog. Treatments were applied either 1) to the soil surface at planting, 2) incorporated into the planting hole, or 3) as a supplemental labelled foliar spray, either early or late in the season. Half of these treatments were surrounded by black plastic mulch to exclude the possibility of run-off and root uptake. Whole plants were excavated at intervals one week and one month after treatment, and at the end of the growing season. 15-N and rubidium analyses were done with a mass spectrophotometer or an ICPU, respectively. In order to answer questions about the uptake, translocation and partitioning of N and K, roots, stems, leaves, and new growth were analysed separately. Application methods differed in their ability to supply the plant with N or K.

721
EFFECT OF ZINC DEFICIENCY ON RANCIDITY IN WALNUTS
Patrick H. Brown*, Joseph Grant, Janine Hasey, and Kathy Kelly, Department of Pomology, University of California, Davis, CA 95616* and University of California Cooperative Extension

Rancidity of walnuts is the result of the production of volatile compounds released during the breakdown of fatty acids. Walnuts are particularly prone to rancidification because of the high percentage of unsaturated fats in the nut

oil (>90%) notably linolenic and linoleic acids. In this study we investigate the effect of Zn deficiency on the production of Free Fatty Acids (FFA) and Superoxide Radicals (SR) and the resulting effect on nut quality and rancidity.

Levels of FFA in walnut oil increased dramatically with increasing Zn deficiency, Zn deficiency also markedly decreased the SR content of nuts. These responses were most marked at tissue Zn levels of less than 17 ppm a value which coincides with the appearance of symptoms of Zn deficiency in leaves of walnut. The low level of peroxide in Zn deficient plants most likely is the result of 'consumption' of peroxides in the process of formation of FFA's. This cycling of FFA and peroxide values is typical of nut crops. Results are discussed in relation to known effects of Zn deficiency on superoxide formation as well as possible effects of Zn deficiency on stability of membrane bound liposomes within the walnut kernel.

722
NITROGEN DEMAND AND UPTAKE CAPACITY OF ALTERNATE-BEARING PISTACHIO TREES
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The nitrogen (N) requirements and uptake capacity of mature, alternate-bearing pistachio *(Pistacia vera* L.) have not been determined. This study was conducted to obtain this information using 25-year-old 'Kerman' trees on *P. atlantica* seedling rootstocks. Three "on" trees were deflorated in 1984 to permit fertilization of both "on" and "off" trees in the same year. Three "on" and 3 "off" trees were fertilized with "N-depleted $(NH_4)_2SO_4$ in Jan. 1987, and annually thereafter with non-labelled N. Trees were excavated in Jan. 1991, separated into various organ fractions, and analyzed for total and labelled N. Preliminary evidence indicates that N loss from "off" trees is only 20-30% of the N removed from "on" trees, and that "off" trees have an increased capacity for fertilizer N recovery.

178 ORAL SESSION (Abstr. 723-730) Postharvest Physiology: Floriculture

723
POST-PRODUCTION STORAGE REDUCES CARBOHYDRATE LEVELS IN EASTER LILIES
William B. Miller, Dept. of Horticulture, Clemson Univ., Clemson, SC 29634

Easter lilies may be held in cool (2-4° C) storage for one or more weeks if not properly timed during forcing. In addition, most lilies are sleeved, packed into boxes and shipped 4 or more days without temperature control. Since these plants do not photosynthesize, stored reserves are utilized for plant maintenance. Post-production characteristics of these plants are often poor due to these accumulated stresses. A time course study was conducted to document changes in carbohydrate (CHO) pools in Easter lily leaves, stems and flower buds during dark storage of 0 to 3 weeks at 4°C or 0 to 6 days at 21°C. Storage at both temperatures resulted in losses of CHOs from the whole plant. Warm storage caused more rapid CHO loss than cool storage. Stems lost 6% of the total CHO over a 1 week period at cooler temperatures, but lost 43% of total CHO after 6 days of 21°C. Leaves lost 67% or 57% of leaf CHO when stored at 21°C or 4°C, for 6 days or 3 weeks, respectively. The average loss of total CHO in the buds was 42% at 21°C, whereas buds of plants stored at 4°C for three weeks lost only 0 to 8% CHO.

724
EVALUATION OF POINSETTIA CULTIVARS GROWN IN CENTRAL FLORIDA.
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Seventeen poinsettia cvs and 3 seedlings were grown in a mesh shade house and a glass house during 1990. Cube-rooted cuttings were potted on 8/31, pinched to 6 nodes on 9/17, and treated with pgrs on 10/5 and 10/12. Lighting was provided at night from 9/15 through 10/5. Data collected included number of days to first bract color, days to marketability, plant ht. and diam, inflorescence diam, no. of laterals, and no. of bracts in color on 12/12. Seedlings were compared to 6 cvs in a post-production room for 4 weeks. Days to marketability ranged from 51.2 (Ecke's sdlg 490) to 67.8 (Peace Frost), compared to Gutbier V-10 Amy (44.9), Gross Subjibi (45.7). Gutbier V-14 Glory (52.2), and Annette Hegg Dark Red (53.7). Tallest plants were Ecke's sdlg 441 (46.6 cm) and Eckespoint Lilo (45.8 cm) while V-10 Amy plants were the shortest (27.4 cm). Laterals of V-10 Amy were weak and often collapsed at flowering. The remaining cvs ranged in height from 27.7 to 39.4 cm. Sdlg 490 produced inflorescences similar in diam to Supjibi, had more bracts, but had slightly smaller individual bracts. Sdlg 490 exhibited leaf retention intermediate to Supjibi and V- 14 Glory.

725
POTTED CHRYSANTHEMUM LONGEVITY AFFECTED BY FLOWER RESPIRATION AND CARBOHYDRATES.
Jose A. Monteiro*, Terril A. Nell and James E. Barrett. Department of Environmental Horticulture, University of Florida, Gainesville, FL 32611,

Chrysanthemum cultivars vary in longevity under interior conditions Four chrysanthemum cultivars ('Iridon', 'Jade', 'Jasmine' and 'Tip') with different postproduction longevities were grown to flowering and moved to interio conditions (12 µmol $s^{-1}m^{-2}$ of cool white fluorescent light for 12 hr daily and 21 ± 1C) to determine interior longevity (senescence of the inflorescence). Also, carbon exchange rates (CER), dry matter (DM) and nonstructural carbohydrates were determined at flowering and after 17 days postproduction.

Whole plant dark respiration, flower and root respiration, whole plant light compensation point, flower and stem nonstructural carbohydrates, root soluble sugars and total root nonstructural carbohydrates decreased from flowering to 17 days postproduction. Flower respiration after 17 days postproduction was negatively correlated with postproduction longevity. No correlation was found between whole plant or plant pan DM or carbon partitioning to the flower and plant longevity. Stem nonstructural carbohydrates at flowering, stem starch and root soluble sugars after 17 days postproduction, were positively correlated with postproduction longevity. The percent of leaf starch in total leaf nonstructural carbohydrates after 17 days postproduction was negatively correlated with postproduction longevity. These results indicate that flower respiration and carbohydrates may serve as valuable physiological indicators of potted chrysanthemum longevity.

726
DIFFERENCES BETWEEN ROSE CULTIVARS IN SUSCEPTIBILITY TO INFECTION BY *BOTRYTIS CINEREA*
Philip E. Hammer*, Kathleen B. Evensen, Department of Horticulture, The Pennsylvania State University, University Park, PA 16802

Differences in susceptibility of rose flowers *(Rosa hybrida)* to grey mold, caused by *Botrytis cinerea*, were investigated. 'Supra' and 'Royalty' rose flowers were inoculated with various concentrations of B. cinerea conidia and stored in humidified chambers at 21C. Disease severity was quantified 2 days later as the number of lesions that had developed on each flower. The slope of the inoculum concentration - disease severity (IC-DS) regression line was used as a measure of susceptibility. In five separate experiments 'Supra' was consistently more susceptible than 'Royalty', although the susceptibility of each cultivar and the difference in susceptibility changed over the growing season. In experiments using isolated petal disks there was no difference between the cultivars in the germination of B. *cinerea* conidia on the petal surfaces, but fewer of the germinated conidia penetrated into the 'Royalty' petals. The site of inhibition of penetration is being investigated.

727
DIFFERENTIAL TEMPORAL AND TISSUE EXPRESSION OF AN APPARENT LOW ACTIVITY ISOFORM OF CARNATION CATALASE
Steven A. Altman[1]*, Gordon S. Inamine[2], James E. Baker[2], and Theophanes Solomos[1]. Department of Horticulture[1], University of Maryland, College Park, MD. USDA/ARS Plant Hormone Laboratory[2], Beltsville, MD

Sim-type carnation (Dianthus caryophyllus L., cv Elliot's White) apical petal tissue contains two distinct catalase isoforms which differ in Mr and in temporal accumulation of immunoreactive protein. Both Native and SDS-PAGE/western analyses using cross reactive antiserum raised against a subunit of a low specific activity catalase from tomato pericarp tissue showed that accumulation of the most prevalent, lower apparent Mr isoform increased beginning shortly following harvest, reaching a peak at 6-8 d postharvest. A second catalase isoform of higher apparent

Mr declined initially then increased coincident with the respiratory climacteric. Northern blot hybridization analysis performed using a heterologous 1.7 kb cDNA clone corresponding to a low specific activity catalase from tomato indicated cross-hybridization to a 2.8 kb carnation mRNA. Hybridization of the clone to poly $(A)^+$ mRNA preparations from apical petal tissue generated a weak signal relative to mRNA obtained from stem internode tissue. Abundance of catalase mRNA determined by northern hybridization was in agreement with the amount of protein recovered by immunoprecipitation /SDS-PAGE of ^{35}S-labeled *in vitro* translation products.

728

VOLATILES PRODUCED BY CARNATION FLOWERS TREATED WITH 2,4-D

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It has previously been demonstrated that exceedingly high concentrations of 2,4-D, when taken up by cut carnations, inhibit petal senescence, while application of low concentrations of this synthetic auxin promote petal senescence. The mode of action of such high concentrations of 2,4-D has not been elucidated.

In previous work, it was observed that significant amounts of volatiles always emanated from those flowers treated with high 2,4-D, and which displayed inhibition of ethylene synthesis as well as petal senescence. In the present work, the headspace of treated flowers was therefore tested by gas chromatography after enclosure for a short period of time. Two of the major constituents of the volatiles produced by the treated flowers were found to be ethanol and acetaldehyde.

Since ethanol has formerly been shown to delay senescence in carnation flowers, and since 2,4-D has been shown to induce alcohol dehydrogenase, it is suggested that the mode of action of 2,4-D in this case is by means of the ethanol produced as a result of the 2,4-D treatment.

729

ETHYLENE PRODUCTION PATTERNS OF CARNATIONS AFTER TREATMENT WITH NORBORNADIENE

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'White Sim' carnations were harvested and placed in 2000 to 3000 µl/1 norbornadiene (NBD) in air. Successive groups of flowers were removed from NBD every two days and exposed to laboratory air. Regardless of the duration of exposure to NBD, flowers produced virtually no C_2H_4 at the point of removal from NBD. Control flowers (no exposure to NBD) exhibited a typical climacteric-like burst of C_2H_4 production about 6 days after harvest. Flowers held for 2, 4, or 6 days in NBD and then transferred to air showed a climacteric-like pattern of C_2H_4 production, but the maximum rate was reduced by about 33% when compared with the control. Flowers held in NBD for 8 days showed an even smaller burst in C_2H_4 production (reduced by about 75%). C_2H_4 production by flowers held for 10 or 12 days in NBD was reduced by about 90%, and no climacteric-like burst of C_2H_4 production was evident. Flowers showed minimal loss in fresh weight while they remained in NBD, but they rapidly lost fresh weight immediately upon removal from NBD. The expression of senescence-related genes after removal from NBD is currently under investigation.

730

ETHYLENE-INDUCED FLORET ABSCISSION IN SNAPDRAGON

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Postharvest quality of snapdragon *(Antirrhinum majus)* is limited by the abscission of florets. Ethylene has been implicated as a causal agent of floret abscission. I have investigated the role of ethylene in floret abscission and genotypic variation in this response. Floret abscission was induced by exposure to 2 µl/L ethylene for 48 hr or longer. Returning inflorescences to air following 24 hr or less of ethylene treatment prevented ethylene induced abscission. Ethylene-responsiveness was found to increase with floret age in sensitive genotypes. Several inbred lines were identified which did not abscise in response to 2 µl/L ethylene. Reciprocal crosses were made between ethylene sensitive and insensitive lines. All of the F1 progeny responded to ethylene by floret abscission similar to the sensitive parent. The F1 progeny have been selfed and backcrossed to both parents for segregation analysis.

179 ORAL SESSION (Abstr. 731-735) Cell and Tissue Culture: Transformation

731

AGROBACTERIUM-MEDIATED TRANSFORMATION OF PLUM PRUNUS DOMESTICA L.) WITH THE PAPAYA RINGSPOT VIRUS COAT PROTEIN GENE

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Hypocotyl slices from ungerminated plum seeds were co-cultivated with A. tumefaciens EHA101 (Hood et al., 1986. J. Bact. 168:1291-1301) containing the plasmid pGA482GG/cpPRV-4. This plasmid carries the papaya ringspot virus (PRV) coat protein gene construct and chimeric NPTII and GUS genes (Fitch et al., 1990, Plant Cell Repts. 9:189-194). Shoots were regenerated from hypocotyl slices cultured on shoot regeneration medium consisting of Murashige and Skoog (MS) salts, vitamins, 2% sucrose, 2.5 µM indolebutyric acid (IBA), 7.5 µM thidiazuron, 300 mg/liter carbenicillin, 200 mg/liter cefotaxime and 75 mg/liter kanamycin. Regenerated shoots were rooted on half strength MS salts with vitamins, 1% sucrose, 2.5 µM IBA, and 75 my/liter kanamycin. These plants tested positive for both NPTII and GUS activity. The expression of PRV coat protein is being tested as well as the reaction of transgenic plants to plum pox virus infection.

732

TECHNIQUES FOR RUBUS TRANSFORMATION AND REGENERATION

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Based on Southern and ß-GUS analysis, Rubus somatic tissues were successfully transformed and plantlets were regenerated from disarmed Agrobacterium tumefaciens-infected tissue. Model studies were used to determine several procedural requirements for this system. For example, internodes were used instead of leaves or petioles because they were more susceptible to A. tumefaciens and were equally regenerative. Thidiazuron was more effective than benzyl adenine for shoot organogenesis. Coincubation time was increased to 4 days. The C58 strain, with the same chromosomal compliment as the disarmed GV3101 strain, was almost as virulent as wild strains isolated from Rubus Cefotaxime, used to stop coincubation, increased the number of shoots regenerated from petioles and internode pieces.

