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## RESPONSE OF LONDON PLANE AND CORKSCREW WILLOW TO VARIABLE IRRIGATION

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We investigated growth and water relations of London plane and corkscrew willow irrigated at 80% and 0% replacement of potential evapotranspiration (ET<sub>o</sub>). In Spring 1991, whips were planted in a randomized complete-block design in a silt loam soil that was clean-cultivated through two seasons. In 1992, tree response was measured in water relations [water potential ( $\Psi$ )] at predawn and midday and dawn-to-dusk stomatal conductance (g<sub>s</sub>), trunk growth, and total leaf area. Soil-water depletion was monitored with a neutron probe. Measured ET<sub>o</sub> was 98.6 mm, and actual water applied based on final leaf area was 92% and 38% of ET<sub>o</sub> for plane trees and willows, respectively. Nonirrigated trees received 4% of ET<sub>o</sub> from rain. Soil water content at the 0.90-m depth was lower in the 0% ET<sub>o</sub> treatment. There were, however, no differences in predawn  $\Psi$  through the season. Plane trees had consistently higher dawn-to-dusk g<sub>s</sub> than the willows, but there were no differences in g<sub>s</sub> or midday  $\Psi$  between irrigation treatments for either species. Despite lower g<sub>s</sub>, willows had greater total leaf area and trunk growth than the plane trees, but again, there were no differences among irrigation treatments. Lack of detectable water-stress effects suggests that, in the absence of competition from other species, an expanding perimeter of root growth explored new soil and allowed nonirrigated trees to exploit soil water ahead of moisture depletion within the root zone.

## EVALUATING INTEGRATED CROP MANAGEMENT PRACTICES ON NAVEL ORANGES

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I used a multidisciplinary, multiyear experiment to investigate the effect of interactive application of inputs on growth, productivity, and returns of three mature Washington navel oranges [*Citrus sinensis* (L.) Obseck] grown on rough lemon rootstock. Seventy-two combinations [made up of three levels of irrigation, two levels of fungicides/nematicides (+/-), two levels of miticides (+/-), two levels of growth regulators (+/-), and three levels of N fertilizer] were investigated. The productivity measures indicated statistically significant interactive effects in some cases and only main effects with others. However, knowledge of significant treatment effects in one or the other productivity parameters would not have provided a complete picture to the end user without the economic analysis. Using a partial budgeting procedure, returns (after costs) were calculated for each treatment combination. Statistical analyses of variance also were performed to test for significant differences of productivity, crop value, and returns among the treatments and interactions. The results indicate that returns after costs were higher for the + fungicide-nematicide treatment and also were high with increased irrigation. However, the various treatments and their significant roles in productivity and returns are discussed. Also, the impact of water cost increases are analyzed.

## EFFECTS AND INTERACTION OF SOME MANAGEMENT FACTORS ON THE GLYCOALKALOID CONTENT OF POTATO TUBERS

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Glycoalkaloids are a naturally occurring steroidal alkaloid of potatoes exhibiting human toxicity at levels > 30 mg/100 of tuber fresh weight. It has been documented that genotype and environment have a large impact on tuber levels within a potato crop. The impact on glycoalkaloid content was determined for four management variables including variety grown, N fertilizer rate, storage temperature, and length of storage period. In 1989 and 1990, three varieties (Russet Burbank, Norchip, and Gemchip) were planted in plots with three rates of applied N fertilizer (0, 168, and 336 kg-ha<sup>-1</sup>). Harvested tubers were stored at 4.4 or 10.0°C. Tuber samples were obtained 1 month before harvest, at harvest, and then 3 and 9 months after harvest and analyzed for glycoalkaloid content. All four management variables had a significant ( $P = 0.05$ ) effect on tuber glycoalkaloid content, but only length of storage period had a greater influence than the natural environmental effect as measured by the difference between years. There were significant year the trial was conducted  $\times$  N fertilizer rate, year  $\times$  variety, length of storage  $\times$  variety, and N rate  $\times$  variety interactions. The interactions were analyzed and explored.

