SECTION 1

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STUDENT COMPETITION

Dr. Jeffrey Derr
Section Chairman and Moderator

Shade During Container Production of Flowering Dogwood Increases Growth

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Nature of Work: Because of its desirable flowers, bark, and foliage, flowering dogwood (Cornus florida) is an extensively used landscape tree in the southern United States. Although the majority of flowering dogwoods are grown in the field, some producers are attempting to grow flowering dogwoods in containers. Native flowering dogwoods prefer shade, a moist, yet well drained soil, and cool root zone temperatures. Studies have shown that media temperatures in black plastic containers can exceed 110 degrees F (2). Today, producers are successfully growing other native understory species under shade cloth (1) but, most producers continue to grow flowering dogwoods in containers receiving full sun. This test was initiated to determine the influence of three different production practices on the growth of four cultivars and one variety of container-grown flowering dogwood.

Treatments selected were full sun, 40% white shade cloth, and 40% black shade cloth. Flowering dogwood cultivars used were 'Welch's Junior Miss', 'Barton's White', 'Weavers White', and 'Welch's Bay Beauty'. The variety used was rubra. The location of the experiment was Auburn, Alabama. One year old rooted cuttings of each type were planted in trade 7 gallon black plastic pots on March 18, 1991. The growing medium was a 6 pine bark:l sand mixture which was amended with 1.5 pounds of Micromax (Sierra Chemical Company, Nilpitas, Ca. 95035) and 5 pounds of dolomitic limestone per cubic yard. Osmocote 17-7-12 (Sierra Chemical Company) was top dressed at the rate of 5.25 ounces per pot. Trees were hand watered as needed. There were 4 replications of 3 plants/treatment/ replication arranged in a randomized complete block design.

Tree height and caliper measurements were made at the initiation of the experiment and at 6 week intervals thereafter until November 11. Height was measured from soil level to the tallest terminal node and caliper was measured 6 inches above soil level. Weekly media temperatures were measured at 11:00 a.m. and 4:00 p.m. in the center of each pot at a depth of 4 inches.

Results and Discussion: Trees grown under white shade cloth had the greatest height increase, followed by those grown under black shade cloth and in full sun (Figure 1). The cultivar 'Weaver's White' had the greatest overall height increase regardless of production treatment. 'Welch's Bay

Beauty' and 'Welch's Junior Miss' had the next greatest height increase and the variety rubra had the least height increase.

The greatest caliper increase occurred on the trees grown under the two shade cloth treatments (Figure 2). As with average height increase, 'Weaver's White' had the greatest caliper growth increase regardless of production practice and the variety rubra had the least.

Average medium temperature for the full sun treatment was the greatest of all the treatments with a mean of 87 degrees F. The remaining treatments were similar with an average mean medium temperature near 81 degrees F. Lower root zone temperatures and shade probably contributed to the increased growth for the trees grown under the shade treatments.

Significance to Industry: These data indicate that growing containerized flowering dogwoods under 40% white or black shade cloth can produce larger trees than those grown in full sun. Also, of the cultivars and variety used in this study, 'Weaver's White' and 'Welch's Junior Miss' appear to be the fastest growing white and pink flowering dogwoods, respectively, for producers in the deep south to grow.

Literature Cited

1. Phillips, E.L., T.E. Bilderback, R.E. Bir and D. Torn. 1991. Comparison of light intensity and temperatures under white and black shade cloth. Proc. SNA. Res. Conf. 36:105-107.

2. Johnson, C.R. and D.L. Ingram. 1984. Pittosorum tobira response to container medium temperature. HortScience 19:524-525.

