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QUALITY ENHANCEMENT OF APPLES USING SHORT TERM CONTROLLED-ATMOSPHERE STORAGE

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In 1989 and 1990, 'Golden Delicious' apples from controlled-atmosphere (CA) storage (1% O₂; 3% CO₂) averaged 8.5 N firmer after 30 days and 13.5 N firmer after 60 days of storage than apples from regular-atmosphere (RA) storage. After 7 days of ambient storage, 'Golden Delicious' apples from CA storage were 10.3 N firmer than apples from RA storage. Little change in color was evident in 'Golden Delicious' apples from CA storage after 30 or 60 days, but a distinct increase in yellow color was evident in apples from RA storage after only 30 days. The quality (color, firmness, and acidity) of 'Golden Delicious' apples stored for 30 days under CA and then 30 days under RA was superior to that of 'Golden Delicious' apples after 60 days of RA storage and similar to that of 'Golden Delicious' apples after 60 days of CA storage. 'Granny Smith' apples, traditionally a very firm apple regardless of the type of storage, averaged 3.3 N firmer after 30 days of CA storage (1% O₂; 1% CO₂) and 5.8 N firmer after 60 days of CA storage when compared to apples from RA storage. Little change in color was evident in 'Golden Delicious' apples regardless of storage length, but under ambient storage temperatures, 'Golden Delicious' apples from CA storage maintained their green color longer. Titratable acidity of both 'Golden Delicious' and 'Granny Smith' apples depended on growing season, and neither 'Golden Delicious' nor 'Granny Smith' apples showed consistent trends in titratable acidity after either RA or CA storage.

PHOTOSYNTHETIC INHIBITION OF *MAGNOLIA GRANDIFLORA* 'ST. MARY' LEAVES BY SUPRAOPTIMAL ROOT-ZONE TEMPERATURES

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Leaf photosynthesis of *Magnolia grandiflora* 'St. Mary' (13-month-old rooted cuttings) was studied when tree roots were exposed to 28, 35, or 42 ± 0.8C for 8 weeks. Root-zone temperature (RZT) treatments were sustained for 6 hours per day by an electronically controlled root-heating system. The experiment was conducted in a 3×7.5-m walk-in growth room. Growth room irradiance was supplied by eighteen 1000-W, phosphor-coated metal-arc HID lamps (photosynthetic photon flux = 600 µmol⁻²·s⁻¹ at canopy height) for 13 hours daily augmented with 3 hours of incandescent light during the dark period. Leaf C assimilation (A) at an RZT of 42C decreased linearly over 8 weeks compared to leaf A at RZTs of 35 and 28C. Leaf A was similar for all trees at week 1; however, leaf A at an RZT of 42C was 30% and 34% less than at RZTs of 35 and 28C, respectively, at week 8. Stomatal conductance at RZTs of 28 and 35C increased linearly over 8 weeks compared to conductance at a RZT of 42C. Intercellular CO₂ levels were not affected by RZT treatments. This finding suggests that reductions in leaf A were nonstomatal. Photosynthetic inhibition resulted in reduced shoot and

root growth. Operators of outdoor container production nurseries should implement cultural practices that minimize exposure of tree roots to RZTs >35C.

NACL STRESS ALTERS PRIMARY CELL WALL TENSILE STRENGTH IN THE HALOPHYTIC GRASS, *DISTICHLIS SPICATA* L.

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After 6 months of growth in 200, 400, and 500 mM NaCl, cultured cells of *Distichlis spicata* showed a decreased cell volume (size) despite maintenance of turgor pressure sometimes 2-fold higher than that of the control. Tensile strength, as measured by a nitrogen gas decompression technique, showed empirically that the walls of NaCl-stressed cells were weaker than those of nonstressed cells. Breaking pressures of the walls of control cells were 68 ± 4 bars, while that of the walls of cells grown in 500 mM NaCl (-25 bars) were 14 ± 2 bars. The relative amount of cellulose per cell remained about constant despite salt stress. However, glucuronoarabinoxylans were more readily extractable, presumably because of a decrease in cross-linkage with phenol substances. Therefore, we suggest that cellulose microfibrils are not the only determinants that confer tensile strength to the primary cell wall, but rather subtle changes in the matrix polysaccharides are likely responsible for this event.