## EFFECT OF IRRIGATION AND PRETRANSPLANT INOCULATION OF VESICULAR-ARBUSCULAR MYCORRHIZAL (VAM) FUNGI ON POSTTRANSPLANT GROWTH OF *PROSOPIS ALBA* GRIEB

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*Prosopis alba* (mesquite) in 27-liter containers, either infected or noninfected with the VAM fungi, *Glomus intraradix* Schenk & Smith, during the container production phase were transplanted into a simulated landscape and irrigated at regular intervals or nonirrigated (irrigated only once at transplanting time). Mesquite shoot extension (SE), trunk diameter, rooting density (RD), specific root length density (SRLD), and VAM colonization levels were measured at 6 months and 1 year after transplanting. At 6 months, VAM colonization was observed only in the roots of inoculated mesquite, but by 12 months, roots of inoculated and noninoculated mesquite were colonized by VAM fungi. There were higher levels of VAM colonization in roots of irrigated mesquite (23%) in comparison to nonirrigated mesquite (5%). Irrigation promoted SE and VAM inoculation inhibited SE of nonirrigated trees. Trunk diameter was greater for irrigated trees than for nonirrigated trees and was not affected by VAM fungal treatment. At 6 months after transplanting, VAM fungal and irrigation treatments interacted to affect mesquite RD and SRLD. For irrigated mesquite, RD and SRLD were highest for VAM-inoculated mesquite, whereas

for nonirrigated trees, RD and SRLD were highest for noninoculated trees. At 12 months after transplanting, mesquite RD and SRLD were higher for irrigated than for nonirrigated trees and were not affected by previous VAM inoculation.

#### PROPAGATING SEDGES AND RUSHES FROM SEED

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Recent emphasis on restoration of degraded wetland and riparian areas in the Intermountain area has created a demand for planting stock of native sedges (*Carex* spp.) and rushes (*Juncus* spp.). There are ≈ 100 native sedges and 20 rushes in this region, few of which have been propagated in the past. Many grow in moist to wet areas and are adaptable to water gardens. Some are upland species, capable of growing in drier areas and landscape plantings. Members of both genera are easily propagated vegetatively, but there is increasing interest in seed propagation of these species, with nurseries installing seed production blocks of common sledges. Longevity of sedge and rush seed in sealed, dry storage is unknown, but we have noted little or no viability loss in 15 species after 3 years of storage. Viability testing is used to estimate seed quality because rules for testing seeds of each species are not yet available. Researchers are beginning to examine germination requirements of individual species. Germinability and dormancy vary widely among species and seedlots, but germination is frequently improved by exposure to light and alternating incubation temperatures. Developing seedlings grow rapidly, producing dense, fibrous root systems.

#### INFLUENCE OF HYDROGEN CYANAMIDE ON BUDBREAK OF TABLE GRAPE CULTIVARS IN SOUTHWEST ARIZONA

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Early maturity is of major importance to table grape producers in Arizona and the California desert. However, table grapes in this region often experience a delayed and erratic budbreak thought to be due to a lack of chilling. The influence of three rates of hydrogen cyanamide on budbreak timing and uniformity was evaluated at a commercial vineyard near Dateland, Ariz., during the 1984-85 season. Treatments were made to three table grape cultivars over three application dates. Additional research to evaluate possible interaction between time of pruning and application of hydrogen cyanamide was conducted during 1985-86. Of the three application rates evaluated, the 5% solution provided optimal results, inducing a greater total number of buds to break for perlette and flame seedless cultivars than nontreated plots. Early application resulted in a significantly earlier but extended budbreak; later applications were more dramatic and uniform. Budbreak was accelerated by 1 to 2 weeks for perlette, and up to 2 to 3 weeks for flame seedless and Thompson seedless cultivars. Hydrogen cyanamide applications also had a positive influence on earliness of blossom and percent soluble solutes at harvest. Pruning up to 11 days before or 14 days after application of hydrogen cyanamide generally did not have a significant effect on budbreak or maturity at harvest.