Figure 1. Average height increase.*

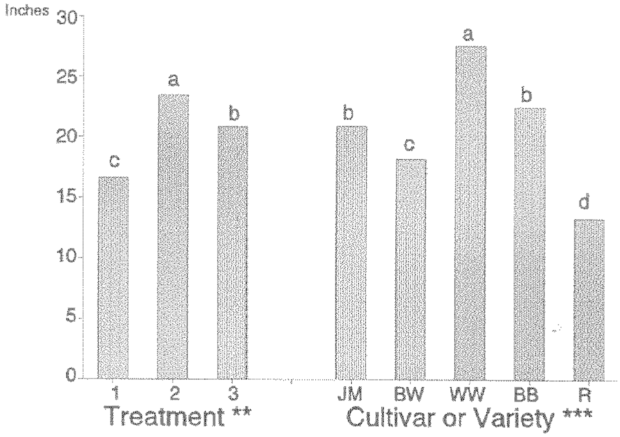
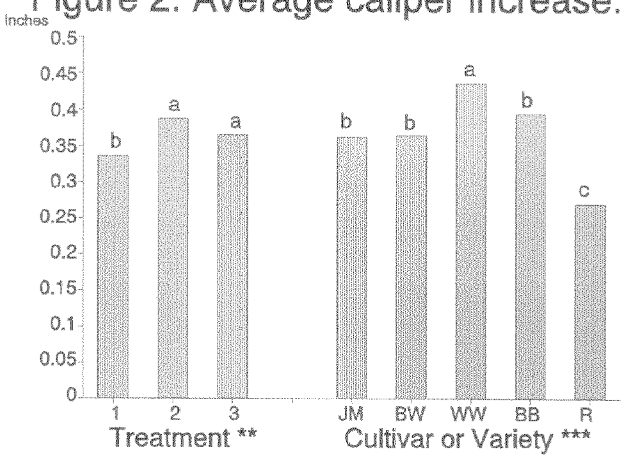


Figure 2. Average caliper increase.*



* Means within treatment or within cultivar or variety with the same letter do not differ (LSD, p=0.05).

** Treatments used: Full sun (1), 40% white shade (2), and 40% black shade (3).

*** Cultivar or variety used: 'Welch's Junior Miss' (JM), 'Barton's White' (BW), 'Weaver's White' (WW), 'Welch's Bay Beauty' (BB), and <u>rubra</u> (R).

Mist Irrigation Reduces Post-Transplant Desiccation of Bare Root Trees

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Nature of Work: Research investigating the effects of water stress on bare root nursery stock has been focused on lift date, length of storage (2) and exposure to dry conditions during processing (1). Water loss from stem tissue, however, can continue after transplanting (4). Desiccation after transplanting and prior to new root growth during warm, sunny and windy weather decreases survivability of certain species. The objective of this research was to investigate the effectiveness of mist irrigation on reducing post-transplant stress in a desiccation sensitive and desiccation tolerant species.

Thirty Acer platanoides 'Emerald Lustre' and thirty Prunus x yedoensis two-year-old branched bareroot liners were received on 17 Feb. 1992. Initial xylem water potential was measured using a portable pressure chamber on a 10.2 cm (4 in.) stem section excised from each tree. Trees were transplanted into 100% pine bark-filled 18.9 liter (5 gal.) plastic containers and dolomitic limestone was surface applied at 2.9 kg m^{-3} (5 lb yd^{-3}). Containers were thoroughly irrigated by hand and fitted with aluminum foil covers around stem and overhanging sides to prevent water entering container. Fifty percent of maples and cherry trees received overhead mist irrigation, 25 sec every 15 min, and remaining trees received no mist. Xylem water potential was measured for each tree 3, 6, and 9 days after initiation of treatments. Plants were greenhouse-grown until May, after which they were moved to an outdoor nursery. Visual assessment of desiccation damage was made 60 days after termination of treatment.

Results and Discussion: Water potentials for both maple and cherry increased to approximately -0.6 MPa after 3 days of mist irrigation. Stem (xylem) water potential for irrigated and non-irrigated maple trees increased (became less negative = more hydrated) for the first three days with the increase being greater in the irrigated treatment than the non-irrigated treatment (Fig. 1). This indicated that transplanting bare root maples into a moist medium relieved a portion of accumulated water stress. For cherry, stem water potential increased for irrigated trees and decreased (became more negative = more dehydrated) for non-irrigated trees (Fig. 2). In contrast to maple, transplanting bare root cherries into a moist medium without misting did not lessen water stress. However, once bud break occurred for some non-irrigated cherries (day 6), water potential increased dramatically (Fig. 2). Root growth has been reported to begin concurrent with shoot growth (5) thereby allowing for an increased capacity to absorb water.

Desiccation damage assessment of trees two months after treatment showed that four of 15 cherry trees in the non-irrigated treatment had severe damage and eight trees had slight damage (Table 1). Irrigated cherry trees had no severe damage and had a lesser incidence of slight damage. Maples in both irrigated and non-irrigated treatments showed no moderate or severe desiccation damage. Similar desiccation sensitivity and tolerance of Washington hawthorne and Norway maple, respectively, has been noted in other work (3).