733

IMPROVED TRANSFORMATION OF TOBACCO CELL SUSPENSION CULTURES AS A MODEL FOR PLANT BIOLISTICS RESEARCH

Julie A. Russell*, Mihir K. Roy, and John C. Sanford, Cornell University, Plant Science Center and Dept. of Horticultural Sciences, Geneva, NY 14456.

The biolistics process uses high velocity microprojectiles to carry foreign DNA into cells. Though biolistics has already proven to be useful for a wide range of species, improvements are still needed, and many of the factors which affect transformation efficiency have not been defined. In our experiments, cell suspensions of *Nicotiana tabacum* (NT1 line) were used as a model to identify these factors. The most critical factors for high efficiency transformation were: cell age, microprojectile type & size, DNA construct, osmoticum in the bombardment medium, use of a new helium-driven biolistic device, and the handling and growth environment of the cells after bombardment. By optimizing these factors, an average of 7,000 transiently expressing GUS cells and 800 kanamycin resistant colonies were obtained per bombarded plate. The high efficiency and rapid results (2 days transient/4 weeks stable) of the NT1 model system make it useful for cell biology studies and for testing DNA constructs.

734

TRANSPOSON TAGGING OF AGRONOMICALLY IMPORTANT GENES FROM PEA

Judith Strommer*, Kenneth Buckley, Jocelyn Fausto, Kamal Malik and Praveen Saxena, Dept. of Horticultural Science, U. of Guelph, Guelph, Ontario N1G 2W1

One strategy for the genetic engineering of crop plants is to modify expression of endogenous genes. We have chosen pea, Pisum sativum, as a model system for the directed modification of agronomically useful genes from legumes.

The first aspect of the project is to target specific alleles meeting the following qualifications: they should confer significant advantage which is currently comprised by limitations that might beeliminated through gene modification; and to facilitate gene isolation they should confer an easily discernible phenotype. Experiments assessing the suitability of alleles of pea including R and af will be summarized.

The second aspect is to create a means of isolating alleles of designated genes through transposon mutagenesis. We are developing a transformation system for the introduction of a vector carrying the maize transposable element Ac, to permit assessment of Ac transposition in pea. The transformation system, vector and preliminary results will be summarized.

735

RESYNTHESIS OF *BRASSICA CARINATA* BY PROTOPLAST FUSION OF ITS PROGENITOR SPECIES

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Brassica carinata (Abyssinian Mustard, 2n = 34) is one of the three major amphidiploid species in the genus *Brassica* ; its progenitors are *B. oleracea* (2n = 18) and *B. nigra* (2n = 16). Leaf protoplasts of kale *(B. oleracea ssp acephala* cv 'Vates Tall Blue Curled') were inactivated with iodoacetate and then fused with either etiolated hypocotyl or green cotyledon protoplasts of *B. nigra* (PI-180416). Sixty somatic hybrids were produced in two fusion experiments. The hybrids were characterized by intermediate morphology; variable chromosome numbers and total DNA content (as determined by flow cytometry); hybrid phosphoglucose isomerase isoenzyme banding patterns; and chloroplast DNA RFLPs predominantly from *B. nigra.* Pollen viability (stainability with 2% acetocarmine) in the hybrids ranged from 1 - 98%, but even hybrids with high pollen viability did not set selfed seed. When crossed with natural *B.* carinata some of the hybrids produced viable progeny. The asexual resynthesis of this amphidiploid opens another method to diversify the germplasm of a potential new crop.

180 ORAL SESSION (Abstr. 736-743) Education/Extension

736

USING HORTICULTURE IN A MIDDLE SCHOOL INTEGRATED ENVIRONMENTAL SCIENCE PROGRAM

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Students at Porter Middle School in Austin, Texas, chosen because of interest and performance in ecology courses, are involved in an integrated environmental science program that uses horticulture as part of the project. Students produce vegetable crops using non-chemical tactics, both in outdoor raised beds and in the "biodome", a greenhouse made from a geodesic dome. The purpose of the program is to teach principles of environmental science while teaching those of horticulture. Additionally, this program aids the development of leadership skills in the children.

737

TEACHING LANDSCAPE CONSTRUCTION SKILLS TO UNIVERSITY STUDENTS

Timothy J. Smalley, Department of Horticulture, University of Georgia, Athens, Georgia 30602

A major complaint of the landscape industry about university horticultural curriculum is the limited practical experience of university graduates. It is difficult to incorporate courses providing practical experience into horticultural curriculum because of the limited time available to teach the numerous required courses. Landscape construction courses can be expensive because of the tools and materials needed and can be labor-intensive for the faculty and staff who often are required to complete unsightly or unfinished student construction projects. Simple, inexpensive lab exercises were devised with the cooperation of the university grounds department to expose landscape contracting students to the basics of site layout and construction practices. Landscape tie, concrete, brick- and paver-laying, and bench construction techniques were demonstrated and practiced in a series of 3 2-hour labs. A limited access site wee used to improve the learning environment and facilitate cleanup procedures with minimal impact upon campus aesthetics. The benefits of using alumni and industry experts to teach the techniques and the perceived enthusiasm of the students and the cooperators for the project will be related.

738

COMPUTER-VIDEODISC ENHANCEMENT OF PLANT IDENTIFICATION

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Plant identification is a challenging task for students, requiring memorization of visual images and scientific nomenclature for numerous plants over a quarter or semester. The basic knowledge gained in plant identification is essentially a prerequisite for the mastery of subsequent information learned in proper plant selection, usage, culture, and maintenance. Species from Acer, Cornus, Crataegus, Quercus, and Viburnum, comprising about 15% total plants in a two-course sequence, were chosen for a pilot study. Color images contained on a videodisc and textual computer databases on each plant were integrated into computer assisted instructional (CAI) modules. Half of the pilot plants in each course were accessible to half of the students via the CAI modules. Exam scores of control versus treated student groups were compared to assess the impact of the system on improving the learning process of plant identification. Demographic and sensory information was gathered before and after computer-videodisc usage to analyse student perceptions about the appropriateness of this technology to supplement instruction of landscape plant identification.

739

INCORPORATION OF AGRICULTURAL DATABASES AND SOFTWARE INTO CITRICULTURE COURSES

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Databases within the Florida Agricultural Information Retrieval System (FAIRS) and microcomputer software developed by the University of Florida for agricultural users have been incorporated into undergraduate citriculture courses. A citrus database and pest control guides, including root-stock/scion selection, young tree care, pest and water management, nutrition, tree size control, cold protection and economics can be accessed by students in computer labs as the most current text for this course. Additional microcomputer software on grove records and decision aids, fertilizer and spray mix calculations, water management and movement of pesticides in soils links resident instruction with extension educational programs for graduating students who will become citrus production managers and extension clientele in the future.

740

TRAINING MATERIALS DEVELOPED FOR THE VIRGINIA NURSERYMEN'S ASSOCIATION'S ADVANCED LANDSCAPE CERTIFICATION.

Bonnie L. Appleton*, Hampton Roads Agricultural Experiment Station, Virginia Polytechnic Institute and State University, Virginia Beach, VA 23455.

An advanced certification in woody landscape plants has been developed for the Virginia Nurserymen's Association's Certified Nurseryman Program. Materials developed for training include a tree and shrub manual with commentary specific for Virginia, and a slide set to illustrate all of the manual's plants.

For auto tutorial purposes the slide set was converted to videotapes with narration. Two 90-minute videos are available, one covering trees, the other covering shrubs. Each covers approximately 80 plants and includes an introductory section on plant identification characteristics.

741

"NATIVE PLANTS OF INDIANA": VIDEOS FOR INSTRUCTION AND EXTENSION

Michael N. Dana*, Horticulture Department, Purdue University, West Lafayette, IN 47907-1165

Interest in native plant species for general landscape planting, mitigation of environmental impact and ecological restoration plantings continues to expand with public awareness of environmental quality. An expanding area

of opportunity exists for the landscape horticulture industry to supply non-traditional plant materials to support landscape planting with native species. To capitalize on the opportunity, horticulture and landscape architecture students and practitioners must become knowledgeable of species native to their region. Video is a useful medium for increasing such knowledge. This presentation will review the development, production, distribution and content of six video programs that survey the native herbaceous flora of Indiana prairies and woodlands. Each program is less than 30 minutes in length, to facilitate classroom use and presentation in broadcast formats. Botanically correct nomenclature is presented graphically as each species is introduced. The narration includes botanical, ecological and horticultural information, but emphasizes plant lore to increase interest for general audiences and provide memory clues for those attempting to learn the plants. This project, supported by the Indiana Association of Nurserymen, provides a good example of how horticultural industries can become leaders as the public expands its demand for improved environmental quality.

742
MULTIMEDIA INFORMATION DELIVERY SYSTEM FOR CONSUMER HORTICULTURE
R. A. Baumgardner* and D. M. Price, Department of Horticulture, Clemson University, Clemson, SC 29634.

Interactive multimediainformation delivery systems are being used in the three primary urban South Carolina counties. Each system is comprised of a MacIntosh SE computer, PVM1390 Sony color video monitor, Pioneer LDV4200 videodisc player, four videodiscs, and five application programs. These systems provide a new and extensive database of consumer horticulture information pertaining to the planting/care of home lawns, general gardening, landscape plant identification, selection, and use, and woody plant disorder identification and control. Systems have been used in a variety of settings, including support of normal consumer horticulture office activities, master gardener programs, and special events such as grounds maintenance workshops, *etc.*

743
WHEN TO WATER, A WATER CONSERVATION PROGRAM
Kathleen M. Mallon, CE Education Center, Greenhouse Conservatory, University of RI, Kingston, RI 02881

During the winter of 1989, a subcommittee of the RI Governor's Water Conservation Program, laid the groundwork for a cooperative program utilizing the resources of that state agency, Cooperative Extension, a local television station and a private conservation association.

A computerized lawn watering model was developed by a graduate student at the University based on others in use for scheduling irrigation of agricultural crops. A brochure was developed by the planning team for free distribution to the RI public. It was paid for by the University of RI and Save The Bay. WJAR-TV, an NBC affiliate in Providence RI, aired the lawn watering factor as a regular feature of its Wednesday and Friday forecasts. In addition, they produced and aired PSA's promoting the program. Help with how to use the weekly factor and the guide was provided to RI'ers by URI's toll free hotline.

An unusually wet summer where the factor was frequently 0, kept the demand for the flyer lower than anticipated. However, thousands of viewers were able to eliminate watering altogether and conserve whenever the factor was 0 and the advice was not to water the lawn.

189 ORAL SESSION (Abstr. 744-751) Genetics and Breeding: Reproductive Factors

744
GENETIC PARAMETERS OF FLOWER COLOR TRAITS IN THE DAVIS POPULATION OF GERBERA
Kenneth R. Tourjee,* James Harding, and Thomas Byrne, Dept. of Environmental Horticulture. University of California, Davis, California 95616.

The Davis Population of Gerbera has been maintained for 15 generations under typical greenhouse conditions utilizing an NCII mating design. Flower color measurements were conveniently made in vivo via a portable reflectance spectrophotometer. Phenotypic distributions for the flower color traits hue, value and chroma (CIELAB color notation) indicate that these variables have a continuous distribution in this population. Analysis of half-sib family data reveal narrow sense heritabilities for value, chroma, and hue of 1.0, 0.8, and 0.6 respectively. The genetic correlation between value and chroma is -0.5, value and hue 0.6, and chroma and hue 0.0.

745
GENETIC CHARACTERISTICS OF SELF FERTILITY IN HIGHBUSH AND HALF-HIGH BLUEBERRIES
Richard E. Harrison*, James J. Luby, and Peter D. Ascher, Department of Horticulture, University of Minnesota, St. Paul, MN 55108

Ten families, of ten plants each, were generated from various crosses among highbush and half-high blueberry genotypes. Data was taken, for both parents and offspring, on percent fruit set, seeds per berry, and seeds per pollination following self and outcross pollination. The objectives were to better understand the inheritance of self fertility and the effect of zygotic levels of inbreeding on fruit and seed set following self vs. outcross pollination. Analyses of variance were used to determine differences between crosses, genotypes within a cross, and the pollination treatments. Inbreeding coefficients were calculated based on the assumptions of autotetraploidy and tetrasomic inheritance. Reduced reproductive fertility following self pollination appears to be acting in a quantitative way and heritability estimates suggest that phenotypic selection for increased self fertility may be effective. Along with phenotypic selection, the results of this study indicate that the specific combining ability of certain parental combinations is also important. High parental self fertility may also lead to increased variability for the trait in the progeny which is beneficial to the breeder. Finally, it appears that reductions in self fertility are, at least partially, a response to increases in the levels of zygotic inbreeding.

746
A METHODOLOGY TO IMPROVE THE EFFICIENCY OF MANGO (Mangifera indica L.) BREEEDING.
Alberto C. 0. Pinto* and David H. Byrne, Department of Horticultural Sciences, Texas A&M University, College Station, Tx 77843-2133.

Controlled hand pollinations in mango is very difficult and expensive because the trees are tall. Furthermore, the hand-pollination is a very time-consuming process which gives poor yields of hybrid seeds. A new methodology is proposed to improve efficiency and decrease cost of mango improvement through insect-aided hybridization. Dwarf mango rootstocks are top-grafted with selected cultivars and grown in small cages. Pollination in the cage is done by flies that are hatched in wet chicken manure. By introducing panicles in the cage or by altering the topworked cultivars, several different breeding approaches can be taken. The protocol for this proposed methodology is presented and the expected results are discussed.

747
SELF-COMPATIBILITY AND AUTOGAMY IN SEVERAL ALMOND SELECTIONS
Nachida Ben Njima and R. Socias i Company*, Unidad de Fruticultura, SIA - DGA (INIA), Apartado 727, 50080 Zaragoza, Spain

Pollen tube growth was studied in ten almond selections of the Zaragoza breeding program, whose main objective is the development of self-compatible cultivars. Pollen tube growth was similar in eight of the selections both after self- and cross-pollinations, confirming their genetical self-compatibility. In the other two selections, self and cross pollen tube growth was different, one showing self-incompatibility and the other an irregular progression of cross pollen tubes. The study of the dynamics of pollen tube growth shows that the growth rate is variable, depending both on the time from pollination and the selection, and that this trait can be correlated with fruit set and also to style length. The stigma position in relation to the anthers varies depending on the selection, favoring the possibility of natural autogamy in some of the selections because anthers and stigma stand at the same level.

748
EARLY FLOWERING INHERITANCE IN CUCUMBER
Jorge Christlieb-Silva* and Todd C. Wehner, Departament of Horticultural Science, Box 7609, North Carolina State University, Raleigh, NC 276957609.