#### SHORT TDR PROBES TO MEASURE WATER AND FERTILIZER ION GRADIENTS IN CONTAINER MEDIA

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Time Domain Reflectometry (TDR) is used to measure in situ soil moisture content and salinity of porous media. Commercially available TDR systems used for field measurements have limited use in laboratory scale experiments where short high resolution probes are needed. A short TDR probe was designed for use with high bandwidth TDR instruments currently available. The probes are designed from SMA bulkhead connectors using gold-plated stainless steel wire 0.035

inches in diameter. A 20.GHz digital sampling oscilloscope (11801; Tektronix, Beaverton, Ore.) with an SD-24 TDR sampling head is used with the probes to determine water content and ion concentrations in porous media. The 7.5- and 3.0-cm-long probes were used to measure soil moisture content and ion concentrations in laboratory columns. Fertilizer and water gradients were observed by using bromide salts brought into contact with the top of laboratory columns, 7.6 cm in diameter and 18 cm long, packed with container media [ 1 peat : 1 vermiculite v/v]. Soil moisture measurements in the presence of high concentrations of salts were made by insulating the probes with Teflon heat-shrinkable tubing to minimize conductivity losses.

#### COMPARISON OF TWO METHODS TO EVALUATE THE RESISTANCE OF HAZELNUT GENOTYPES TO EASTERN FILBERT BLIGHT

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Resistant cultivars are a promising disease control method for eastern filbert blight, which is devastating hazelnut production in Oregon. In 1990, two studies were begun to evaluate the relative resistance of European hazelnut (*Corylus avellana*) genotypes to the causal fungus, *Anisogramma anomala*. A randomized block design of 40 genotypes was planted using inoculated trees planted in the borders as the disease source. The first- and second-year disease incidence (percent) were compared to the published disease incidence (percent) based on exposing potted trees of 44 genotypes to high doses of inoculum. Disease incidence was significantly correlated between the two studies in 1991 ( $r=0.41$ ,  $P=0.02$ ) and in 1992 ( $r=0.64$ ,  $P=0.001$ ;  $r_s=0.35$ ,  $0.025 < P < 0.050$ ). Three genotypes, however, showed no disease in the field, but they had disease in >70% of the potted tree study. A plot of disease incidence in the field planting indicates that the inoculum was present throughout the blocks.

#### CREATING A PROTECTED DIFFUSION ZONE

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In intensive, open horticultural crop production systems, quantities of water and soluble fertilizers are convected by gravitational and evaporative flow through the plant root zone, with only a small fraction being captured by the plant root system. Principles and concepts developed in creating a protected diffusion zone (PDZ) within the closed, insulated pallet system (CIPS) have been extrapolated to create a protected zone for fertilizer diffusion in a surface-irrigated plant container or open field/landscape planting. Incorporating additional evaporative and gravitational water flow barriers has resulted in a semiclosed field system to minimize quantities of water and fertilizer applied and lost from the plant root zone. Use of saline water is more feasible in PDZ system than in open systems.

#### NITROGEN PARTITIONING IN CHERRY DEPENDS ON TIMING OF APPLICATIONS

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Seven-year-old 'Royal Ann' cherry trees were given a total of 244 g of actual N as ammonium nitrate depleted in  $^{15}\text{N}$  (0.01 atom %  $^{15}\text{N}$ ) either in March (M), June (J), or both in March and June (Split). The fertilizer was soil-applied to eight single-replicate trees. The following August, leaves from the trees that had the M treatment had 15.3% of their N from the fertilizer compared to 9.6% for the split treatment. Trees that had a J application were not different from the control trees. Even though cherry trees are physiologically active during the late summer months, little N is translocated to the leaves once the crop is fully developed. The percentage of newly acquired N in the fruit is similar to that in the spur leaves. Leaves from the different treatments had similar N contents; therefore, labeled N is the tool of choice to assess the performance of different fertilization practices.