Significance to Industly: Desiccation stress imposed at harvest, storage and transplanting or establishment is the major cause for poor performance of certain species of bare root plants. Results of this study indicate that mist irrigation applied after potting and before bud break improves the water relations and survivability of sensitive species such as Yoshino cherry. Additional work is needed to document other sensitive tree species and to investigate how water content can be restored at planting and maintained until root initiation occurs.

Literature Cited

1. Coutts, M. P. 1981. Effects of root or shoot exposure before planting on the water relations, growth and survival of Sitka spruce. Can. J. For. Res. 11:703-709.

2. Hermann, R. K. 1964. Effects of prolonged exposure of roots on survival of 2-0 Douglas-fir seedlings. J. For. 62:401-403.

3. Murakami, P., T.H.H. Chen and L.H. Fuchigami. 1990. Desiccation tolerance of deciduous plants during postharvest handling. J. Environ. Hort. 8:22-25.

4. Schoneer, J. and H. Ziegler. 1980. Water permeability of Betula periderm. Planta 147:345-354.

5. Wilcox, H. 1955. Regeneration of injured root systems in noble fir. Bot. Gaz. 116(3):221-234.

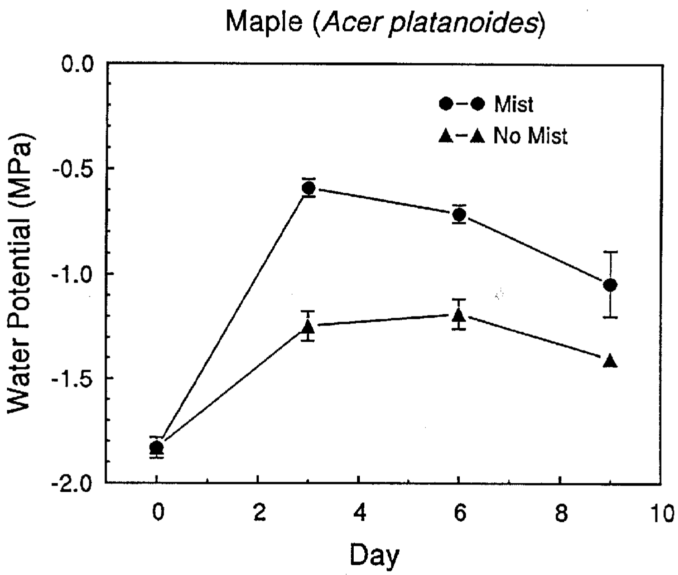

Fig. 1. Xylem water potential of Acer platanoides as influenced by mist irrigation after transplanting. Bars represent SE.

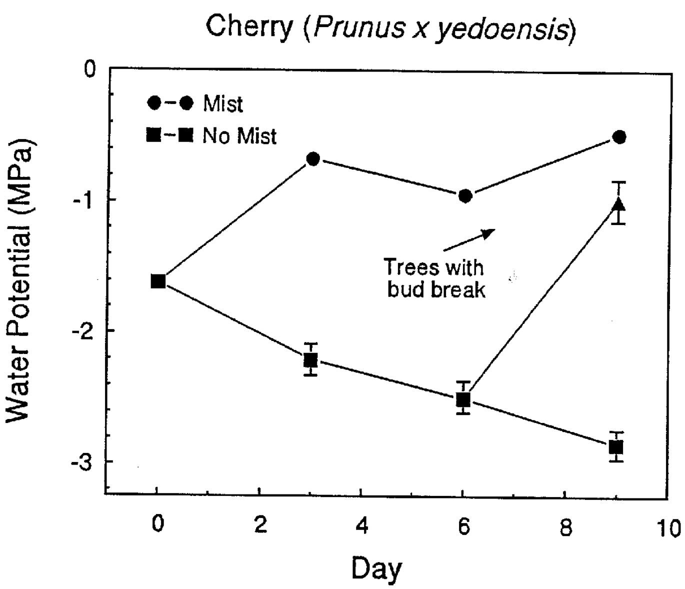

Fig. 2. Xylem water potential of Prunus x yedoensis as influenced by mist irrigation after transplanting. Bars represent SE.

Table 1. Visual assessment of desiccation damage 60 days after treatment in Acer platanoides and Prunus x yedoensis as influenced by mist or non-mist treatment.

	Number of Trees			
	Prunus x yedoensis		Acer platanoides	
Visual Rating[z]	Mist	No Mist	Mist	No Mist
1	9	3	11	15
2	5	8	4	0
3	1	0	0	0
4	0	4	0	0

[z]Ratings scale 1= no damage; 2 = slight, no pruning necessary; 3 = moderate, marketable with remedial pruning; 4 = severe, not marketable.