Early yield gains importance in pickling cucumbers as mechanical once-over harvest becomes a solution to labor problems. An early flowering pollinizer will be needed to provide pollen for gynoecious hybrids. Two populations, North Carolina Wide Base Pickle (NCWBP) and North Carolina Elite Slicer 1 (NCESl) were planted in Clayton, N. C. in different isolated plots in 1990. Days to first flower was recorded. NCWBP ranged 37-46 days (mean=39.6 days, s^2=2.27, n=405), and NCES1 ranged 35-48 days (mean=40.3 days, s^2=3.26, n=439). One fruit was harvested from selected plants and its seeds were planted as half sib

families in two environments in the spring of 1991. Number of days to first flower, sex and node of first flower were recorded for each plant. Heritability was estimated by a parent-offspring regression analysis. In a second study, 12 families were formed by crossing 4 early (30-33 days) and 3 late (37-46) flowering lines. Parental, F_1, F_2, BC_{1PL} and BC_{1PE} generations were planted in the field in Clayton, N. C., and number of days to first flower recorded. The number of effective factors and additive genetic variance were estimated. Results from the two studies will be discussed.

190 ORAL SESSION (Abstr. 752-759)
Tree Fruit: Growth and Development

749

OVULE CULTURE OF SWEET POTATO *(IPOMOEA BATATAS)* AND RELATED SPECIES.

Ruth S. Kobayashi[1]*, John C. Bouwkamp[1] and Stephen L. Sinden[2]
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Sweet potato *(Ipomoea batatas)* breeding progress has been hampered by self- and cross-incompatibilities that are frequently found in the section Batatas. Incompatibility has prevented the hybridization of certain parents and species. Development of tissue culture techniques such as ovule culture may be useful in overcoming some of these incompatiblities. Ovules with embryos at the late globular to heart shaped stage of development were cultured on MS medium containing full strength or one-half strength salts with 3%, 8% or 12% sucrose. Developing ovules of *I. triloba* and *I. trifida* were successfully cultured as early as 3 and 4 days after pollination while sweet potato ovules were successfully cultured 5 and 6 days after pollination. Ovules were either cut longitudinally or cultured intact. Embryos developed and plants were obtained with all media tested. The highest percentage of embryos developed when the ovules were cut longitudinally and cultured on medium containing one-half MS salts and either 8% or 12% sucrose.

750

CHARACTERIZATION OF A MODIFIED Rl (OGURA) MALE STERILE CYTOPLASM IN BRASSICA OLERACEA.

Carolina Celis* and Pablo Jourdan, Department of Horticulture, The Ohio state University, Columbus, Ohio, 43210-1096.

The Rl cytoplasmic male sterility in Brassica oleracea is characterized by absolute male sterility, severe low temperature-induced chlorosis, reduced nectary development, and pistil abnormalities. A modified Rl cytoplasm (R*) was obtained in B. napus after somatic hybridization, that displayed variable male sterility, no chlorosis, mostly normal nectaries and pistils, and atrazine resistance. Four R* -B. napus plants from a BC2 population to cv 'Triton' were pollinated with B. oleracea ssp botrytis (cauliflower cv 'Blue Diamond') and embryos were rescued by ovule culture. All F1 hybrid plants obtained were male sterile and were subsequently pollinated with a rapid cycling B. oleracea line (CrGC3). These progeny were also male sterile and were pollinated once more with CrGC3 and with 1 broccoli and 3 cauliflower lines. In greenhouse studies, these plants retain absolute male sterility, have normal pistils and set abundant seed after pollination. This R* cytoplasm represents a potential new source of usable male sterility in vegetable forms of B. oleracea.

751

FURTHER INVESTIGATIONS INTO GARLIC STERILITY AND SEED PRODUCTION

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Garlic *(Allium sativum* L.) is an obligate apomict which reproduces almost exclusively by means of division of underground cloves or by propagation of topsets. The occurrence of viable, sexually-derived garlic seeds is rare. In order to assess the factors that limit garlic seed production, variables that affect flower initiation and development were studied. The effects on flowering of daylength, growing temperature, bulb and plant cold storage conditions, and cultivar were examined by observing flower development in plants grown under controlled greenhouse conditions. Correlations between isozyme markers and flowering, fertility, and morphological markers will be presented for a diverse collection of garlic clones, including six sexually-derived garlic plants.

752

Irradiance Level Influences 'Delicious' Fruit Quality

Richard J. Campbell and Richard P. Marini, *Department* of *Horticulture, Virginia Tech, Blacksburg, VA 24061.*

The influence of irradiance levels (PPFD levels) at specific canopy positions on 'Delicious' fruit quality was evaluated in 1989 and 1990. Total accumulated PPFD and 15-min PPFD totals were recorded for each canopy position throughout the season. Fruit were harvested from each position at 135, 145, 155, and 165 days after full bloom and fruit quality was evaluated. Fruit quality measurements were regressed against both total accumulated PPFD and the number of 15-min intervals above certain PPFD thresholds. Percent red color and soluble solids content were both positively related in a linear manner with total PPFD, but the relationship was improved when these variables were regressed against the total number or 15-min intervals above 200 $\mu mol \cdot m^{-2} \cdot sec^{-1}$. There was an interaction with harvest date. Fruit size was also positively related to both measures of PPFD, but the relationship was poor. Firmness, L/D ratio, and starch index were poorly related to PPFD level.

753

TIME OF ROOT PRUNING ON GROWTH, FRUIT SIZE, BIENNIAL BEARING, AND YIELD OF "JONATHAN" APPLE

David C. Ferree, Department of Horticulture, The Ohio State University/OARDC, Wooster, OH 44691.

'Jonathan'/M.26 apple trees were root pruned annually on 2 sides, 60 cm from the trunk to a depth of 40 cm for 6 years, while dormant or at bloom or mid-June. Cumulative yield was reduced by root pruning at bloom (14%) or mid-June (20%) and cumulative efficiency was reduced by pruning at mid-June. Average shoot length was reduced by root pruning with no difference among pruning times. The intensity of bienniel bearing was reduced by root pruning with no effects among time of pruning. Root pruning resulted in a decrease in large fruit and an increase in small fruit in 3 of the 6 years. A covariant analysis with yield showed that root pruning reduced average fruit size. Root pruned trees produced firmer fruit with increased soluble solids and had less preharvest drop.

754

THE ROLE *OF* SPUR AND BOURSE LEAVES OF THREE APPLE CULTIVARS ON FRUIT SET AND GROWTH AND CALCIUM CONTENT

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The development of a complete and healthy early season canopy of spur leaves, and later addition of bourse leaves, is essential for fruit set, fruit growth and quality in apple. The present study was undertaken to evaluate the temporal role of spur leaves and bourse shoots on fruit set, growth and return bloom in three apple cultivars and fruit Ca Level at harvest in two cultivars.

Individual flowering spurs on mature wood of "Cox's Orange Pippin", "Golden Delicious" and "Crispin" apple trees were modified by removing the spur leaves, the bourse shoot, or both, at full bloom and two, four and eight weeks afterwards. Leaf removal reduced fruit set, yield (as fruit number and not size), fruit calcium level at harvest, and return bloom. Defoliationhad its greatest effect on fruit calcium level when done early in the season and plots of this against treatment time suggested a curvilinear relationship. Return bloom was dependent on the presence of the bourse shoots on the spur but not on spur leaves. Return bloom of all three cultivars declined with the number of fruitlets per spur four weeks after full bloom.

755
CARBOHYDRATE CONTENT, SPRING GROWTH AND BLOOM OF PARTIALLY DEFOLIATED APPLE TREES.
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Defoliation by pests was simulated with potted tree model systems and field-grown trees. 'Redchief'/M7 apple trees in 10 1 pots were grown as a single shoot. Removal of 25%, 50%, or 75% of apical or basal leaf number reduced leaf area by 25%, 60%, and 85% apically, and 15%, 40%, and 75% basally, respectively. Forty-five days after removal, leaf area was 85%, 69%, 55%, 105%, 100%, and 83%, respectively, of control trees due to new leaf growth. Carbohydrate content of wood and root fractions was measured to indicate the effect of defoliation on growth, partitioning, and reserves. Leaf removal (50%) June 15 or July 30 (1990) of 4-year old 'Early Granny'/Mark did not affect fruit yield, size, or soluble solids, but decreased titratable acidity (a light crop year). Trunk cross-sectional area increase of June-defoliated trees was 35% of control trees. Subsequent (1991) growth and bloom response will be presented.

756
EFFECT OF FRUIT SPACING ON YIELD, HARVEST AND STORAGE QUALITY, AND MINERAL CONTENT OF 'RED CHIEF' AND 'RED SPUR' APPLES ON TWO ROOTSTOCKS
Esmaeil Fallahi* and Brenda R. Simons, S.W. Idaho Research and Extension Center. University of Idaho, 29603 U of I Lane, Parma, ID 83660

Effects of 5 levels of hand thinning on fruit number, yield, fruit quality at harvest and after storage, and fruit mineral content in 'Red Chief apple on MM106 and MM111 and 'Red Spur' apple on M7 and M26 were studied in southwest Idaho. Fruit on branches were thinned to 5.1 cm, 10.2 cm, 17.8 cm, 25.4 cm, or 35.6 cm spacing. Thinning 'Red Chief fruit to 17.8 cm spacing on both rootstocks significantly reduced the yield but increased the fruit weight as compared to 5.1 cm or 10.2 cm spacing. Color in 'Red Chief fruit with 17.8 cm spacing was higher than that of 5.1 cm and 10.2 cm at harvest. There was no increase in sugar or color when the 'Red Chief fruit spacing was increased from 17.8 cm to 25.4 cm. Yield, color, and sugar in 'Red Spur' fruit with 10.2 cm spacing on M26 or M7 were similar to those with 17.8 cm spacing; however, fruit was heavier with 17.8 cm spacing. Fruit spacing had no effect on firmness or starch content at harvest. Negative correlation existed between yield and fruit weight; yield and sugar; and yield and color. No correlation was found between fruit starch and sugar in 'Red Spur' on M7 or 'Red Chief on MM111 at harvest. Differences existed in mineral content of fruit from different thinning levels.

757
^{14}C-ASSIMILATE TRANSLOCATION IN APPLE WITH ROOT SYSTEM UNDER PRESSURE
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Root hydraulic conductance of plants may be determined by subjecting the root system to pressure which may interrupt shoot to root communication. This study was conducted to determine the effect of pressurizing root systems on the translocation pattern of $^{14}CO_2$ in apple *(Malus domestica* Borkh.). Imperial Gala on MARK rootstock trees in 4.6 *l* pots were placed in 4 *23-l* pressure chambers and pressurized to 3.5 MPa for 79 hr with 4 unpressurized controls. After 1 hr to equilibrate, one leaf per plant was pulsed with $^{14}CO_2$ for 30 min. Leaf discs were taken following the $^{14}CO_2$ pulse to determine initial uptake. CO_2 assimilation and gas exchange were monitored at noon daily with a portable gas analyzer. CO_2 assimilation was slightly higher for the pressurized treatment but there was no difference in other gas exchange parameters. The treatments were repeated twice more subsequent to removal of the previous replicate. After pressurization, plants were separated into roots and shoots and dried and pressed for autoradiography. Autoradiography indicated similar translocation for pressurized root systems and controls. Determination of ^{14}C-assimilates present in the shoot and root systems will be presented.

758
SUMMER DORMANCY AND MEMB RANE LIPIDS OF APPLE.
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Lipid composition of apple leaf bud meristem tissues were compared during dormancy and induced budbreak. In both situations palmitic acid predominated in phosphatidyl- ethanolamine, -glycerol and -inositol. Oleic acid predominated in phosphatidyl-choline. There was no overall change in fatty acid content of buds. Lipid composition of buds during summer dormancy (SD) and endodormancy (ED) was significantly different in that ED buds contained much higher level of unsaturated fatty acids in phospholipids and galactolipids than SD buds. During budbreak, regardless whether happened after ED or SD linoleic and linolenic acids were relatively high. BASF 13-338, a known inhibitor of linoleic acid desaturation, decreased linolenic acid content. With BASF 13-338 budbreak still occurred following SD, but not after ED.

759
IMPROVED APPLE QUALITY FROM A LOW-DAMAGE BAGGER.
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A totally new automatic apple bagger was designed to reduce impacts that result in bruises and downgrading of apples destined for the fresh market. The new concept bagger was based on the principle of putting a conventional 3 lb. polyethylene film bag over a nearly horizontal pan of apples. Weighed groups of apples gently roll onto this pan from compartments of a weight sizer and then stop at the end of the polyethylene bag. The pan/bag/apples combination is then tipped nearly vertical, whereupon a cushionedbox receives the combination and holds the bag of apples upright while the pan is removed from the bag. The apples settle. but do not drop into the bag. Finally, the receiver box moves the bag of apples to a bag closer. This design nearly eliminates any high velocity impacts like those occurring in conventional baggers. In laboratory tests there was a 14 fold decrease in bruises/fruit and in bruise area/fruit for 'Golden Delicious' apples compared to conventional baggers. The experimental bagger has been installed at a local packing house and operated under commercial conditions. The quality of bagged apples was maintained at nearly the U.S. Extra Fancy grade, which benefits both the apple industry and consumers.

191 ORAL SESSION (Abstr. 760-765) Vegetables: Growth and Development II

760
USING PLASTIC MULCH, DRIP IRRIGATION AND LEGUMES ALONE AND IN COMBINATION WITH MANURE FOR THE PRODUCTION OF MUSKMELONS
William J. Lamont Jr.*, Wilford Singogo and Charles W. Marr, Department of Horticulture, Waters Hall, Kansas State Univ., Manhattan, KS 66506.

Before the introduction of mineral fertilizers, all farmers were "organic farmers". Legumes, barnyard manure and composts were the only sources of additional nutrients. As concerns increase over agriculture's impact on the environment - particularly surface and ground water resources - there is a renewed interest in crop production systems which utilize renewable organic sources of fertilizers and alternative pest control measures. This study investigated the production of muskmelon cultivar 'Magnum 45', using 3 legumes alone (Alfalfa, Hairy Vetch and Austrian Winter Pea) and in combination with manure as organic fertilizer sources while incorporating the modern technology of drip irrigation and plastic mulching. Legumes were fall planted, overwintered, and plowed-in prior to bedding for the mulch application. There were no significant differences in melon yields between any of the treatments including the mineral fertilizer checks, although the additional of manure increased yields over legumes alone. The highest yield of 29,999 melons/ha was from the alfalfa + manure treatment.

761
MORPHOLOGICAL AND PHYSIOLOGICAL RESPONSES OF CUCUMBER TO INVERSE DAY/NIGHT TEMPERATURE AND OZONE POLLUTION
Donald T. Krizek[1]*, Madhoolika Agrawal[2], Shashi B. Agrawal[2], George F. Kramer[1], Edward H. Lee[1], Roman M. Mirecki[1], and Randy A. Rowland[1], [1]Climate Stress Laboratory, ARS, U. S. Department of Agriculture. Beltsville, MD 20705-2350, USA and [2]Banaras Hindu University, Varanasi-221005, India

Cucumis sativus L. (cv 'Poinsett' and 'Ashley') plants were grown from seed in a growth chamber at 28/18° (normal) or 18/28°C

(inverse) day/night (D/N) temperature on a 12 hr photoperiod for 24 days prior to ozone (O_3) fumigation (3 hr @ 0.5 µmol mol^{-1}). Plants grown under inverse D/N temperature showed a significant reduction in height, node number, fresh weight, dry weight, and leaf area as compared to those grown under normal D/N temperature. The photosynthetic rate (Pn), chlorophyll (chl) concentration, and chl fluorescence (fl) were lower and polyamine (PA) concentration and O_3 injury higher at 18/28°C than at 28/18°C D/N temperature. O_3, increased PA and reduced Pn and chl fl in both cvs. irrespective of D/N temperature. There was little or no cv. difference in growth, Pn, or O_3 injury but cv. differences in chl and PA concentration.