## INHERITANCE OF VERTICILLIUM WILT RESISTANCE IN PI 215699, AN *CAPSICUM ANNUUM* ACCESSION

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The segregation ratios for verticillium wilt resistance in PI 215699 suggests that verticillium wilt resistance is a quantitative trait. Additive and dominance genetic variance effects were studied. The  $F_1$ ,  $F_2$ ,  $F_1B C_1$ , and  $F_2B C_2$ , using the resistant parent ( $P_r$ ) and the susceptible parent ( $P_s$ ), PI 215699, and BG. 1668, respectively, were accomplished. The plants were grown in soil temperature tanks with a  $25 \pm 1^\circ\text{C}$  soil temperature, an inoculum level of 2000 microsclerotia of *Verticillium dahliae* Kleb. per gram of soil, and 18 hours of  $250 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$  light. The experiment consisted of four replications with 30 plants per replication for each generation. The seedlings were individually scored 70 days after sowing for an interaction phenotype score (IP) using a scale ranging from 1 to 9 in which 1 = no aerial symptoms and 9 = death. Means, variance, and standard deviations for the percentage of resistant plants (IP = 1) were calculated. A joint three-factor scaling test to estimate the parameters [mid-parent value (m), additive effects (d), and dominance effects (h)] revealed that the data did not fit a simple additive-dominance model. Epistasis was suspected to be present and a joint six-factor model was therefore tested. The joint six-factor model estimates m, d, h, and three epistatic interactions parameters [additive  $\times$  additive (i), additive  $\times$  dominance (j), and dominance  $\times$  dominance (l)]. All epistatic interactions parameters were significant. These results indicate that additive and epistasis effects were involved in the genetic control of verticillium wilt resistance in PI 215699. Broad-sense and narrow-sense heritabilities for percentage of resistant plants in population PI 215699 were estimated to be 0.81 and 0.48 after 70 days of sowing, respectively.

## FACTORS INFLUENCING PREEMERGENCE DAMPING-OFF AND SEEDLING BLIGHT OF *SH-2* SWEET CORN CAUSED BY *PENICILLIUM OXALICUM*

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*Penicillium oxalicum* is a seed- and soilborne fungal pathogen that causes preemergence damping-off and postemergence seedling blight of sweet corn. While seed infection and infestation by *P. oxalicum* is common, the amount of injury observed in the field is variable. Our objective was to determine factors influencing the occurrence and severity of disease due to *P. oxalicum*. Inoculation of *sh-2* sweet corn seeds with conidia of *P. oxalicum* reduced seedling emergence and resulted in seedling mortality. Disease severity in the greenhouse and the field was greater as inoculum density increased from  $\approx 102$  to  $106$  conidia per seed. Increasing soil temperatures after planting inoculated seed resulted in more preemergence damping-off. *Penicillium oxalicum* is capable of growth and sporulation in soil that is too dry for seed germination. Nontreated (naturally infected) *sh-2* sweet corn seeds or seeds inoculated with *P. oxalicum* were incubated in pasteurized soil that had been adjusted to various moisture levels—all too low for seed germination. Increasing soil moisture was associated with visible growth of *Penicillium* spp. on seed after incubation, and greater levels of damping-off and seedling blight when the seed was planted.

## CHILLING HOUR ACCUMULATION MODELS AND CALENDAR DATE USED TO PREDICT ROOTING OF WHITE FIR STEM CUTTINGS IN NORTHERN NEW MEXICO

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Historically, calendar date has been used to determine when cuttings are collected for rooting. However, year-to-year variations in climate limits the usefulness of using calendar date. More recently, rooting of stem cuttings has been associated with chilling accumula-

tion. In the winter, daily temperatures in northern New Mexico can fluctuate from below freezing to well above freezing. Eight chilling accumulation models and calendar date were tested to determine the best predictor of rooting of white fir. The chilling accumulation models ranged from those based on number of hours at low temperatures to weighted models that calculated chilling unit accumulation and loss. In addition, temperature data based on 3-, 6-, 12-, and 24-hour averages were used. Most of the models were better than calendar date in predicting rooting. The best model was a weighted model that accumulated chilling from  $-5$  to  $10^\circ\text{C}$  with loss of chilling  $>15^\circ\text{C}$  and less than  $-10^\circ\text{C}$ . Other models that performed well included models that accumulated chilling from  $0$  to  $7.2^\circ\text{C}$ ,  $0$  to  $15^\circ\text{C}$ , or  $-3.5$  to  $10^\circ\text{C}$ . On the average, the data based on 12-hour means was the best for modeling chilling accumulation to predict rooting.