EFFECTS OF ⁶⁰COBALT IONIZING IRRADIATION ON GROWTH AND POLYSOME CONTENT IN *PISUM SATIVUM* L. 'ALASKA'

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This research tested the hypothesis that ⁶⁰Co ionizing irradiation degrades polysomes to monosomes, a process that reduces growth of *Pisum sativum* seedlings. Dry and imbibed seeds and 5-day-old seedlings were exposed to 1.8, 3.6, 7.2, 14.4, or 28.8 krad of ⁶⁰Co irradiation. Immediately after irradiation treatments, dry and imbibed seeds were planted, and later seedlings were harvested and analyzed. Five 1-cm root-tip samples from 5-day-old seedlings were crushed and layered onto 15% to 60% sucrose gradients and centrifuged for 55 min. The samples were processed through an ISCO ultraviolet chart maker. The monosome and polysome weights were read and analyzed. The monosome content was greater in the irradiated 5-day-old seedlings than in seedlings from dry and imbibed seeds. The growth of 5-day-old irradiated seedlings and seedlings from imbibed seeds was less than that of seedlings from dry seeds. The reduced growth of the irradiated seedlings suggests damage to the polysomes. When protein synthesis in plant cells is altered, perhaps through RNA decoding mechanisms, growth may be partially or completely arrested. Using sensitive plants to establish the injurious effects of ionizing irradiation on living organisms can educate and alert society to the detrimental effects of overexposure to irradiation such as that caused by nuclear accidents.

CRYOPRESERVATION OF DORMANT BUDS FROM COLD-TENDER TAXA USING A MODIFIED VITRIFICATION PROCEDURE

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Cryopreservation of woody-plant, dormant buds may provide cost-effective, long-term, back-up conservation of germplasm for vegetatively propagated crops that are presently maintained as trees in field gene banks. Dormant buds can be recovered quickly by grafting to dwarfing rootstocks, thus producing flowers for breeding purposes, with minimum potential for inducing somaclonal variants. These attributes are essential to preserve the clonal integrity of unique gene combinations such as those found in tree fruit crops. Previous research has shown that dormant buds from cold-hardy apples can be recovered from storage in liquid nitrogen (LN) with high survival rates (80% to 100%) using controlled desiccation and slow freezing before immersing in LN. On the other hand, dormant buds from cold-tender taxa and buds collected at less than optimal stages for desiccation and freezing have much lower (0% to 50%) survival rates. We increased survival of cold-tender taxa by using a modified vitrification procedure. Dormant apple buds from tender and hardy cultivars were perfused with modified PVS [15% (w/v) ethylene glycol, 15% (w/v) propylene glycol, 7% (w/v) DMSO, and 15% (w/v) glycerol in 0.5 M sorbitol]. Toxicity from the PVS was reduced by dilution soaking in 1 M sorbitol, 0.2 M raffinose, and 15 mM CaCl₂ before and after quench-freezing and slow-freezing cryopreservation. Up to 100% of some cold-tender taxa survived. In addition, xylem ray parenchyma tissues that supercool and are normally killed at about -40C with the desiccation protocol survived this vitrification procedure.

MODELING THE OCCURRENCE OF THE FLOWERING PEAK OF MACADAMIA NUT (*MACADAMIA INTEGRIFOLIA*)

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The objective of this study was to develop models to predict the occurrence of the flowering peak of macadamia nut (*Macadamia integrifolia*). At Hilo and Kona, weather and 'Ikaika' flowering data were collected. The best model that described the time from the starting date of the flowering season to the highest flowering peak was days = 249.15 + 0.12 (total growing degree days) - 5.81 (maximum temperature) - 6.26 (minimum temperature). The model predicted the highest peak 4 days before it occurred at Hilo and 4 days after it occurred at Kona. Two statistical models, one for each location, were developed to predict the time from the starting date of the flowering season to the first peak. At Hilo, the best model was days = 118.61 - 0.11 (total growing degree days) + 0.000168 (total solar radiation). The model predicted the first peak 1 day before it occurred in the field. The best model at Kona was days = (-156.34) + 12.67 (minimum temperature) + 0.01 (total growing degree days). The model predicted the first peak on the day it occurred in the field. These models may aid growers in predicting the flowering peak so that bees can be brought into orchards at the proper time to increase cross-pollination.