762

THE EFFECT OF TRANSPLANT AGE ON WATERMELON PRODUCTION

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A study to evaluate 'Crimson Sweet' watermelon *[Citrullus lanatus* (Thumb). *Matsum.* & *Nakai]* yield response to transplant age was conducted over 2 seasons in southwest Florida. A direct-seeded treatment and 6 commercially-grown transplant age treatments of 3, 5, 7, 9, 11, and 13 weeks were assessed in the spring. A direct-seeded treatment and 4 commercially-grown transplant age treatments of 3, 5, 7, and 9 weeks were assessed in the fall. The same containerized cell size was used throughout the study to minimize differences in root ball volume. Data from both seasons indicated that transplant age had no effect on yield of consecutive harvests or on total yield.

763

NITROGEN RATE AND CULTIVAR INFLUENCE NITROGEN DISTRIBUTION, ACCUMULATION, AND YIELD OF COLLARDS

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Collard plants were grown in sand culture with 5, 10, 15, 20 or 25 mM nitrogen in the nutrient solution. Cultivars included in this study were 'Vates, the standard open pollinated cultivar; 'Top Bunch' and 'Heavi Crop', which are both hybrid cultivars. Increasing the N rate from 5 to 10 mM resulted in an increase in plant dry weight for 'Top Bunch'. however it had no influence in the plant dry weight of 'Vates'. 'Top Bunch' plants cultured with 10 mM had a similar plant dry weight to 'Vates' plants that were cultured with 15 mM N. Leaf N concentration increased more for 'Vates' than 'Top Bunch' as the N rate was increased. Response to N rate was linear within the rates used in this experiment. A field experiment, conducted at the Clemson Experiment Station on a Lakeland sand soil (Thermic typic quartzipsamments) near Columbia, SC. Increasing the postplant N rate from 45 to 67 $kg \cdot ha^{-1}$ resulted in a yield increase of 7,600 $kg \cdot ha^{-1}$ for 'Top Bunch', whereas it had no influence on the yield of 'Vates'. The highest yield for all cultivars was obtained with a total postplant N rate of 134 $kg \cdot ha^{-1}$. In the field experiment, as in the sand culture study. leaf N concentration increased more for 'Vales' than 'Top Bunch' as the total postplant N rate was increased from 45 to 134 $kg \cdot ha^{-1}$. lnfluence of cultivar on nitrogen accumulation rate will be discussed.

764

DIURNAL AND LEAF AGE EFFECTS ON GAS EXCHANGE IN OKRA

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Two studies were conducted during summer 1990 to determine the influence of time of the day and leaf age on gas exchange of okra *(Abelmoschus esculentus* (L.) Moench). In the diurnal test, transpiration (E), conductance (g_s) and net photosynthesis (P_n were measured hourly from 0700-1800 h on three occasions. For the leaf age test, similar measurements were made weekly at midday starting 15 days after leaf emergence until senescence. Photosynthetically active radiation (PAR) at the time of gas exchange measurements was also recorded. The variation in E and P_n rates were significant at different hours of the day. The highest range for P_n (14.42-17.28 µmol $CO_2 m^{-2} s^{-1}$) and E (13.54-14.39 mmol $m^{-2} s^{-1}$) occurred between 1000-1500 and 1200-1400 h, respectively at PAR - 1440 µmol $m^{-2} s^{-1}$. The gas exchange rates significantly changed during leaf maturation with the highest range for E (12.64-14.71 mmol $m^{-2} s^{-1}$), g_s (1142.15-1279.75 mmol $m^{-2} s^{-1}$) and P_n (22.43-24.51 µmol $CO_2 m^{-2} s^{-1}$) occurring when the leaves were 22-23 days old. From these studies, it may be concluded that okra leaves are most active between 22-23 days of age with maximum photosynthetic rates occurring between 1000-1500 h.

765

IRRIGATION METHODS FOR GREENHOUSE TOMATOES

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The use of potential evapotranspiration (PET) values to estimate the nutrient solution and irrigation requirements of greenhouse tomatoes grown in peat bags was evaluated. Two levels of nutrient solution electrical conductivity (1.5 and 3.0mmhos) and two substrate-dryness irrigation setpoints (-45 and -65mbars) were used in a tensiometer controlled irrigation system. PET values were calculated from a number of environmental parameters using the Penman equation. Average daily PET values were calculated for both spring (134.4W/m^2) and autumn (95.2W/m^2) growing seasons. It was found that profiles of peat bag dryness were well correlated with PET values from one irrigation to the next. This was found to be true regardless of tension setpoint or solution conductivity. It was also found that PET was well correlated with plant leaf water potentials at the highest E.C. and/or at the more negative setpoints suggesting that PET measurements may be used to indicate plant water status under these conditions. It was concluded that where tensiometers may indicate at what setpoint to begin or end irrigation, PET values can give a good estimate of plant requirements for water and nutrients according to current and past environmental conditions.

192 ORAL SESSION (Abstr. 766-773) Strawberries

766

USE OF COVER CROPS IN PEST MANAGEMENT STRATEGIES FOR STRAWBERRIES

Marvin P. Pritts, Department of Fruit and Vegetable Science, Cornell University, Ithaca, NY 14853

Nonchemical methods of pest management are becoming important as fewer pesticides are available for use and as the market demands pesticide-free produce. Many plants have negative effect on pest populations, so our objective was to learn if any might be used to help control pests in commercial strawberry plantings. Both preplant and interplanted cover crops were examined for their effects on weed populations, nematode levels, soil nutrient status, soil moisture levels, and strawberry plant performance. Preplant cover crops included ryegrass, buckwheat, marigold, sudangrass, wheat, perennial rye, oats, and hairy vetch. Preplant cover crops had marked effects on weed populations the following year. Weed populations were reduced as much as 70% with a marigold cover crop. Interplanted cover crops included marigold, tall fescue and sudangrass. If height can be controlled, sudangrass competitively displaces weed species, yet does not compete strongly with the strawberry plant in established plantings. Strawberry yields in interplanted sudangrass plots were equivalent to herbicide-treated plots. Sudangrass appears to be a favorable interplanted cover crop if managed properly. Strawberry growers can reduce herbicide use significantly if certain preplant cover crops are used, and if an interplanted cover crop is managed correctly in established plantings.

767

EFFECTS OF FRUITING STATUS ON GAS EXCHANGE, CHLOROPHYLL CONTENT AND FOURTH DERIVATIVE SPECTRA OF STRAWBERRY

Chuhe Chen*, J. Scott Cameron. Stephen F. Klauer and Paul W. Foote, Washington State University Research and Extension Unit, 1919 N.E. 78th St., Vancouver, WA 98665

The influence of sink demand on the composition and function of the photosynthetic apparatus was monitored in strawberry *(Fragaria* x *ananassa).* The cultivar 'Joe Reiter' was grown in the field at Oxnard, CA, and 'Totem' and 'Olympus' were grown in the greenhouse at Vancouver, WA. CO_2 assimilation rate, chlorophyll content, attenuance and 4th-derivative spectra were measured on leaves taken from deflowered (DF) and fruited (F) plants at the red fruit stage.

CO_2 assimilation rates of DF plants were lower than F plants in the greenhouse and field. Chlorophyll b, total chlorophyll content and leaf dry weight of DF plants were higher, but chlorophyll a/b ratio was lower than F plants in the greenhouse and field. Chlorophyll a content of DF plants was slightly higher than F plants in the field, but not changed significantly in the greenhouse. Peak amplitudes of Ca 677 and Cb 630 in the 4th-derivative spectra of DF plants were significantly higher than F plants in the greenhouse. Cb 640 and Cb 649 of DF plants had greater amplitudes than those of F plants in the field.

Preliminary evidence suggests that changing sink demand may alter chlorophyll b content and the amount of light-harvesting complex in the chloroplast more significantly than it alters chlorophyll a content and the size of photosystems I and II.

768
SOLUTE ACCUMULATION IN LEAVES OF *FRAGARIA CHILOENSIS* AND *F.* VIRGINIANA IN RESPONSE TO WATER DEFICIT STRESS
Baolin Zhang and Douglas D. Archbold*, Department of Horticulture and Landscape Architecture, University of Kentucky, Lexington, KY 40546-0091

The effect of water deficit stress on foliar solute content of *Fragaria chiloensis* 'BSP14' (FC) and *F. virginiana* 'NCC85-13V' (FV) was studied to assess solute contribution to osmotic adjustment. Water deficits increased the total soluble carbohydrate content from 75 to 134 $mg \cdot g^{-1}$ leaf dry weight (DW) for FC and 60 to 81 $mg \cdot g^{-1}$ leaf DW for FV. Leaf starch content declined appreciably in both FC and FV in response to stress, though relatively more in FC, and total free amino acid content increased in FC only. The major solutes detected, in order of their relative contributions to osmotic potential at full turgor (π_{100}), were glucose, fructose, sucrose, and *myo*-inositol. Although the measured solutes did not account for the total π_{100}, they did account for the osmotic adjustment occurring in stressed FC plants. Lack of appreciable solute accumulation in FV was correlated with an inability to osmotically adjust in response to water deficit stress.

769
MULCH COLOR AFFECTS STRAWBERRY YIELD AND FRUIT SIZE
E. E. Albregts*, C. M. Howard, and C. K. Chandler University of Florida, IFAS, Agricultural Research and Education Center, 13138 Lewis Gallagher Rd., Dover, FL 33527.

Fruiting strawberry were grown on black polyethylene mulch which was painted white, yellow, red, orange, green, brown, blue, or was the original color black. Soil temperature at the 2.5 and 5 cm soil depth in the plant bed center was 2 to 4°C warmer with the black, blue, and brown mulches than with the white and yellow mulches during the warmest part of day. Red, orange, and green mulch temperatures were intermediate between that of the black and white mulches. At sunrise, soil temperatures were similar with all mulches. January fruit yields were lowest with dark color mulches; February yields were highest with yellow mulches; and seasonal yields were highest with white, yellow, orange, and green mulches. The lowest percentage of marketable fruit was with plants grown on yellow mulch because of a greater number of rotten fruit. Average fruit weight was highest with the yellow and white mulches.

770
DEVELOPMENTAL CHANGES IN CELLULAR COMPONENTS OF FRUIT SIZE IN STRAWBERRY.
G.W. Cheng* and P.J. Breen. Department of Horticulture, Oregon State University, Corvallis, OR 97331

Number of cells and mean cell volume of strawberry receptacles were determined throughout the development of secondary fruit of three day-neutral cultivars grown in a greenhouse. Receptacle tissue was digested with pectinase and cellulase and number of cells determined with a Batch counting chamber. Cultivars differed in fruit size throughout development. The size of ripe fruit was small (3.8 g) in 'Tillikum', medium (11.6 g) in 'TriStar', and large (15.6 g) in 'Selva'. Cell division continued in all cultivars for 15 days after anthesis (DAA) and was exponential during the first 10 days. The number of cell per fruit after 15 DAA averaged 0.71, 1.96, and 2.94×10^6 for 'Tillikum', 'TriStar', and 'Selva' respectively. Mean cell volume, as estimated from number of cells and volume of receptacle tissue, increased rapidly between 10 and 25 DAA. Cells of the pith were larger than those of the cortex during early fruit development. Mean cell volume of mature fruit was approximately $6 \times 10^6 \mu m^3$ in the three cultivars. Genotypic variation in fruit size was primarily due to the difference in number of receptacle cells.

771
SOIL SOLARIZATION EFFECTIVE AS A SOIL DISINFESTATION TECHNIQUE FOR STRAWBERRY PRODUCTION
T. K. Hartz and D. B. Holt, Dept. of Botany & Plant Sciences, Univ. of Calif., Riverside, CA 92521, and J. E. DeVay, Dept of Plant Pathology, Univ. of Calif., Davis, CA 95616

Soil solarization, alone and in combination with metam sodium, was evaluated as an alternative to methyl bromide/chloropicrin (MB/CP) fumigation, the standard soil disinfestation technique in the California strawberry industry. Treatments included MB/CP (67%/33%) at 250 and 400 kg ha-l, solarization alone, and solarization plus metam sodium at 75, 150, or 225 1 ai ha^{-1}. Studies were conducted in Irvine, California, an environment representative of the coastal strawberry production area; solarization treatments were applied late July through September for October strawberry plantings. All solarization and fumigation treatments provided substantial control of Verticillium dahliae and Phytophthora cactorum when compared to pathogen survival in untreated soil. Solarization gave significant control of annual weeds but was less effective than MB/CP in that regard. Solarization alone increased berry yield 12% over untreated plots; when combined with as little as 75 1 ha^{-1} metam sodium yield increase was 29%, equivalent to that achieved with either MB/CP rate.

772
SIMULATING THE EFFECT OF SPRING FROST AND CLIPPER WEEVIL ON YIELD OF STRAWBERRY
Shahrokh Khanizadeh, Michel Lareau, Michel Lamarre and Deborah Buszard*, Agriculture Canada, St-Jean-sur-Richelieu, Que., J3B 3E6.; Agriculture Canada, I'Assomption, Que, J0K 1G0; McGill University, Ste-Anne-de-Bellevue, Que, H9X 1C0

Strawberry growers are often faced with frost or clipper weevil injury but they have little information about the effect of such injury on total yield and fruit size. Experiments were conducted in two locations to simulate the effect of frost and clipper weevil injury on fruit size and total yield of 'Kent' and 'Glooscap' strawberries. Before opening of the primary flowers the following treatments were applied: 1) control, 2) primary flowers removed, 3) primary and secondary flowers removed. Removal of primary or primary and secondary blossoms did not significantly increase fruit weight in inferior positions at each harvest. When total yield was compared, however, significant differences among treatments were observed and removal of primary plus secondary flowers reduced yield by 40%. Removal of the primary flowers alone was not significantly different from the control. Contrary to previous reports, there appears to be some compensation in fruit weight following the loss of primary and secondary strawberry flowers. This compensation appears to be sufficient to negate the loss in yield resulting from the loss of primary flowers only.