Micropropagation of Pieris floribunda

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Nature of Work: Pieris floribunda (Pursh ex Sims) Benth. and Hook. (mountain andromeda) is a native ericaceous, evergreen shrub of the southeastern United States. The species has several desirable growth and cultural characteristics which contribute to its demand for landscape usage (7). Unfortunately, supplies are often limited because propagation, both sexual (by seed) and asexual (vegetative) by stem cuttings, is slow and generally difficult. It would be beneficial if a reliable procedure could be developed to rapidly propagate P. floribunda. One possibility might be micropropagation (tissue culture), which is currently being used commercially to propagate such ericaceous species as Kalmia latifolia L. (mountain laurel) (5) and various species of Rhododendron L. (rhododendron) (1, 2, 3, 4, 6). Therefore, the objective of this research was to develop a protocol for micropropagation of P. floribunda.

Stock plants used as an explant source were 1 1/2 year-old seedlings of P. floribunda raised from locally collected seed. Plants were grown under natural photoperiod and irradiance (light intensity) in a greenhouse maintained at a day/night temperature of 24°/20°C (75°/68°F). Prior to the onset of the research in February 1991, the plants were stimulated to produce a flush of new growth by providing them with an incandescent night interruption, thus eliciting a long-day response.

Three weeks after the new growth was produced, actively growing shoot tips, 3 cm (1.2 in.) in length, were taken from the plants. All leaves and petioles were removed. Shoots were placed under running tap water for 10 min., washed in soapy water for 2 min. and rinsed in tap water for 5 min. The shoots were then submerged in 70% ethanol for 20 sec., removed, and placed directly in a 20% Clorox (1.05% sodium hypochlorite) solution containing 0.05% Tween-20 and gently agitated for 15 minutes. Shoots were then rinsed three times with sterile, distilled water and 2 to 3 mm (0.08 to 0.12 in.) of the apical and basal portions of the shoots were removed. Four shoots were placed horizontally into 15 x 100 mm (0.6 x 4.0 in.) plastic petri dishes containing Woody Plant Medium [WPM (5)] solidified with 0.8% agar and containing 8 ppm 6-(∂,∂-dimethylallylamino)-purine (2iP), 200 ppm NaH_2P0_4 and 80 ppm adenine hemi-sulfate. The pH was adjusted to 5.2 with 1 N KOH prior to autoclaving. Cultures were maintained in a controlled environment room at 25°C (77°F) with a 16-hr. photoperiod provided by a combination of cool-white fluorescent lamps and incandescent bulbs. The lamps and bulbs provided a photosynthetic photon flux [PPF (400-700 nm)] of 51 umol•m^{-2}•s^{-1} (4.0 klx) as measured at the tops of the dishes.

After 4 weeks, axillary shoots developed to a length of approximately 1 cm (0.4 in.). The explants with axillary shoots were taken from the petri dishes and all dead or vitrified tissues removed. These explants were transferred to baby food jars containing WPM with 4 ppm 2iP. The jars were placed in the culture room under reduced irradiance created with 50% shade cloth suspended directly beneath the above described lamps and bulbs.

Axillary shoots ≥2 cm (0.8 in.) developed in 4 weeks. These shoots were removed from the original explant, the terminal portions removed and five decapitated shoots were placed horizontally into 25 x 100 mm (1.0 x 4.0 in.) plastic petri dishes containing WPM solidified with 0.8% agar and containing 4 ppm 2iP. These shoots were subcultured at 5 week intervals under reduced irradiance in 7.6 x 7.6 cm (3 x 3 in.) culture vessels containing WPM with 4 ppm 2iP for 5 months until sufficient numbers of uniform shoots were available for a shoot proliferation study.

Eight-node axillary shoots were decapitated and placed horizontally on agar-solidified (0.8%) WPM supplemented with the following concentrations of 2iP: 0, 0.5, 1, 2, 4, 8, or 16 ppm. Each concentration was replicated five times with a replication consisting of a culture vessel containing four shoots. Cultures were maintained in the controlled environment room under reduced irradiance for 8 weeks. At the end of this period, data was collected on the number and length of all shoots ≥ 5 mm (0.2 in).