IN VITRO HARDENING OF STRAWBERRY, *FRAGARIA* × *ANANASSA*, USING POLYETHYLENE GLYCOL-STAGE 3

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Polyethylene glycol (PEG) was evaluated for its influence on hardening of in vitro-propagated 'Fern' strawberries (*Fragaria* × *ananassa*) when applied just before transplanting. Strawberries were micropropagated via shoot tips and grown in vitro until roots were well developed. Plantlets were then transferred onto filter paper bridges in liquid medium with 15% (w/v) of PEG-8000. After treatment in the medium for various periods, the plants were compared to the control (no PEG) for water loss from detached leaves, stomatal aperture, and

survival rates after transplanting. Leaf epicuticular wax was also quantified. Overall, the in vitro PEG treatment was not successful in significantly increasing hardiness and survivability of the strawberry plants after transplanting from in vitro conditions to a soil medium. Osmotic stress was created, but apparently not for the time needed to increase survival. Further tests are needed to pinpoint the proper exposure time required to increase hardiness and survivability after transplanting plantlets. To increase survival, the time exposed to PEG should be 15, 18, or possibly 21 days.

VIABILITY AND GERMINATION TESTS OF FRINGED GENTIAN, *GENTIANA THERMALIS* (O. KUNTZE) ILTIS

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Fringed gentian, *Gentiana thermalis* (O. Kuntze) Ilitis is an attractive wildflower, that may be used as a fall flowering ornamental. This species has received limited attention in terms of seed viability and germination. Seeds were subjected to a tetrazolium viability test that involved imbibition for 24 hours at 22C. No embryos in any line tested were stained. However, imbibition at 3C for up to 4 weeks followed by staining at 22C resulted in significant levels of positive viability, as indicated by embryo staining. A germination study indicated that stratification was necessary for germination, with 6 weeks chilling giving better results than 0 or 3 weeks. However, the number of seeds germinated was less than expected, given the results of the tetrazolium test.

FIELD GROWTH ANALYSIS OF WATERMELON PLANTS UNDER VARIOUS ROWCOVERS AND MULCHES

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'Crimson Sweet' watermelon plants grown under various mulches and rowcovers were harvested weekly and analyzed for absolute growth rate (AGR), relative growth rate (RGR), net assimilation rate (NAR), leaf area ratio (LAR), specific leaf area (SLA), specific leaf weight (SLW), leaf weight ratio (LWR), leaf area duration (LAD), biomass duration (BMD), and runner growth. Hourly air and soil temperatures were monitored inside the rowcovers. Vispore and Reemay rowcovers generally showed greater mean AGR, LAR, SLA, LAD, and BMD than Agronet black-clear and black mulches. No significant differences in LWR were found between mulched and rowcovered plants. Plants under mulches and rowcovers showed significant increases in AGR, RGR, NAR, LAR, SLA, LAD, and BMD over noncovered (bare ground) plants. Longest runner length was highly correlated with total runner length. Growth analyses depicted decreased growth rate inside the rowcovers during the hottest weeks of the summer, and generally correlated well with the earliness and total yield of the crop.

EFFECTS OF BUD VIABILITY AND MINIMUM TEMPERATURES ON REGROWTH ASSAYS OF GRAPE WOOD DURING FREEZING STUDIES

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During freezing studies of 'Concord' grape (*Vitis labrusca* L.), bud viability significantly affected callus formation, adventitious root initiation, and root dry weight during regrowth assays conducted to assess freezing injury. Applying exogenous 1- *H*-indole-3-acetic acid (IAA) partially offset bud loss and stimulated root initiation. Further tests demonstrated that buds were less cold hardy than internode woody tissues in dormant 'Concord' canes. Because of cold-hardiness differences between buds and wood and because bud viability affects callus formation, root initiation, and root dry weight, regrowth assays do not seem to be sensitive indicators of freezing injury in grape woody tissues. Regrowth assays, however, seem to be reliable indicators of overall viability for frozen 'Concord' grape cuttings.