773
FIELD SUSCEPTIBILITY OF STRAWBERRY CULTIVARS TO TARNISHED PLANT BUG INJURY
David T. Handley*, James F. Dill and James E. Pollard, University of Maine Cooperative Extension, P.O. Box 179, Monmouth, Maine 04259

Tarnished plant bug is an important insect pest of strawberries, causing a severe malformation of the receptacle. Twenty strawberry cultivars grown in a matted row trial were evaluated for susceptibility to tarnished plant bug injury over two seasons. A wide range of injury was observed among cultivars. Honeoye, Sparkle, Veestar and Canoga had significantly less injury than other cultivars, as measured by number and weight of fruit showing apical seediness. Mic Mac, Scott, Blomidon and Redchief were most susceptible. Cultivars with the least injury tended to have the greatest marketable yields. Characteristics which might impart resistance were not obvious from this study, but there is some evidence that tarnished plant bug resistance could be selected for in breeding programs.

44 WORKSHOP 2 (Abstr. 774-777)

774
DEFINING MARKET SEGMENTATION AND PRODUCT TARGETING AT A CONCEPTUAL LEVEL
Bridget Behe*, 101 Funchess Hall, Auburn University, Alabama, 36849-5408.

As improved technology and travel decrease the perceived size of the globe, consumers become more aware of new products and services. Markets consist of buyers with increasingly

different needs; sellers must strive to meet those needs to remain competitive. Meeting the needs of such a diverse population puts increased constraints on the already limited resources of a firm. In order to more efficiently utilize limited time and money, businesses can adopt a strategy of market segmentation and product targeting. This strategy involves the division of the market into segments based upon common needs of consumers and targeting specific products and services to those segments. These concepts are widely used in the business sector and also have potential for use in horticulture.

775

BUILDING A NEW FERTILIZER PRODUCT FOR THE GREENHOUSE MARKET

John R. Peters*, Grace Sierra, P. 0. Box 789, Fogelsville, Pennsylvania, 18051

The development of the Peters 20-10-20 water soluble fertilizer took place at a time when energy costs and raw materials costs were rising at double digit rate. Developing a product which could save money for greenhouse crop growers and meet the high performance standards established by the company was the challenge. Product, market, pricing, distribution, and communication issues and strategies will be discussed.

776

RECRUITING STUDENTS BY MARKETING HORTICULTURE

Margaret Balbach, Department of Agriculture, Illinois State University, Normal, IL 61761

Introductory Horticulture at Illinois State University is approved for inclusion in the University Studies Program. This program is comprised of courses whose content is considered of general importance to the educated layperson, rather than to the specialist in the field. Departments may use the University Studies Program as a means of attracting students to the field. This has been done with fair success with Introductory Horticulture. Because the course must provide personal enrichment, be broad in scope, offer a systematic design for further learning, and assure a breadth of knowledge and understanding, this course has been designed to focus on the economies of the various horticultural industries, how they are related to the socioeconomic history of the various regions of the country and how the marketing of horticultural products and enterprises affects the personal life of individuals. Acceptance of this approach has been two- fold: first: student evaluations are positive, a steady enrollment has been maintained, and the course has steadily provided 10% to 15% of new Horticulture students, and second: the University Studies review committee has twice affirmed the "tenure" of Introductory Horticulture in spite of increasingly stringent guidelines that discourage many traditional science courses.

777

FOCUSING EXTENSION RESOURCES TO DIVERSE CLIENTLE

Melvin P. Garber, University of Georgia, PO Box 1209 Tifton, GA 31793

As resources for extension programs become more limiting, extension specialists will have to focus on key leverage points to have a significant impact on client groups. This is especially difficult in the ornamentals industry where one specialist may be expected to improve the financial performance of several segments including propagators, container growers, in-ground producers, and landscape contractors. Also, each business has critical needs in several areas such as production, marketing, and regulations in order to be profitable. Historically, extension resources have been focused on 'how to produce' product with little attention on 'what to produce'. This presentation will demonstrate how to apply market research techniques, such as market channel maps, to ensure that an extension program is focused on key leverage points. The process will help specialists and administrators reduce duplication and spot critical areas not being addressed. The result is a better balanced support program and a greater financial return on the extension service investment.

57 WORKSHOP 5 (Abstr. 778)

778

INFLUENCE OF RESTRICTED ROOT-ZONE VOLUME ON SHOOT BEHAVIOR

Donald T. Krizek, Climate Stress Laboratory, ARS, U. S. Department of Agriculture, Beltsville, MD 20705-2350

Roots exposed to drying soil have been shown to generate non-hydraulic signals which can be communicated to the shoot. Such 'root signals' can cause an inhibitory effect on leaf growth without causing detectable water deficits in the shoots. Plants grown in restricted root zone volumes also typically show a reduction in leaf and shoot growth. Although water stress and root restriction both impair growth, their effects on photosynthesis, leaf initiation, and C, N, and P metabolism may be quite different. Abscisic acid (ABA) has been shown to be produced in the roots after only mild dehydration and to play a major role in signal transduction from the roots to the shoots. Whether root-restricted plants are capable of generating 'root signals' such as ABA or other plant hormones, which can be communicated to the shoot, remains to be determined. The application of new tools, such as gas chromatography/mass spectrography for hormone analysis, nuclear magnetic resonance imaging, and photoacoustic spectroscopy, should help to identify the nature of 'root signals' generated during root restriction and clarify their regulatory role in shoot behavior.

92 WORKSHOP 8 (Abstr. 779-782)

779

HISTORY OF VIDEO IMAGING TECHNOLOGY

Michael Fitzpatrick, New Image Industries, Inc., 21218 Vanowen St., Canoga Park, CA 91303

Twenty years ago, computers were valued primarily for their ability to perform mathematical calculations. In the last dozen years, we have come to depend upon them to manipulate text, as well. "Word Processing" is practically universal in businesses, large and small. Pictorial, or "Image Processing," had its origins in the many "paint" programs and with the "cut and paste" features found in desktop publishing programs. Graphics Image Processing (GIP) is different in that it works with a computer generated model or texture or video "real world" image as its base image. GIP allows the operator to merge graphics, text, 3-D models and live-video images in one dense, electronic "soup" that may be mixed to order. Within GIP applications, either computer generated or video images may be modified to alter them or create "artificial realities." The current generation of GIP tools effectively mixes graphics with text, and even sound. Some of today's many applications are found in engineering, architecture, instructional media, environmental planning, the performing arts, law enforcement, landscape design, medicine, dentistry and cosmetology.

780

BRINGING VIDEO IMAGING TO THE UNIVERSITY CLASSROOM

Dan T. Stearns, Department of Horticulture, 306 Tyson Building, Pennsylvania State University, University Park, PA 16802

Increased use of video imaging in the landscape design/build industry has created the need for professionals trained in its operation. The extensive marketing benefits associated with video technology ensure that it will rapidly become a common tool in firms providing professional landscape services. Students with training in video imaging are valued for

their technical abilities with both hardware and software. They are capable of visualizing and evaluating proposed design alternatives at the concept stage, which serves to enhance their understanding of scale, form, and spatial relationships. Students enrolled in classes utilizing the Imaging Lab have shown a high level of interest in learning to use video imaging tools. The Landscape Contracting Video Imaging Lab at Penn State contains 12 DOS workstations that are configured to use New Image Design System software. AutoCAD and Landcadd software are also installed to provide a link with computer aided design. Initial efforts in the development of the lab were concentrated on funding, space allocation and selection of hardware and software. Continuing efforts are associated with staffing, operating expenses and integration of lab activities into the existing curriculum.

781

APPLICATION OF IMAGING IN ENVIRONMENTAL PLANNING

Robert Sullivan, Reclamation Engineering and Geosciences Section, Energy Systems Division, Argonne National Laboratory, 9700 S. Cass Ave., Argonne, IL 60439

Traditionally, environmental planners have used video imaging technology to visualize landscape change through the creation of realistic simulations of visual impacts. Video simulations have been used to portray highway improvements, forest clearcuts, bridge and dam construction, erosion control and revegetation proposals and other large scale impacts. The relatively low cost, combined with the high level of realism achievable, make them ideally suited for analysis of controversial, large scale projects requiring extensive regulatory coordination, approval or permitting. Environmental planners can also use the powerful image editing tools used with such systems to assist in the visualization of geographic data. Current research at Argonne National Laboratory is exploring the use of video imaging technology to visualize Geographic Information System data and to visualize impacts from Army training maneuvers and energy facilities siting.

782

IMAGING IN PROFESSIONAL PRACTICE

Marie A. Stalnecker, Home Design Solutions, P.O. Box 13874, Reading, PA 19612

Home Design Solutions is a Pennsylvania based small business which offers video imaging services to a variety of professional practitioners and design-related businesses on a contract basis. The owner/operator will describe the problems and successes involved in starting and operating such a business, such as the marketing and pricing of the service. Practical questions which must be faced in each project include selection of original images, conflicting sun angles and contrast levels, and the management of shadows. Among the firm's customers have been landscaping contractors, remodeling contractors, developers, builders, architects, pool installers, public utilities, and individual homeowners. A selection of suggestions and comments on the usefulness of the application of video imaging to client needs will be included.

93 WORKSHOP 9 (Abstr. 783-786)

783

TECHNIQUES FOR IDENTIFYING GENETIC DIVERSITY

Norman F. Weeden (1)* and Stephen Kresovich (2), (1) Department of Horticultural Sciences and (2) USDA-ARS Plant Genetic Resources Unit, Cornell University, Geneva, NY 14456

Genetic diversity can be defined in terms of several different parameters, including habitat distribution, morphological variation, gene combinations, or allozyme or DNA polymorphism. These diverse methods will be briefly described and evaluated. Allozyme and DNA polymorphism have become popular for measuring genetic diversity because they usually display significant variation within a species or population, they offer a method for quatifying genetic diversity free of environmental effects, and they generate data that can be directly compared among taxa. However, molecular methods of measuring diversity may each introduce a particular bias. It is important to know if allozyme diversity data place taxa in the same relative order as data generated by morphological variation or DNA polymorphism. A comparison of data from several crops will be presented to investigate the degree to which relative levels of genetic diversity are technique-dependent Other applications of clearly defined genetic markers in the analysis of diversity also will be discussed.

784

PRESERVATION OF PHENOTYPES VS. GENOTYPES?GENES

Larry R. Baker*, Asgrow Seed, 1984 Berlin Road, Sun Prairie, WI 53590

Key examples of germplasm use to resolve industry varietal problems will be reviewed. The pros and cons of preserving phenotypes and genotypes will be presented with a view to the future from a private breeder viewpoint.

785

USE AND ABUSE OF THE CORE COLLECTION CONCEPT IN MANAGEMENT OF PLANT GENETIC RESOURCES

James McFerson* and Stephen Kresovich, USDA-ARS Plant Genetic Resources Unit, Cornell Univ., Geneva, NY 14456

Indiscriminate growth can lead to germplasm collections that are too large to maintain, too large to use, or both. Curators' budgets do not often increase with collection size, so conservation and utilization activities are hindered. Maintenance of genetic integrity in large collections is practically impossible. Evaluation is restricted to easily-observed traits, potentially limiting utilization. One strategy to improve management of large collections is the core collection concept, proposed by O.H. Frankel in 1984 and subsequently expounded by A.H.D. Brown. It establishes one subset of accessions, the core, selected to represent "with a minimum of repetitiveness, the genetic diversity of a crop species and its relatives". The other subset, the reserve, includes all accessions not in the core. Both subsets are conserved according to the highest standards feasible, but the core receives priority for characterization and evaluation to facilitate use and provide subsequent directed access to the entire collection. Use and abuse of the core concept will be discussed, including: definition of terms, genetic and statistical assumptions, and practical implementation.

786

FILLING IN THE GAPS IN COLLECTIONS

Calvin R. Sperling, National Germplasm Resources Laboratory, USDA/ARS, Bldg. 001, BARC-West, Beltsville, MD 20705.

Accessions presently held in the U.S. National Plant Germplasm System (NPGS) were analyzed using a gene pool concept in order to identify gaps in existing ex situ collections. U.S. dollar value was used as a preliminary criterion to rank the relative importance of over 80 crops. An assumption was made that priority should be given to preservation of primary gene pool species and lesser emphasis on secondary and tertiary gene pool species. This methodology resulted in identification of gaps in current NPGS collections. Ecogeographical data, rarity and threats to continued existence were additional criteria used in determining significance of apparent gaps in the collections. In general, horticultural crop collections have more significant gaps than did agronomic crops. Exploration priorities were developed to acquire germplasm to fill identified gaps. Explorations have been undertaken to fill existing gaps and further explorations suggested to develop collections reflecting needs and priorities for preservation of plant genetic resources. Recommendations are made to develop collections which will lead to preservation of maximum genetic diversity with a minimum number of accessions.

116 WORKSHOP 11 (Abstr. 787-789)

787

THIN-IT: A SOFTWARE PROGRAM FOR MANAGING CHEMICAL THINNING OF APPLES

Kathleen M. Williams* and M. Anthony Wright, Washington State University, Tree Fruit Research and Extension Center, 1100 N. Western Ave., Wenatchee, WA 98801

A decision support software package for chemical thinning of apples has been developed for use by growers, extension agents and fieldmen. The program, "Thin-It", is menu-driven and requires a minimum of 640K RAM on an IBM or IBM-compatible computer. It is a stand-alone, executable module. Output is written to screen, printer or to

disk as either simplified or expanded explanations and recommendations. An overall evaluation of the orchard block to be thinned, as well as specific evaluation of tree vigor, cultivar, rootstock, training system, etc. is included. Specific recommendations for chemical thinning of cultivars such as 'Red Delicious', 'Golden Delicious', 'Granny Smith', 'Gala' and 'Fuji' as influenced by fruitlet size and weather factors are included in the program.

788

EASY-MACS: EXPERT ADVISORY SYSTEM FOR MANAGING APPLE CROPPING SYSTEMS

Philip J. McInnis, Jr.*. Jan P. Nyrop and Walter A. Wolf, New York State Agricultural Experiment Station, Geneva, NY 14456

Rule-based expert systems often lack the powerful data-entry, data manipulation, and reporting facilties that are needed by end users. A hybrid decision support system (DSS) composed of an expert system, data management system, and utility programs can be designed to increase system usability, performance, and user friendliness. Such a system, EASY-MACS, has been developed for use in coaching implementation of apple integrated pest management. Hybrid systems promote the use of the correct programming tool for each function within a DSS. This speeds program development and maintenance and offers flexibility not available in a single programming environment. If carefully chosen, these tools can promote portability between the most widely used microcomputers. With careful design, these systems can be quickly adapted for use with crops other than the crop for which it was originally intended. Finally, the relationship between procedural programs, rule-based expert systems, and recommendations needs to be carefully explored to insure that the recommendations a DSS provides are easy to maintain without substantial changes in the programs.

789

DEVELOPMENT OF AN EXPERT SYSTEM

Janice E. McClure*, 501 Agricultural Sciences and Industries Building, University Park, PA 16802

The development of expert systems in agriculture consists of many steps such as problem definition, selection of experts, audience considerations, knowledge representation, coding, testing, and feedback. The problem definition and selection of experts for the problem domain are the foundation of a working system. Audience definition, economics and goal setting are areas that must be documented before knowledge engineering. Knowledge representation methods and system conceptual layout are the next level of development. The use of the user feedback and field testing data to improve the system are often overlooked. Benefits of expert systems for on farm decision making include education, efficiency, and adaption to changing regulations. Many aspects of agricultural expert systems are similar to traditional expert systems; yet special problem inherent in agriculture make the development interesting and challenging.