Microcuttings of P. floribunda were, as are traditional stem cuttings, difficult to root. The best rooting treatment involved pulsing the shoots for 10 days on medium containing 15 ppm K-IBA in comparison to higher or lower K-IBA concentrations. Microcuttings treated for 10 days with K-IBA and removed to medium without this growth regulator rooted better than those continually maintained on medium containing K-IBA. The pulse treatment with 15 ppm K-IBA resulted in 76% rooting of the microcuttings and 49% acclimation and survival of the plantlets.

Significance to the Industry: Presently, Pieris floribunda is limited in the trade due to inherent difficulties in conventional seed and vegetative propagation methods. Micropropagation procedures as described herein may provide a means for enhanced production of this desirable native and increase availability in the nursery industry.

Literature Cited

1. Blazich, F.A. and J.R. Acedo. 1988. Micropropagation of flame azalea. J. Environ. Hort. 6:45-47.

2. Blazich, F.A., C.G. Giles, and C.M. Haemmerle. 1986. Micropropagation of Rhododendron chapmanii. J. Environ. Hort. 4:26-29.

3. Fordham, I., D.P. Stimart, and R.H. Zimmerman. 1982. Axillary and adventitious shoot proliferation of Exbury azaleas *in vitro.* HortScience 17:738-739.

4. Kyte, L. and B. Briggs. 1979. A simplified entry into tissue culture production of rhododendrons. Proc. Intern. Plant Prop. Soc. 29:90-95.

5. Lloyd, G. and B. McCown. 1980. Commercially-feasible micropropagation of mountain laurel, Kalmia latifolia, by use of shoot-tip culture. Proc. Intern. Plant Prop. Soc. 30:421-437.

6. McCown, B.H. and G.B. Lloyd. 1983. A survey of the response of Rhododendron to *in vitro* culture. Plant Cell Tissue Organ Culture 2:77-85.

7. Van Etten, J. 1992. In praise of Pieris. Fine Gardening 24:60-63.

Natural Control of the Azalea Lace Bug in the Landscape

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Nature of Work: Damage to azaleas caused by the azalea lace bug (ALB), *Stephanitis pyrioides,* is a major economic concern to the industry since azaleas are among the most widely planted flowering shrubs (3). In north and central Georgia, four generations of ALB occur annually; overwintered eggs hatch around mid-March. Feeding and excretory activities of adults and nymphs result in diminished plant vigor and the chlorosis that is symptomatic of lace bug damage.

Two natural enemies of ALB that occur in Georgia include a plant bug, *Rhinocapsus vanduzeei* Uhler (2), and a parasitoid wasp, *Anagrus takeyanus* Gordh (1). *Rhinocapsus* overwinters in the egg stage, emerges in April and is present on azaleas until late June (SKB, unpublished). *Anagrus* females oviposit in the eggs of the lace bug throughout the season.

The objectives of this study were to determine the prevalence of the parasitoid in Georgia and to assess the potential impact of these insects as natural enemies of the ALB.

In early 1992, eighty leaves per site were collected from each of ten sites in four counties in Georgia. To determine the percent parasitism by *Anagrus,* sixty leaves from each site were examined for the presence of ALB eggs. The eggs were scored as intact, hatched, or parasitized. Leaf area of the remaining twenty leaves was measured using a Lycor leaf area meter.

Rhinocapsus were collected from azaleas at Calloway Gardens in Pine Mountain, Ga., during May 1992. Consumption rates for *Rhinocapsus* were determined for the following predator/prey combinations in petri dish arenas: one adult/twenty second instar ALB, ten adults/ten fourth instar ALB, one adult/six adult ALB, and one fifth instar/three adult ALB. Controls were as above, but without the predator. After twenty-four hours, the number of dead ALB was counted to calculate percent consumption. Plates in which ALB had molted to the next instar, or in which the plant bug had died were not included in our calculations.

Results and Discussion: Anagrus was present at all sampling sites. Mean percent parasitism ranged from 2.40% in Cherokee County in northern Georgia to 31.3% in Spalding County located in the piedmont (Figure 1). Overall parasitism was 23.7%. The factors we examined which potentially influence parasitism included leaf area, egg density/leaf and number of eggs/location. Plants having greater numbers of eggs were no more likely to have higher levels of parasitism than plants with fewer eggs ($P < .05$, R^2 -.0065). However, percent parasitism was greater on leaves with higher egg densities. Figure 2 illustrates the positive correlation between percent parasitism and number of eggs/leaf at one site in Spalding County. We found no relationship between parasitism and leaf area within the plant. In certain instances, then, the wasp displays a tendency to exploit host resources and further study is necessary to determine what factors promote this behavior.