ENDOGENOUS PRODUCTION OF RAFFINOSE FAMILY OLIGOSACCHARIDES INCREASES DURING THE FIRST STAGES OF COLD ACCLIMATION IN SEVERAL WOODY PLANTS

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Woody plants can be induced to cold-acclimate by exposure to sublethal low temperatures, but only after the onset of vegetative maturity. We monitored seven woody plant taxa, at monthly intervals, to determine the date of vegetative maturity, freeze-killing temperature, cell membrane electrolyte leakage, and the quantity and diversity of endogenous oligosaccharides. The freeze-killing temperature changed from -5 to -7°C before vegetative maturity to -15 to -20°C after vegetative maturity. There was a 10-fold increase in raffinose and about a 3-fold increase in endogenous stachyose in samples that were cold-acclimated under controlled conditions. In field samples, endogenous raffinose increased from <0.02% in August to 2% to 11% in cortical stem tissues of all cold-acclimated taxa. The tetrasaccharide stachyose increased from <0.02% to 0.25% to 2.5% for similar comparisons. None of the other sugars or polyols showed similar, consistent patterns during the onset of cold acclimation. In response to low temperature, raffinose family oligosaccharides (RFOs) have previously been shown to increase substantially in cabbage, soybean, kidney bean, and *Chlorella*. RFOs also possess high water-binding characteristics and tend to enhance aqueous glass transitions. Accordingly, we hypothesize that the endogenous production of these oligosaccharides may play an important role in metabolic events associated with cryoprotection of critical cellular functions during low-temperature stress.

ANALYSIS OF FLOWER BUD DEVELOPMENT TEMPERATURE RESPONSE CURVES OF ORCHARD SPECIES

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The effect of thermal accumulation on anthesis rate in apricot, apple, peach, and tart cherry flowers during dormancy, dormancy release, and normal anthesis was determined. Data from several studies in warm and cold climates have indicated that thermally driven anthesis has an early low-temperature optimum that rises during anthesis. This is not true. Erroneous interpretation of results may have been due to inadequate measurements of the endodormancy status of seeds and buds. After endodormancy, flower-bud development temperature responses follow a normal sigmoidal curve with small but significant contributions at temperatures as low as 2°C. The grand phase of the growth curve occurs between 16 and 20°C in tart cherry. Asymptotic growth vs. temperature responses occurred at <10 and >22°C, with minima near 0 and optima >24°C. These data indicate that asymmetric curvilinear anthesis models need to be fitted to each species.

TRANSLOCATION AND USE OF ¹⁴C-LABELED PHOTOSYNTHATES FROM SENESCING 'CARIGNANE' GRAPEVINE LEAVES AND THEIR STORAGE IN OTHER PARTS OF THE PLANT

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The extent of translocation of ¹⁴C-labeled photosynthates from the senescent leaf to the parent vine before leaf abscission and the short-term effects of premature leaf removal on the carbohydrate balance of the vine were studied by using autoradiography and trapping ¹⁴CO₂ respired from the treated leaf. The treated leaf abscised 1.5 days after administering the label. The plant was harvested after natural leaf abscission. The radioactivity recovered from the plant, excluding the treated leaf, was 20% of the input. Radioactivity was detected in the roots, trunk, shoot, and leaves. Most of the radioactivity remained in the trunk and the young and old roots. The implications of premature leaf removal by mechanical harvesting on the carbohydrate balance of the vine are discussed.

APPLE TREE DENSITY AS RELATED TO PRODUCTION AND ECONOMICS

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Spur and nonspur 'Red Delicious' apple trees on M.26, 7, 106, and 111 were planted at different spacings. Yields were recorded for 15 years to assess the effect of early production on the M.26 trees with the later production on the M.106 and M.111 trees. The field data have been used to calculate income and expenses on a hypothetical 16-ha orchard during the 15-year period.

LOWBUSH BLUEBERRY PRODUCTION IN THE NINETIES

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The wild lowbush blueberry (*Vaccinium angustifolium*) in Maine and the Maritime Provinces of Canada has been managed for hundreds of years, first by native Americans and more recently by European settlers. Early production practices consisted of periodic free burns over large tracts of land for pruning and weed control. New practices have centered on intensifying production and include flail mow pruning, mechanical harvesting, herbicides for weed control, and monitoring pest populations. Most recently, land smoothing for improved mechanization and leaf sampling for nutrient analysis have been adopted. Land smoothing allows producers with rough land to use labor-saving equipment and apply pesticides more precisely. Leaf analysis predicts nutrient availability much more accurately than soil testing.