126 WORKSHOP 13 (Abstr. 790-796)

790

AN ADMINISTRATOR'S VIEWPOINT ON REFEREED EDUCATION PUBLICATIONS. Paul E. Read*, Department of Horticulture, University of Nebraska. Lincoln, NE 68583-0724

There are many avenues available for scholarly documentation of creativity al various levels of educational endeavor. HortScience and the newly created HortTechnology, the NACTA Journal and numerous others are appropriate. Department Heads, Deans and other pertinent administrators must do more than give lip-service to rewarding teaching. One way to document creativity by professional educators is by publishing innovative approaches, lab exercises that work, creative teaching technology and new applications of "old tried and true" methods. Such publications are valuable contributions that should be shared with one's peers and given credibility by administrators. Methods of evaluating teaching publications at the department administrator level and the relationship of such evaluation strategies to salary increments and promotion will he discussed.

791

EDUCATION PUBLICATIONS IN HORTTECHNOLOGY

Barbara Fails, Department of Horticulture, Michigan State University, East Lansing, MI 48824

HortTechnology offers educators an opportunity to publish articles on many topics of interest to other educators, as well as those in related horticultural communications fields. Topics suitable for publication are numerous; methods of incorporating analytical skills into the curriculum, practical laboratory exercises, new audiovisual and computer technologies for the classroom, and successful internship programs are but a small sample. Manuscripts submitted for publication are circulated for review, as with other refereed papers. Publishing enables innovative teachers to share and receive recognition for ideas, and rewards readers with useful skills and concepts that can improve teaching effectiveness.

792

JOURNAL OF AGRONOMIC EDUCATION--HISTORY, SCOPE, FUTURE

David A. Munn, Ohio State Univ. Agr. Tech. Inst., 1328 Dover Rd., Wooster, OH 44691.

The American Society of Agronomy created the Journal of Agronomic Education (JAE) in 1972 as a journal to serve educators and extension specialists. The journal publishes refereed manuscripts and notes and edited teaching ideas, book reviews, and profile features about famous agronomists. Manuscripts and notes describe courses, lab activities, teaching, or extension creation/utilization of computer software, slide sets, extension programming, and evaluation. Subscribers and contributors need not be Am. Soc. of Agronomy members. New directions include case studies as a manuscript category and review of videos in a mode like book reviews. A new more inclusive title and editorial board are possible future directions for the journal.

793

WRITING FOR THE AMERICAN BIOLOGY TEACHER

Randy Moore, Department of Biological Sciences, Wright State University, Dayton, OH 4.5435

The American Biology Teacher is a peer-reviewed journal that publishes original articles relevant to biology and biological education. Published papers include feature articles, "how-to-do-it" descriptions of laboratory experiments, book and audio-visual reviews, computer updates, essays, and editorials. The journal publishes about half of the manuscripts it receives, has a circulation of about 10,000, and is indexed in Current Contents.

794

THE TEACHING PROFESSOR, A NEWSLETTER FOR COLLEGE TEACHERS

Maryellen Weimer, Instructional Development Program, 1 Sparks Bldg., Penn State University, University Park, PA 16802

Many faculty continue to argue that teaching is not rewarded or recognized. Most often the argument is that administrators don't value it. Frequently faculty don't either as witnessed by the lack of published literature on teaching and learning. An education research literature does exist, but faculty in the trenches seldom read it and are quick to criticize it. They want a literature of "practice"; instructional strategies, techniques, experiences and ideas from fellow pedagogues who know the challenges of teaching college students today. The Teaching Professor, a ten-month, six-to-eight page newsletter publication, is written for, by and about faculty members. Its interdisciplinary character encourages dialogue about general teaching and learning issues. Now in its fourth year of publication, the newsletter has 19,000 subscribers making it one of the most widely read publications in higher education.

795

A HORTICULTURIST PUBLISHING IN REFEREED SCIENCE EDUCATION JOURNALS

David R. Hershey, Department of Horticulture, University of Maryland, College Park, MD 20742-5611

Horticulturists generally publish in three major types of periodicals: refereed research, grower, and popular. A fourth major periodical type, refereed science education, is seldom used but is an excellent place for horticultural education articles. Horticultural teachers often write excellent lectures, labs, problem sets, etc. for their own courses, but do not receive appropriate credit for these scholarly writings because they remain unpublished. Also, other teachers cannot easily obtain such unpublished teaching materials, causing them to waste time creating similar materials. A solution to these problems is for horticulturists to document and share their scholarly achievements in education by

publishing in science education journals. Among the benefits to this approach is that a now-absent horticultural perspective can be brought to education journals in general science, biology, chemistry, and math. Also, other university professionals may be persuaded to adopt the National Science Foundation's position that "the term 'research' includes projects to improve the teaching and learning of science".

796
NON-PRINT MEDIA FOR HORTICULTURE
Ellen T. Paparozzi*, Dept. of Horticulture, 377 Plant Sciences, University of Nebraska, Lincoln, NE 68583-0724 and Robert E. Tripepi, Dept. of Plant, Soil and Entomological Sciences, University of Idaho, Moscow, ID 83843-4196

Providing easily accessible resources for teaching has encouraged teachers to utilize new, different or updated resources for lectures and laboratories. Non-print media, an important part of these resources, are increasing in popularity. With this in mind, the ASHS Educational Media Committee has compiled a listing of available slide/tape sets, videotapes, movies and videodiscs covering all aspects of horticulture. As the number of educational media which cover horticultural topics increases, educators and the general public want to know which are worthwhile and which are not. The question is how (or even if) these media should be peer-reviewed to produce a select listing marked 'approved by ASHS'. A draft of pre- and post-evaluation guidelines will be presented. Additionally, since reviewing media will be a time-consuming effort, who should review these media and how these individuals would be recognized for this effort will be discussed.

143 WORKSHOP 15 (Abstr. 797-801)

797
BLACKBERRY CULTIVARS OF THE WESTERN STATES
Bernadine C. Strik*, Department of Horticulture, Oregon State University, Cordley Hall 2042, Corvallis, OR 97331.

Blackberry production statistics were compiled from surveys mailed to berry production specialists in British Columbia, Canada, and Washington, Oregon, and California, USA. Production in the Western states/provinces will be summarized with regards to total acreage, cultivars grown, market (processing, fresh, or Pick-Your-Own), and method of harvest (machine or hand). Trailing, erect, and semi-erect cultivars will be discussed separately. The genetic characteristics of current cultivars that most limit production as well as research trends and cultivar trials will be discussed for each area.

798
BLACKBERRY CULTIVARS OF THE MID WESTERN, EASTERN AND SOUTHERN UNITED STATES
John R. Clark, University of Arkansas Fruit Substation, Rt. 2 Box 154, Clarksville, AR 72830

Results of a survey conducted in early 1991 to determine blackberry cultivars grown in the midwestern, eastern and southern United States will be reported. Information presented will include total production area by cultivar, use (processing or fresh) and method of harvest. Additionally, predictions of trends of future production in each region will be reported. Current research programs on blackberries and their focus will be updated, as will respondent's opinions on limiting factors for blackberry production in their states.

799
RASPBERRY CULTIVARS IN THE PACIFIC NORTHWEST AND CALIFORNIA
Patrick P. Moore, Washington State University, Puyallup Research and Extension Center, Puyallup, WA 98371 and Hugh A. Daubeny, Agriculture Canada, Research Station, 6660 N.W. Marine Drive, Vancouver, B.C., V6T 1X2

'Willamette' has been the established floricane fruiting cultivar in Pacific Northwest for many years. In recent years it has been replaced by newer cultivars. 'Meeker' is now the most widely grown cultivar. Recent releases 'Comox', 'Chilliwack' and 'Tulameen' are still finding their market niches. 'Chilcotin' is grown for fresh market and 'Skeena' in British Columbia and colder inland sites.

'Heritage' is the established primocane fruiting cultivar in the Pacific Northwest with 'Malling Autumn Bliss' as an earlier alternative. 'Summit' is also earlier than 'Heritage' and is adapted to heavier soils. These early maturing cultivars provide an overlap with late fruiting floricane fruiting cultivars. Several selections out of England and Australia look promising. There is a need for more early fruiting alternatives to 'Heritage'.

In California, 'Heritage' and 'Willamette' are widely grown, but the best cultivars are from the private sector.

800
RASPBERRY CULTIVARS FOR THE UPPER MIDWEST
Jim Luby, Department of Horticultural Science, University of Minnesota, St. Paul, MN 55108.

The current state of cultivar usage and development in the upper Mississippi Valley and Great Lakes areas will be discussed. Data from current cooperative cultivar evaluation trials will also be presented. Detailed yield and growth component analyses have been used to determine how to improve primocane bearer productivity.

801
RASPBERRY CULTIVARS IN THE EASTERN U.S.
Harry Jan Swartz and S. Kristine Naess, Department of Horticulture. University of Maryland, College Park, MD 20742

A survey was conducted of North American Bramble Growers Association members. Questions included those on cultivar usage and performance. Results will be reported. Of interest will be the increasing use of 'Redwing' in the southeast and the use of several newer cultivars from breeding programs within and outside the region. The initial performance of advanced selections from the cooperative University of Maryland, Virginia Southern Piedmont Station and Rutgers University breeding program will be presented.

144 WORKSHOP 16 (Abstr. 802-803)

802
EFFECTS OF OVULE POSITION AND SEED ABORTION ON SEED QUALITY IN PHASEOLUS COCCINEUS.
Oscar J. Rocha and Andrew G. Stephenson,* Department of Biology, Penn State University, University Park, PA 1682.

The ovaries of P. coccineus possess 6 linearly arranged ovules. We found that about 95% of the ovules are fertilized but only about 50% produce mature seed. The others abort early in development. Moreover, the 3 ovules at the stylar end of the ovary are more likely to Produce mature seed than the 3 at the basal end of the ovary. The seeds from the 3 stylar end ovules are also more vigorous than the seeds produced at the basal end. An experimental destruction of the 3 stylar ovules, after fertilization but prior to any seed abortion, significantly increased the probability of seed maturation in the 3 basal ovules, indicating that some potentially viable seeds are aborted in the basal Positions. Finally, the seeds from basal ovules of control fruits are more vigorous than the seeds from experimental fruits indicating that the least vigorous seeds from the basal ovules are typically the ones that abort.

803
DOES SEED VIGOR INFLUENCE CROP YIELD?
Dennis M. TeKrony*, and Dennis B. Egli, Department of Agronomy, University of Kentucky, Lexington, KY 40546-0091

Both seed viability and vigor directly affect the performance of seeds planted to regenerate the crop. Although seed quality can influence many aspects of performance (e.g., total emergence, rate of emergence), this presentation will primarily examine the relationship of seed vigor to one aspect of performance - crop yield. Reductions in yield can be indirectly related to low seed vigor if the low vigor seed results in plant populations that are below a critical level. Thus, we investigated the direct effects of seed vigor on yield in the absence of population differences for annual crops that are harvested at three stages; during vegetative growth, early reproductive growth or at full reproductive maturity. Seed vigor affects vegetative growth and is frequently related to yield in crops that are harvested during vegetative growth or during early reproductive growth. However, there is usually no relationship between vigor and yield in crops harvested at full reproductive maturity because seed yields at full reproductive maturity are usually not closely associated with vegetative growth. The use of high vigor planting seed can be justified for all crops; however, to insure adequate plant populations over the wide range of field conditions which occur during emergence.

806
Environmental and Postharvest Temperature Stress Alters Tomato Fruit Chilling Sensitivity and Quality
Mikal E. Saltveit, Mann Laboratory, Department of Vegetable Crops, University of California, Davis 956 16

Plant temperatures fluctuate in accord with seasons, weather patterns, time of day, and movement of clouds and wind. Physiological responses to these changes can alter the sensitivity of tissue to subsequent temperature stresses. Diurnal temperature changes affect plant sensitivity to low, non-freezing temperatures that cause chilling injury in plants indigenous to the tropics and subtropics. Similar changes in chilling sensitivity can be induced in the laboratory by conditioning tissue for 4 to 6 hr at various temperatures. Freshly harvested tomato fruit that were conditioned at 10C to 20C developed similar levels of chilling injury after holding at 2.X for 4 to 7 days. Chilling injury was more severe in fruit conditioned at 25% to 32C, while fruit conditioned at 34C to 37C were more chilling tolerant than fruit conditioned at 10C to 20C. The physiological basis of enhanced chilling sensitivity after conditioning at 25C to 32C is unknown, but the tolerance induced by conditioning at 34C to 37C appears related to the synthesis of heat-shock proteins. Since chilling injury is cumulative from the field to the consumer, and since it adversely effects quality factors like ripening, flavor, texture and disease susceptibility, the control of chilling injury is paramount to modern postharvest handling and marketing.

153 WORKSHOP 18 (Abstr. 804-806)

804
ENVIRONMENTAL AND CULTURAL FACTORS AFFECTING THE POSTHARVEST QUALITY OF TEXAS CITRUS
John Fucik, Texas A&I Citrus Center, P. 0. BOX 1150, Weslaco, TX 78596

Within the world wide citrus trade, significant quantities of fresh fruits enter both processed and fresh markets. To stay competitive growers must regulate the many preharvest stress factors which have an impact on postharvest fruit quality. These stresses can be attributed to: climate, cultural, and physiological/ genetic interactions. During the growing season these factors may act alone or in concert to affect fruit size; peel texture, thickness and blemishes; fruit shape; flesh color and texture; and the amount of juice and its flavor. These preharvest stress factors affecting fruit quality subsequently alter postharvest fruit shipability, marketability, and storage life.

805
HEAT STRESS AT HARVEST ON POSTHARVEST MUSKMELON FRUIT QUALITY AND PHYSIOLOGY
James R. Dunlap*, Texas A&M University System, Texas Agricultural Experiment Station, Weslaco, TX 78596.
G.E. Lester and S.E. Lingle, USDA-ARS, Subtropical Agricultural Research Laboratory, Weslaco, TX 78596.

Exposure to high temperatures before and during harvest can adversely affect the postharvest quality of fruits and vegetables. The underlying cause of deterioration is often traced to physiological changes triggered in response to temperature stress. Muskmelon fruit *(Cucumis melo* L.) can be exposed to temperatures as high as 57C at the fruit surface during maturation, harvest or post-harvest handling. Brief treatments of less than 5 min at 57C are actually beneficial to controlling diseases during storage without adversely affecting the physical integrity of the fruit. However, longer exposure to slightly lower temperatures (45C for 1.5 or 3 hr) resulted in elevated ethylene production, electrolyte leakage, sucrose accumulation and sucrose synthase activity. The increase in electrolyte leakage indicates either membrane damage or altered function, possibly related to changes in lipoxygenase activity and lipid composition of hypodermal plasma membranes. hypodermis or rind appears to be the last barrier to loss of tissue moisture and structural collapse in the ripening fruit.