The plant bug was a more effective predator of ALB nymphs than ALB adults. The mean number of ALB consumed ranged from 0.4 ALB adults per fifth instar mirid to 6.92 second instar ALB nymphs per adult mirid (Figure 3). Both *Rhinocapsus* and *Anagrus* are effective natural enemies of ALB. Their life cycles make them complementary control agents of this pest. *Anagrus'* life history appears to be synchronized with that of its ALB host. In 1992, the wasp emerged in March with the first ALB generation and we found a second parasitoid emergence synchronous with the second generation of lace bugs. Additional sampling will further document the seasonal activity of the parasitoid.

Significance to the Industry: Results of these and additional planned studies will refine integrated pest management strategy for azaleas for more efficient plant protection. Our studies with A. *takeyanus* and R. *vanduzeei* emphasize the opportunity to consider the role of natural enemies as part of any pest control program.

Literature Cited

1. Braman, S.K., A.F. Pendley, B. Sparks and W.G. Hudson. 1992. Thermal requirements for development, population trends, and parasitism of azalea lace bug (Heteroptera: Tingidae). J. Econ. Entomol. 85: 870-877.

2. Henry, T.J. and A.G. Wheeler, Jr. 1988. The family miridae. *in* Catalog of the heteroptera, or true bugs, of Canada and the continental United States. T.J. Henry and R.C. Froeschner, eds. E.J. Brill. New York. p. 499.

3. Raupp, M.J. and R.M. Noland. 1984. Implementing landscape plant management programs in institutional and residential settings. J. Arboric. 10: 161-169.

Figure 1. Mean percent parasitism of ALB eggs by *Anagrus* in four Georgia counties.

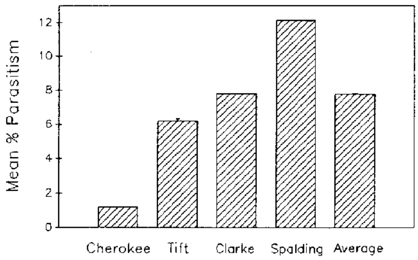


Figure 2. Percent parasitism vs. egg density at one site in Spalding Co., Georgia.

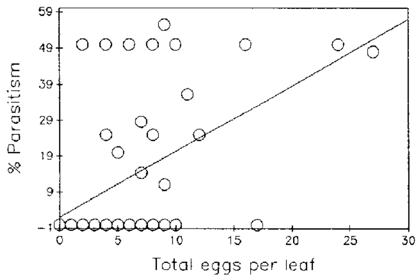
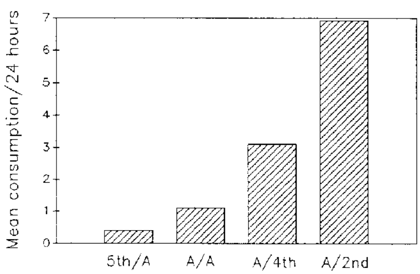


Figure 3. Consumption by 5th instar or adult mirids/ on adult (A), 4th or 2nd instar ALB.



Rout Herbicide Movement In Runoff Water:
Quantification and Bed-Cover Effects

**Renee J. Keese, N. Dwight Camper, Melissa Riley,
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South Carolina**

Nature of Work: Granular preemergence herbicides are preferred for control of problem weeds in the production of ornamental landscape plants. Broadcast applications deliver herbicides to growing containers and surrounding surfaces, such as gravel or plastic, which absorb little water or herbicide. These herbicides are routinely watered-in by overhead irrigation and a significant percentage of the irrigation and rainfall runs off of these growing areas into holding ponds. Many ornamental nurseries are recycling their containment pond water by using it for irrigation.

The literature on this subject is slim; monthly water and sediment sampling have detected the presence of pendimethalin, oryzalin and oxyfluorfen (1, 2). Other herbicides including simazine, alachlor and metolachlor have been evaluated, comparing spray to granular application (3) and phytotoxicity of runoff water (4). Turfgrass 2,4-D runoff was 5 mg/L, and water loss was less than expected, with more water lost from seeded than soded areas (5).

Pendimethalin and oryzalin (dinitroaniline herbicides) and oxyfluorfen (a diphenyl ether) are marketed in combinations as OH-2 (Scotts) and Rout (Grace-Sierra Chemical Company). The objective of this research was to determine losses of Rout due to runoff following application, and the effect of different bedding covers on runoff.