## SHORTENED STOCK PLANT PHOTOPERIOD IMPROVES ROOTING OF ELДАРICA PINE STEM CUTTINGS

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Dormancy level is an important factor in rooting stem cuttings of conifers. Eldarica pine, a Mediterranean species, is a multiple flushing pine that does not appear to express endodormancy in southern New Mexico. Photoperiod manipulations can alter the dormancy level of some conifer species; however, effects on eldarica pine are unknown. Half-sib stock plants were randomly assigned to one of three photoperiods: natural daylength ( $>12$  hours, control), long-term (7 months) exposure to 9-hour daylength (LTSD), and 2-week exposure to 9-hour daylength (STSD). Of the cuttings from LTSD stock plants, 78% rooted; however, only 67% of the cuttings from the other two treatments rooted. Differences in rooting also were related to shoot type of the cuttings. Cuttings from expanded short shoots without a bud rooted more frequently than cuttings from branch shoots with or without a bud present. Applications of these results are discussed.

## PROCESSING POTATOES FOR THE SPECIALTY MARKET IN WASHINGTON

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Specialty potatoes have been evaluated in a number of on-farm trials conducted by Washington State Univ. Cooperative Extension. This work has led to the commercial success of a number of yellow- and purple-fleshed potato cultivars in Washington. These cultivars are currently marketed as fresh potatoes for baking and boiling. In 1992, the processing quality of selected specialty potato cultivars was evaluated. Twenty-five cultivars were prepared as chips and french fries and evaluated for taste, color, and market acceptance. Evaluators noticed differences in flavor and texture, as well as in color, and the scores of individual cultivars varied widely. Strong opinions were expressed on the market acceptance of the various yellow-, orange-, pink-, and purple-fleshed cultivars. A majority of evaluators said that they would buy chips and french fries made from specialty potatoes.

## PLANT WATER RELATIONS OF *ARTEMISIA CANA* AND *AGROPYRON INTERMEDIUM* DURING AND AFTER WATER STRESS PRECONDITIONING

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Typically, dormant seedlings are transplanted when revegetating disturbed lands to prevent transplant shock triggered by water stress. It may be possible to transplant nondormant seedlings by inducing drought-tolerant acclimation responses such as solute accumulation. *Artemisia cana* and *Agropyron intermedium* seedlings were subjected to three different water stress preconditioning treatments. After conditioning, seedlings were dried down in their containers until leaf senescence, or were transplanted to disturbed land sites. Leaf water potential components and relative water content were measured.

Following treatments, water relations parameters of preconditioned seedlings were not markedly different from controls in either species. At the end of the final dry-down, water stress preconditioning had not induced active or passive solute accumulation, prolonged leaf survival during lethal drought conditions, or differences in transplant survival under the experimental conditions of this study.

EFFICIENT REGENERATION AND TRANSFORMATION PROTOCOLS FOR SAFFLOWER (*CARTHAMUS TINCTORIUS* L.)

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Our goal was to develop efficient regeneration protocols for

safflower that could be used in conjunction with *Agrobacterium tumefaciens* -mediated transformation to introduce genes conferring economically important traits. Direct regeneration of whole plants has been achieved from cotyledon and hypocotyl explants of 30-day-old 'Centennial' and 'Montola' seedlings. Explants transformed with Ti plasmids containing NPTII and the  $\beta$ -glucuronidase (GUS) reporter gene produced kanamycin-resistant calli and shoots testing positive for GUS activity. Current work is incorporating the *bar* gene into appropriate Ti plasmids that will be used to confer glufosinate herbicide resistance to elite safflower cultivars. An esterase gene from *Bacillus subtilis* will be introduced to confer resistance to *Alternaria carthami* leaf spot disease.