154 WORKSHOP 19 (Abstr. 807-812)

807
POLICIES AFFECTING PESTICIDES AND PESTICIDE USE
Ricardo E. Gomez*, Extension Service, Rm 3347-s, USDA, Washington DC, 20250

Pesticides and pesticide uses are governed by several federal, state, and in some cases, local laws and regulations that affect consumers in various ways. Presently, policies are being developed based on scientific findings, however, there is a danger that policies could be developed and implemented based on perceptions and mis-information, creating severe constraints on agriculture and the public in general. The role of Extension is to ensure that those in agriculture understand the need for regulation, the necessity for maintaining the environment, and the perceived risks by the consumer. At the same time Extension needs to communicate the need for a complete array of tools for pest management including the prudent use of pesticides.

Horticultural food crops, especially those that are eaten fresh and used in infant/baby foods are going to be under public scrutiny from the pesticide use point of view. As horticulturists, we must become involved in pesticide education at the national, State, and local levels. We should be active in the IPM. PIA, PAT and the nascent ICM programs. Through these programs we can be more attuned to policies and practices and better able to communicate with the general public as well as with the agricultural community.

808
ASPECTS OF CURRENT PUBLIC PESTICIDE POLICY
Gordon E. Moore, EPA, 841 Chestnut Bldg., Philadelphia, PA 19107

Newer, safer pesticides are on the horizon as older pesticides disappear under EPA mandate - Revisions of Federal pesticide regulations, dating from 1988, have focused on examing registration data for all currently registered pesticides. Future pesticide registrations will emphasize safer, short term active pesticides. Many older pesticides are being removed from the market because they do not meet current Federal pesticide standards.

The level of competence for state certified applicators has risen in most states due to better training. Applicator tests are targeted toward areas of misuse modeled on computer-based questions. New worker protection regulations in time will make working conditions safer, but new container designs and disposal regulations are nearly developed. A national drinking water survey shows that some wells are contaminated as result of high fertilizer and nitrogen (manure) use. States will be making plans for protection of both ground water and endangered species as related to pesticide use.

809
PUBLIC RISK PERCEPTIONS
Winand K. Hock, Director, Pesticide Education Program, 113 Buckhout Laboratory, Penn State University, University Park, PA 16802

One of the major misconceptions in contemporary society is the widespread belief that our food supply is unsafe. The public's perception of risk is quite different than scientific assessment of risk. While scientists see microbial contamination as the key issue (100 to 10,000X greater risk than from exposure to pesticide residues), consumers appear to be most concerned about the effects of synthetic pesticides and fertilizers in the food they buy. Consumers equate "synthetic" with harmful or bad and "natural" with safe or good, yet they ignore the fact that 99.9% of all pesticides humans are exposed to are naturally occurring. Americans eat approximately 1.5 g. of natural pesticides per person per day, or about 10,000 times more than synthetic pesticide residues. Although few plant toxins have been tested for carcinogenicity so far, of those tested about half are rodent carcinogens. Contrary to public perception, environmental pollution accounts for only 2% of all cancers. By contrast, smoking, diet and other personal lifestyle choices account for more than 75%.

810
PESTICIDES AND WATER QUALITY
Scott A. Harrison*, Pennsylvania State University, 113 Buckhout Laboratory, University Park, PA 16802.

The quality of U.S. drinking water has gained widespread attention in the past decade and is the subject of an extensive federal initiative to improve and maintain it. Agriculture is considered by some authorities to be the largest nonpoint source of pollutants (e.g., sediment, nutrients, pesticides) contributing to the degradation of water quality. Agricultural pesticides have been exhaustively studied to determine the extent of their occurrence in water resources and the mechanisms by which they get there. Recently, the EPA estimated that about 10% of U.S. community drinking water wells and 4% of rural domestic wells contain detectable residues of at least one pesticide. Wells containing pesticide residues in excess of federal health guidelines were estimated to be less than 1% of the total, however this number represents some 375 community and 100,000 domestic wells. A similar comprehensive survey of surface drinking waters has not been conducted. Alleviation of point sources entails the identification and management of pesticide storage, mixing, and disposal problems. The conditions leading to the nonpoint movement of pesticides into ground and surface waters are quite complex and require a thorough site assessment to predict the likelihood of contamination. Site assessment requires the understanding of interactions between pesticides, soils, biota, and various components of the environment. The problem will not likely be managed simply by the use of alternate pesticide products since growers are limited in their choice of chemicals by factors such as efficacy, resistance management, economics, and federal pesticide laws. The development of total crop management strategies that address production, economic, and environmental factors equally is necessary in order to effectively maintain water quality in agricultural ecosystems.

811
ALTERNATIVE PEST MANAGEMENT OPTIONS FOR CONSUMERS
Diane Matthews-Gehringer*, Terry Schettini, Ed Lachowski, Rodale Research Center, 611 Siegfriedale Rd., Kutztown, PA 19530

Many consumers are requesting information on alternative pest management methods. Information is somewhat limited and not readily available on effective alternatives such as horticultural oils, insecticidal soaps, biologicals, botanicals, commercially available parasites and predators, traps, barriers, and cultural techniques. Extension workers, garden center managers and pest control companies are aware of the importance of educating consumers on home and yard sanitation and management to prevent pest problems including proper soil management, selection of hardy, resistant cultivars, and mixed plantings. Consumers need to have information on the pest's biology, any natural enemies which can be encouraged and conserved and how IPM strategies including monitoring before any spray applications can facilitate the sensible use of pesticides and may save them money.

812
PESTICIDE SAFETY FOR HOMEOWNERS
B. Rosie Lerner, 1165 Hort Bldg, Purdue University, Department of Horticulture, West Lafayette, IN 47907-I 165

Safe use of pesticides should be of concern to all gardeners. Yet 38% of individuals surveyed never read the product labels, and less than 50% wear protective clothing, according to a recent California study.

Each US state was surveyed to obtain a list of teaching materials used to extend information on pesticide safety. Some states offer a bulletin on the subject and fewer have audio/visual materials. A summary of the results will be available.

Much of what is available is aimed at commercial growers, rather than home gardeners. Yet, pesticide products were purchased by over 50% of US households in 1988, according to a National Gardening Survey.

A video tape developed at Purdue University attempts to maintain audience interest in what could be a dull subject through the use of light humor. Highlights of the tape will be presented.

182 WORKSHOP 24 (Abstr. 813-815)

813
APPROACHES TO BREEDING VEGETABLE CROPS FOR IMPROVED NUTRITIONAL QUALITIES AND CONSUMER ACCEPTABILITY
Teddy E. Morelock*, Dept. of Horticulture & Forestry, University of Arkansas, Fayetteville, AR 72701

Vegetable breeding at the University of Arkansas has always considered nutritional and culinary quality as important selection criteria. Much of the breeding work has centered around processing vegetables. Close cooperation with scientists in other departments has made processing of advanced breeding lines one of the last steps before varietal release is considered. These general procedures have been used for mustard, okra, processing tomatoes, turnip greens, southern peas, and spinach. Frequently traits such as stability of okra pod color after blanching, bleeding of the eye and percentage of split seed with southern peas would not be detected by the breeder unless the final product was processed. This attention to processed quality has allowed breeders to make significant progress in varietal improvement with these crops.

814
BREEDING CARROTS FOR IMPROVED NUTRITIONAL AND CULINARY QUALITY
Philipp W. Simon, USDA, ARS, Dept. of Horticulture, University of Wisconsin, Madison, WI 53706.

The carotenes of carrots account for 30% of the vitamin A available to U.S. consumers. Genetic improvement of carrot nutritional value has resulted from both intensive selection pressure in U.S. germplasm and the incorporation of Oriental germplasm into Western genetic background. Genetic increases in carotene content have been possible without compromising other horticultural aspects. To assure consumer acceptance of high carotene carrots, culinary quality has also been improved. Future breeding efforts should combine sweet, mild flavor and succulent texture with high carotene content. Also needed is genetic research to estimate the combining ability of carotene content and desirable flavor and to elucidate the effects of specific genes on carrot culinary and nutritive quality.

815
BREEDING TOMATOES FOR CONSUMER AND NUTRITIONAL QUALITIES
E.C. Tigchelaar, Dept. of Horticulture, Purdue University, West Lafayette, IN 47907.

"Not so long ago, tomatoes were soft and juicy and tasted of tomato. Several varieties available in today's supermarket are rubbery gobs of cellulose that taste of nothing. They are bred that way for mechanical picking" (Miller, 1974). Is this still a widely held perception of fresh tomatoes of the 1990's? What progress has been made to meet consumer quality and nutritional demands for this commodity as it is used in fresh or processed form? Given its diverse uses, this presentation will review the parameters of tomato quality for processing and fresh use. Progress and limitations to improving fresh tomato quality will be emphasized.

816

OVERVIEW OF SOCIAL SCIENCE RESEARCH METHODOLOGY IN HORTICULTURE

Rex H. Warland*, Department of Agricultural Economics and Rural Sociology, Penn State University, University Park, PA 16802

During this presentation, several basic issues related to survey research will be introduced and illustrated. First several issues related to sampling will be considered. These will include how to determine sample size, where to obtain a sampling frame, how to compute error rates, and how to estimate costs associated with sampling. Mail surveys, telephone surveys, and face-to-face interviews will then be described and compared. The state of the art of these methods will be discussed, the costs associated with each method will be reviewed, and the advantages and disadvantages of each method will be described. Response rates will also be discussed. Next we will briefly review the kinds of information that can and cannot be obtained from a survey. Several principles concerning question wording, question order, and question context will be introduced. The presentation will conclude with a few suggestions about the linkages between surveys and statistical analysis.

817

FOCUS GROUP INTERVIEWS AS A RESEARCH TECHNIQUE IN HORTICULTURE

Candice A. Shoemaker*, Department of Agriculture, Berry College, Rome, GA 30161

Focus group interviews are a commonly used qualitative technique in market research and social science research. Focus groups are useful either as a self-contained means of collecting data or as a supplement to both quantitative and other qualitative methods. Focus groups are an effective way to investigate what a certain population thinks as well as why they think as they do.

Focus groups can be successfully used for market research in horticulture as well as for research on human issues in horticulture. A specific example using focus group interviews to investigate the what and why of sympathy flower sales will be presented.

818

USING QUESTIONNAIRES AS RESEARCH TOOLS IN HUMAN ISSUES IN HORTICULTURE

Virginia I. Lohr*, Department of Horticulture and Landscape Architecture, Washington State University, Pullman WA 99164-6414

There are two general types of questionnaires: 1) those developed by researchers for a particular study or issue, and 2) standardized tests prepared by social science researchers for use in many studies. Among the latter are well-established and tested questionnaires for which the validity and reliability are well known. These standardized questionnaires are especially important if a researcher wants to compare responses to standardized reference groups. Questionnaires developed for a particular study are essential to answer specific research issues that have not been addressed by other researchers. Both types of questionnaires have important applications in research related to human issues in horticulture.

The appropriate use of both types of questionnaires will be presented by showing examples from studies in human issues in horticulture.

819

FOOD SAFETY POLICY AND EDUCATION: INDUSTRY IMPACT

Orlo Ehart, CIBA-GEIGY, Greensboro, NC 27419-8300

A risk-averse public views residues in food as a harmful side effect to some pesticide uses. We, in industry, supported by reams of data and years of experience, see no evidence that exposure to health-based tolerance levels is harmful. Many food safety experts profess scientific views that our food supply is the safest. Some politicians and interest groups, while agreeing policy must be set using the best available science, feed public fears by claiming residues are under-regulated.

The federal tolerance program is conservative and protects our food supply. Because of public concerns and some inconsistencies in policies, food safety will be debated in the media, states, and Congress. Some existing proposals would impose regulatory burdens without adding protection.

Science education is needed to assure food safety policy is based on knowledge and facts. But, public policy is based on credibility and trust. Industry and academia must venture outside traditional views of education to gain public trust needed to support rational food safety regulation.

820

THE AGRICULTURAL CHEMICAL INDUSTRY'S ROLE IN LEGISLATION AND PUBLIC PERSPECTIVE

John F. McCarthy, National Agricultural Chemicals Assn., 1155 Fifteenth St., N.W., Washington, DC 20005

The National Agricultural Chemicals Association's primary purpose has been, and continues to he, to provide a collective industrial force to advance the level of public understanding of the value of crop protection chemicals in the production of food and fiber, to foster legislation that will promote the safe and proper use of industry products and encourage continuing research for new products. While there are disagreements on what constitutes appropriate legislation, all agree that safety should be the number one concern. To assure this, we must have a strong and ever-vigilant regulatory system of approval and monitoring. While we can take comfort in the fact that we have such a system and our food is safe, we can do better-improvements can, and should, be made. The science requires change and the public demands it. In the final analysis, public trust is the most important element.

821

GOVERNMENT REGULATIONS, AND VIEWS ON FOOD SAFETY AND EDUCATIONAL STRATEGIES

L. George Wilson*, 1990-91 ASHS Congressional Science Fellow, Senator Terry Sanford's Office, 716 Hart Senate Office Building, Washington, DC 20510

Government regulations dealing with food safety and Pesticides are drafted by legislators and staff members who often have only limited knowledge of the subject matter involved. However, they have unlimited access to the extensive resources of the Congressional Research Service and its excellent research staff. They also utilize USDA, EPA, FDA, university, and private professionals and other information networks. Input from horticulturists and other scientists is encouraged and welcomed. Final legislation is the result of the democratic processes of deliberation and compromise, In 1991, Congress is considering reauthorization of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), the basic law guiding EPA's regulation of pesticides. Lawmakers also are expected to reintroduce legislation to modify EPA's regulation of pesticide residues in food under the Federal Food, Drug, and Cosmetic Act. Also, agriculture's role in environmental quality could receive attention during upcoming deliberations on reauthorization of the Clean Water Act.

822
INFORMING AND EDUCATING THE PUBLIC ABOUT THE RISKS OF AGRICULTURAL CHEMICALS
Vincent T. Covello, Ph.D., School of Public Health, Columbia University, 60 Haven Ave., B-l, New York, New York 10032

This paper reviews the literature on informing and educating people about the risks of agricultural chemicals. The paper describes the principle obstacles to public understanding and concludes with a set of guidelines for effective risk communication. The paper argues that the goal of informing people about such risks seems easy in principle but surprisingly difficult in practice. To be effective, several significant obstacles must be overcome : (1) characteristics and limitations of scientific data: (2) limitations of government, industry, and other sources of information in communicating with the public; (3) characteristics and limitations of the media in reporting information: and (4) characteristics and limitations of the public in understanding information about the risks of agricultural chemicals.