Materials and Methods: A real-time application event was conducted at a nursery in the upstate of S. C. in August 1991 and May 1992. Rout was applied (100 lbs/Ac) to container beds and followed by irrigation for 2.75 hours (1/2"). Active runoff was sampled at 0.25, 0.5, 1.0, 1.5, 2.5 and 3.0 hours. Pond samples were collected prior to application and 1, 2, 3, 7 and 14 days after application. Depth of runoff leaving the drainage culvert was measured to determine the quantity of runoff water.

A micro-plot study was conducted at the Clemson University Botanical Gardens in July and September of 1991. Azaleas in #1 pots were placed on inclined trays which facilitated runoff; the trays were covered with gravel, plastic or fabric, to simulate nursery conditions. Rout was applied at 100 lbs/Ac (0.112 9 oryzalin/pot) and plots were irrigated with 95.6 L/day. Runoff was collected on the day of application ffour consecutive 400 ml samples), and following treatment at 1, 2, 5, 9, and 19 days.

All samples were collected in silanized glass jars and transported on ice to the laboratory. Water pH was adjusted to 2 to 2.3 prior to filtering. Herbicides were extracted by solid phase extraction (C_{18} columns) and eluted with 2 ml acetone. Duplicate water extracts were analyzed by a Varian HPLC with C_{18} column for herbicide quantification. Running conditions consisted of a gradient of 65:35 acetonitrile:water to 100% acetonitrile and UV detection at 206 nm. Retention times of oryzalin and oxyfluorfen were 6.7 and 11.8 min., respectively. Detection limits were 1 ppb (1 ng/ml) for water and 0.1 ppm (1µ g/ml) for sediment.

Results and Discussion: From the nursery application, greatest loss of oryzalin occurred in the first 2 hours (Fig. 1), and herbicide levels in the pond were near the detection limit 2 weeks following application. Oxyfluorfen levels were low in water samples throughout the study, probably due to its low water solubility. Water runoff peaked at 3 hours, with losses of 1.15 gallons/second. The micro-plot study of different bed-cover materials demonstrated differences in oryzalin loss from plastic (84%) > fabric (80%) > gravel (62%). Oryzalin was detected in the first 2 days at 6 to 7 µ g/ml from plastic and fabric. Gravel retained significantly more Rout (Fig. 2). For oxyfluorfen, no differences were observed between coverings tested and detection levels were low.

In conclusion, rapid movement of oryzalin from the site of application was demonstrated; no Rout accumulation in the containment pond was detected. Micro-plot tests illustrated differences in bedding covers with plastic losing more water and herbicide, while gravel retained and impeded movement.

Significance to Industry: This study demonstrates the large quantities of chemicals transported by water shortly after application; no accumulation was evident in the ponds. Targeting the herbicide application into containers only, or selecting bed covers which reduce granule flow can reduce herbicide loss due to runoff.

Literature Cited

1. Keese, R. J., T. Whitwell, N. D. Camper and M. Riley. 1991. Ornamental herbicide detection in nursery irrigation and containment water. Proc. SNA Research Conf. 36:21.

2. Keese, R. J., T. Whitwell, N. D. Camper and M. B. Riley. 1992. Oryzalin, pendimethalin, and oxyflorfen levels in water and sediment from container nursery ponds. Southern Weed Sci. Soc. Abstracts 45:141

3. Mahnken, G. E., W. A. Skroch, and T. J. Sheets. 1992. Loss of simazine and metolachlor in surface runoff water from a container ornamental production site. Weed Sci. Soc. Am. Abstracts, 32:111.

4. Skimina, C. A. 1992. Studies with herbicides in a recycled water system in the production of container ornamentals. Weed Sci. Soc. Am. Abstracts, 32:111.

5. Watschke, T. L., S. A. Harrison and G. W. Hamilton. 1992. Herbicide runoff from turfgrass areas. Weed Sci. Soc. Am. Abstracts, 32:112.

Acknowledgement: Thanks to HRI and Grace-Sierra Chemical Co. for partial funding of this research. Trade names and companies are mentioned with the understanding that no discrimination is intended nor endorsement implied. South Carolina Agricultural Experiment Station Number 3315.