ESTIMATING WATER REQUIREMENTS OF LANDSCAPE PLANTINGS

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Since it is unlikely that crop coefficients will be established for landscape plantings, a method to estimate landscape water requirements is proposed. By evaluating three factors that significantly influence water use—species planted, vegetation density, and site microclimate—and assigning numerical values to each, an estimate of a landscape crop coefficient (or landscape coefficient, K_c) can be calculated. An estimate of evapotranspirational water loss for landscapes is then the product of the landscape coefficient multiplied by the reference evapotranspiration. This paper presents values for the above three factors and discusses the rationale for each. Examples using the landscape coefficient formula are included, as well as a discussion of special considerations relative to its use.

AUXIN ACTIVITY OF 3-METHYLENEOXINDOLE

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3-Methyleneoxindole (MO), a metabolite of the plant auxin 1-*H*-indole-3-acetic acid (IAA), is a potent sulfhydryl reagent that can profoundly affect bacterial growth and metabolism. For investigative purposes, MO is obtained from the degradation of 3-bromooxindole-3-acetic acid (3-Br-IAA) in aqueous media. Alternatively, it can be prepared from the riboflavin-catalyzed photooxidation of IAA. My earlier claims that MO possesses auxin activity were refuted by independent investigators either because the results could not be reproduced when 3-Br-IAA was used, or the results were ascribed to contamination with residual IAA if MO obtained from photooxidation was used. Recent investigations indicate that, contrary to previous assumptions, the quantitative degradation of 3-Br-IAA resulting in the formation of MO is not instantaneous; depending on the purity of 3-Br-IAA, it may take several hours to several days to reach completion. Furthermore, aqueous solutions of MO ≥0.1 mM are rapidly polymerized, thus causing a loss of biological activity. These findings may explain why MO that is derived from 3-Br-IAA often fails to produce auxin action. Ultrapure MO, obtained from either 3-Br-IAA or photooxidation, is 50- to 1000-fold as effective as IAA in the straight growth assay, induction of xylogenesis in parenchymatous tissue, and rooting of explants in tissue culture.

RELATIONSHIP BETWEEN PUNGENCY, SOLUBLE SOLIDS, AND SUSCEPTIBILITY TO NECK ROT IN ONIONS

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A field study was conducted to determine the relationship between pungency, soluble solids content, and susceptibility to neck rot in onions. 'Golden Cascade', 'Sweet Amber', 'Valdez', and 'Vega' onions were planted in a field with low soil S content. Sulfur, as coarse-ground calcium sulfate, was applied as a band before planting. After harvest, yield was determined and a sample of jumbo onions was taken from each plot to determine pungency, dry matter content, and soluble solids content. Healthy bulbs were returned to storage and evaluated for neck rot after 4 months. Yield, grade, and neck rot incidence after storage were not affected by S treatments. However, there was a trend toward lower neck rot incidence at the highest S application rate (160 lb/acre). Pungency of jumbo onions increased after the application of S as gypsum. 'Sweet Amber' and 'Valdez' were less pungent than 'Golden Cascade' or 'Vega'. Neck rot susceptibility was evaluated with an inoculation test of detached bulb scales. Growth and sporulation of the neck rot pathogen *Botrytis allii* were reduced by S application. Pungency and neck rot susceptibility were negatively correlated.

FARMER'S BOOKSHELF FOR THE IBM: A HYPERMEDIA PERSONAL INFORMATION MANAGEMENT SYSTEM FOR CROPS

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The objective of this study was to develop a computerized personal information management system for use by extension agents and growers. Agents and growers need an easy-to-use computer information system to access quickly information about specific topics for different crops. An information system helps agents provide faster, better service and up-to-date information to their clients. Using the software LinkWay (IBM Corp.) on an IBM personal computer, we developed such a system called the "Farmer's Bookshelf for the IBM." This information system uses "index cards" with information stored on separate screens called "pages." Both textual and graphical information may appear on a page. Using a mouse, the user navigates from one page to another by clicking on a "button" on the page. This easy-to-use system requires no typing except to enter a word for the computer to search. The user can easily browse for the desired information and then print it. The "Farmer's Bookshelf for the IBM" provides an easy, fast tool for agents and growers to obtain vitally needed information.