72 COLLOQUIUM II (Abstr. 823430)

823
MULTILEVEL HABITAT MANAGEMENT AS A PARADIGM FOR DEVELOPING REGENERATIVE CROP PRODUCTION SYSTEMS
Terry M. Schettini*, Rodale Research Center, 611 Siegfriedale Road, Kutztown, PA 19530

Maximizing productivity on a per plant or per acre basis has provided a successful R&D model for crop production systems that are based on field-scale management strategies. Optimizing productivity in evolving crop production systems that are based on agroecological principles will require managing the various levels of "habitat" that affect crop growth and development. Macro-habitat includes watershed-scale to farm-scale factors; meso-habitat includes field-scale to plant row/bed-scale factors; micro-habitat includes individual plant-scale to harvested plant part-scale factors. In addition, each of these levels is composed of both aerial and subterranean factors. Both component-focussed and systems-level research are needed to understand and optimize both main effects and interactions in regenerative crop production systems. The multilevel habitat management model provides a frame work for (1) designing both component and agroecosystem studies, and as importantly (2) for organizing and synthesizing the resulting information.

824
INTEGRATED SUSTAINABLE VEGETABLE PRODUCTION SYSTEM
Sharad C. Phatak*, Horticulture Department, University of Georgia Coastal Plain Experiment Station, Tifton, GA 31793

Cover crops, living and dying mulches, relay cropping, companion cropping, crop rotations, etc. are important components in sustainable agriculture. However, each system influences fertility, diseases, nematodes, and insect pests differently. Beneficial arthropods and other beneficial organisms are also affected. Work done on individual components often results in reports which are contradictory. Biological, cultural and mechanical strategies will play important roles in sustainable production to reduce dependence on chemical control of weeds, diseases and insect pests. Use of cultivars resistant to diseases, nematodes, and insects, and cultivars which will compete with weeds and other stresses will become integral parts of any sustainable crop production system. If we are to achieve a sustainable vegetable production system, risks and benefits from several strategies will have to be evaluated. Appropriate strategies will vary from region to region and from farm to farm in different regions.

825
USING COVER CROPS TO MANAGE ARTHROPODS ON TRUCK FARMS
Robert L. Bugg, Sustainable Agriculture Research and Education Program, University of California, Davis, CA 95616.

Ideally, cover crops should harbor few pests of associated vegetable crops, but high densities of beneficial insects. Pests may disperse to vegetable crops when cover crops mature, die, are stressed by drought, or are mowed, tilled, or herbicided. Cover crops may be managed to prevent the buildup or reduce the movement of pests, through timely mowing and irrigation, mowing or tillage of alternate ships, choice of early- or late-maturing varieties of cover crops, and seeding mixtures. Some of these tactics are mutually exclusive; others may be complementary.

When pests are scarce on vegetable crops, alternate prey or hosts amid cover crops may sustain beneficial arthropods. Nectar or honeydew are desirable whenever beneficial insects are active. Mowing and tillage prompt dispersal of beneficial arthropods. The sickle-bar appears a gentler alternative to flail or rotary mowing; setting flail or rotary mowers at greater heights might permit better survival of beneficial insects. Disking appears less damaging than deep cultivation. Timing of mowing or tillage may be adjusted to allow maturation or dispersal of beneficial insects. Remnant strips of cover crops could provide habitat to beneficial insects.

826
ALTERNATIVE TILLAGE AND HERBICIDE OPTIONS FOR SUCCESSFUL WEED CONTROL IN VEGETABLES
Russell W. Wallace* and Robin R. Bellinder, Dept. of Fruit and Vegetable Science, Cornell, Ithaca, NY

Recent research with four vegetable crop systems has involved mulches (winter-killed and spring-killed) combined with tillage and reduced rates of herbicides. These systems were evaluated for ease of mulch establishment and regulation, weed suppression, and yield performance within each vegetable/mulch combination. Potatoes (Solanum tuberosum), sweet corn (Zea mays), snap beans (Phaseolus vulgaris) and tomatoes (Lycopersicon esculentum) were evaluated in one or more of the following mulches: rye (Secale cereale), red clover (Trifolium pratense), oats (Avena sativa), hairy vetch (Vicia villosa), red fescue (Festuca rubra), and annual ryegrass (Lolium multiflorum). Regulation varied with mulch, and was not always complete. Greatest weed suppression occurred with rye and red fescue (4 to 5 weeks), however, red fescue was never completely controlled. Weed control and crop yields were generally equivalent regardless of herbicide rate.

827
COVER CROPS, N CYCLING AND SOIL PROPERTIES IN SEMI-ARID IRRIGATED VEGETABLE PRODUCTION
Carol Shennan, Dept. of Vegetable Crops, University of California, Davis, CA 95616

A large body of literature exists that describes the ability of cover crops to enhance soil organic matter, improve physical properties, and in the case of legumes, provide fixed N. Most of this work relates to temperate regions, where limitations to biological processes differ from those in semi-arid regions. The utility and benefits of incorporating cover crops into crop rotations in semi-arid systems are less well documented. Discussion will be limited to winter cover crops, since production constraints and desirable characteristics for summer cover crops are quite different. In Mediterranean regions, such as California, the climate is characterized by hot, dry summers and mild, wet winters. Mild winters, together with winter rains (or optional minor irrigation in years of low, or unusually distributed rainfall) support high rates of biomass production and N-fixation. These conditions also promote rapid root development which can help reduce leaching of residual nutrients by fall/winter rains. High summer temperatures combined with frequent irrigation, however, favor rapid decomposition of soil organic matter such that large increases in % organic matter are generally nor observed when cover crops are used. Yet cover crop incorporation does affect soil microbial and biological processes. The question is how are properties such as N mineralization and immobilization, crusting, water infiltration and suppressiveness to pathogens affected by incorporation of cover crops even though bulk organic matter contents may change little? The literature available for irrigated semi-arid systems will be briefly reviewed, and a number of experimental and on-farm studies of cover crop use in vegetable production systems in California described.

828
OPPORTUNITIES AND CHALLENGES FOR THE INCLUSION OF SOIL-IMPROVING CROPS IN VEGETABLE PRODUCTION SYSTEMS
Marianne Sarrantonio, Rodale Institute, 611 Siegfriedale Rd., Kutztown, PA 19530

Current vegetable production systems offer both special opportunities and special challenges to the inclusion of green manures and cover crops in the rotation for soil improvement and protection. Niches often exist between spring and fall crops which may be filled by warm-season green manures. Other opportunities exist to establish cover crops prior to planting summer

crops, or prior to harvest of summer and fall crops. The use of permanent beds, irrigation, plastic mulches, row covers, hand-harvesting and other management techniques need to be taken into account in the selection of appropriate species for soil improvement. Preliminary trials at Rodale Research Center, as well as innovative techniques developed by growers and researchers, indicate that soil-improving crops can be successfully included even in intensively cropped vegetable systems.

829

ORGANIC VEGETABLE PRODUCTION AND HOW IT RELATES TO LISA

Vernon P. Grubinger, University of Vermont Extension Service, P. 0. Box 2430, W. Brattleboro, VT 05303-2430

The goals of organic producers and the LISA program overlap significantly. Both aim to link environmental stewardship and crop production, primarily by emphasizing cultural and biological over chemical approaches to pest and fertility management. However, organic standards severely limit the use of synthetic inputs and thus represent only a subset of LISA practices. Successful organic systems are particularly pertinent to LISA because they depend upon integration of various LISA techniques, such as diversification, rotation, mechanical cultivation, and biological control.

830

SUSTAINABLE AGRICULTURE & I.P.M. PRACTICES FROM A GROWER'S PERSPECTIVE

Daniel Tawczynski*, Taft Farms, Inc., 21 Division St., Gt. Barrington, Ma. 01230

Taft Farms is a 200 acre mixed vegetable farm growing for a retail operation. Many items are raised for P.Y.O. and all are raised on no or low pesticide programs. Fallow, legume and compost practices are used extensively to reduce need of commercial fertilizers. A major emphasis is placed on the reduction of stress as a means of pest and disease control. Nutritional manipulation - especially trace elements - is a large factor in our growing program. Major Problems: A. the polarization of various agricultural philosophies - us vs. them. We need more of an attempt at integration of practices. B. We need a credible clearing-house for information and research especially efficacy. C. We need major public educational effort. Future farm - A farm where all technologies are melded into a productive, environmentally harmonious and profitable venture capable of meeting the food needs of all economic levels of society.

110 COLLOQUIUM III (Abstr. 831-836)

831

MECHANICAL INJURY AND LATENT INFECTIONS LEADING TO POSTHARVEST DECAY

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The fresh fruit and vegetable industry is rapidly changing, especially in the areas of mechanized harvesting, grading, packaging, and modified postharvest atmospheres. Postharvest diseases can be attributed to preharvest infections, the harvesting process, storage conditions, or the inherent susceptibility of the product to infection and decay. In order to understand postharvest diseases, it is important to know the conditions that are conducive to infection and subsequent disease development. The least understood, and possibly the most difficult to control, is the latent or quiescent infection. These infections occur during growth and development of the produce and subsequently go into a dormant stage. After harvest, quiescent infections are triggered by some mechanism, for the most part unknown, to become active, creating a postharvest decay. In most cases, by the time the infection is detectable, the produce is not marketable and must be discarded. Secondly, field infections can occur as the produce approaches maturity and may remain undetectable through the grading process. These incipient infections are often slowed by cold storage, but may become active when the produce is placed on retail display or after it is purchased by a consumer. In addition, many postharvest decays occur as a result of mechanical or physiological Injuries that lead to rapid breakdown and decay.

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LATENT INFECTIONS IN THE PRE- AND POSTHARVEST ENVIRONMENT

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Latent (quiescent) infections by bacteria and fungi, both symptomless and causing visible lesions, are common in a wide variety of flower crops, fruits, and vegetables. Soft rotting bacteria of the genera Pseudomonas, Erwinia, Bacillus, and Xanthomonas occur without symptom in vegetables and may become activated by host stress in storage, while fungi of the genera Botrytis, Sclerotinia and Colletotrichum usually infect the host in the field, and may remain quiescent for several days or weeks. The aggressive state may commonly occur in the field, as in strawberries infected by Botrytis cinerea or in storage, as in carrots infected by Sclerotinia sclerotiorum or bananas with Colletotrichum musae. While factors affecting initial infection are generally well known, those determining the transition of the pathogen from quiescence to aggression, or conversely host resistance to susceptibility, are poorly understood. Among the hypotheses proposed are predisposing strains in the host induced by changes in temperature, water and osmotic relations, cell wall structure and chemistry, and other biochemical events associated with the ripening process. There are important implications of latency in the timing of prophylaxis and in the regulation of storage and marketing environments.

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ENHANCING NATURAL INTERNAL MECHANISMS OF RESISTANCE TO LATENT INFECTIONS THROUGH MINERAL NUTRITION

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Calcium content of stored fruits and vegetables was shown to be closely related to physiological and pathological disorders. When apple fruit were pressure infiltrated at harvest with varying concentrations of calcium chloride solutions, the quality of fruit in storage was maintained longer than in nontreated fruit. Fruit remained firmer, ethylene production was suppressed, and senescence was delayed. When calcium treated fruit were inoculated after storage with either Penicillium expansum, Botrytis cinerea or Glomerella cingulata, there was less decay than in nontreated fruit, although the effect was differential, depending upon the pathogen being studied. Similarly, when potato tuber calcium was increased, either through vacuum infiltration of the tubers with calcium solutions or application of nutrient solutions to plants, bacterial soft rot caused by Erwinia carotovora pv. atroseptica was reduced.

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GLOBAL REGULATORY SYSTEMS CONTROL PRODUCTION OF PECTINASES AND OTHER DEGRADATIVE ENZYMES IN ERWINIA CAROTOVORA SUBSP. CAROTOVORA (ECC), THE INCITANT OF POST-HARVEST DECAY IN VEGETABLES.

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Pectinases such as pectate lyase (Pel), pectin lyase (Pnl) and endo-polygalacturonase (Peh) of Ecc elicit tissue maceration. The production of these enzymes as well as cellulase (Cel) and protease (Prt) appears to be regulated by at least three global systems. (i) Physiological and genetic data indicate a positive regulation of pel genes by the cAMP-CRP system. (ii) In addition, the production of Cel, Peh, Pel, and Prt is regulated by the products of at least two other genes: aepA and aepB. Plant metabolites stimulate the expression of aepA, the product of which is required in the activation of pel-1 transcription. (iii) The transcription of pnlA, the structural gene for Pnl, is activated by DigR, which also controls the expression of several other genes responding to DNA damaging agents The RecA-LexA pathway, known to regulate SOS genes, in turn controls digR expression. Thus, it would appear that Ecc can utilize diverse regulatory systems to control enzyme production during its interaction with host tissues.

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INTEGRATING BIOLOGICAL CONTROL INTO POSTHARVEST DISEASE MANAGEMENT STRATEGIES
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As development of biological control agents for postharvest diseases continues, attention must be focused on how these agents can be used within the constraints imposed by modern postharvest handling practices. Application methods and formulations should be compatible with existing processing equipment and procedures, including compatibility with fungicides and antioxidants. Fruit maturity, pathogen spore concentration, storage atmosphere and temperature, and timing of application can effect biocontrol efficacy, especially of the non-antibiotic-producing yeasts. Good horticultural practices in the field and during postharvest handling can address many of these factors. Postharvest biological control agents will be used most effectively when integrated into disease management systems which deliberately minimize pre- and postharvest factors which are conducive to postharvest decay, and which maximize those conditions which both delay pathogen development and enhance development of biocontrol agents.

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GENETIC MANIPULATION OF PLANTS TO IMPROVE DISEASE RESISTANCE
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Creation of plant cultivars with inheritable genes for disease resistance is the most environmentally sound strategy for management of plant disease. This can be an effective means of imparting endogenous resistance to either biotic or abiotic disease causal agents. Thus, the need for applying pesticides, and/or for other manipulations of the milieu, is reduced or eliminated. Classical plant breeding can be a slow process, often too slow to keep up with the pathogen's ability to mutate and overcome the newly created defenses. Advances in genetic engineering techniques have opened new avenues for the efficient production of disease-resistant, transgenic plants. Cell transformation, electroporation, cell fusion, microinjection, use of high-impact projectiles, and other techniques used to introduce foreign DNA into various recipient plant cells (intact tissue, callus tissue, protoplasts, pollen, etc.) will be reviewed. DNA vectors systems (ie. Agrobacterium, plasmids, etc.), and potentially useful genes from microorganisms and plants that may concur disease resistance if cloned into plant hosts, will also be discussed.

Miscellaneous

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FLORICULTURE IN ZIMBABWE - A FULBRIGHTER'S PERSPECTIVE
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Zimbabwe is the fourth largest producer of imported flowers to the Dutch market. Production is increasing and becoming more sophisticated by the year. Although the cost of shipping may be as high as 50% of the total cost of production, recent government trade liberalization policies seem to offer additional incentives for enlarging the scope of floriculture production in Zimbabwe.