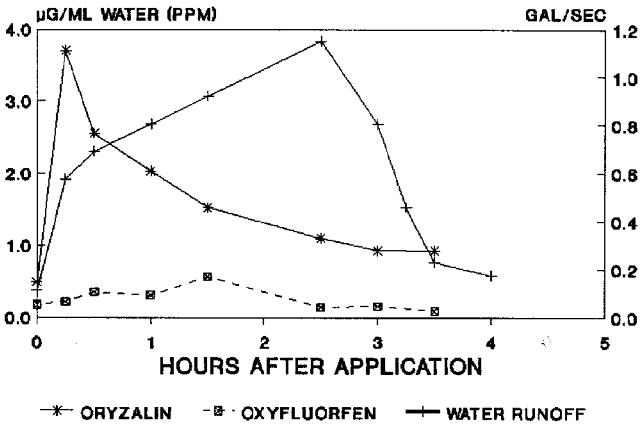

Figure 1: Runoff study at nursery site following Rout application, average of 2 years data.

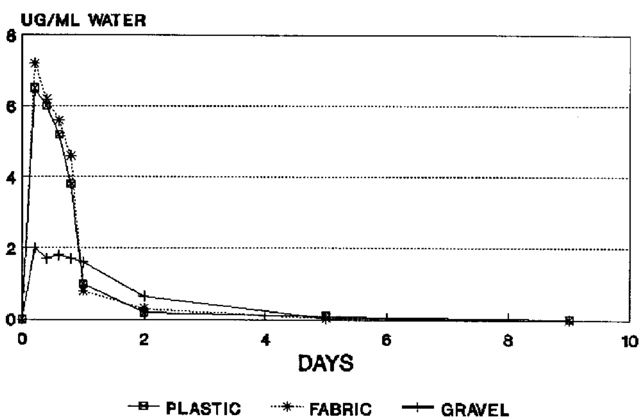

Figure 2: Runoff of oryzalin in simulator study following application of Rout

Role of Convergent Lady Beetle, *Hippodamia convergens* (Coleoptera: Coccinellidae), in Dispersal of *Discula* Spores and Spread of Dogwood Anthracnose

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Tennessee

Nature of Work: Native dogwood trees occupy a specific niche in the forest ecosystem. Dogwoods have also established a place in the nursery industry as people have come to appreciate the trees' aesthetic qualities (9). *Cornus florida* L., the flowering dogwood, is native to the eastern United States and exhibits year round beauty. They tend to be short but widespread trees with thick crowns (2). The early spring bloom draws many tourists to the south's national parks and town festivals.

In the late 1970's, a lower twig dieback on the trees was recorded in some of the northeastern states (8). Later, the name for the disease attacking dogwoods, caused by the fungal pathogen *Discula destructiva* Redlin, *sp. nov.,* was changed to dogwood anthracnose (5,8,10). Recent accounts of the disease progression have documented contaminated trees as far south as Alabama and Georgia and westward to middle Tennessee and Kentucky (7). Dogwood anthracnose symptoms begin as a leaf blight with characteristic purple rimmed leaf spots. Diseased leaves do not senesce in the autumn months and are recognizable to researchers analyzing the disease progression. The pathogen becomes endemic as it progresses to the trunk through epicormic shoots. Cankers form at the base of the shoots and most often, coalesce, girdling the tree (2,5,8,11). A tree exhibiting symptoms of a severe infection may survive only a few years.

Research has shown that many environmental factors may predispose a tree to *Discula* invasion. However, little information is known about the transmission of the pathogen. Researchers have concluded that *Discula* spores are often dispersed by heavy winds during rainy periods; however, no study has examined the role of insects as possible transporters of the disease (6). Insects comprise over one half of all living organisms and exist in almost any type of habitat (3,4). Because of their abundance and diversity, some insect species play a role in the transmission of more than 200 plant diseases (3,4,12). These insects may release the pathogen into the host during feeding or carry the pathogen on or within their bodies. The succulent growth of dogwood epicormic shoots may be a target for infection and a feeding ground for herbivorous and predaceous insects. However, no information is available about the role of insects in dissemination of *Discula destructiva.* Therefore, research on insect involvement in the dispersal of *Discula* spores is a crucial component in the study of disease development and spread of dogwood anthracnose.

This research was designed to determine whether or not select insect species can disseminate *Discula* conidia to susceptible dogwood hosts. Fulfillment of this project is being accomplished through experiments constructed to determine if selected insects can transport *Discula* conidia both on and within their bodies and, if so, the length of time that the spores can remain viable on the bodies of the insects. Insects used in these experiments will be both purchased from commercial companies and collected from diseased dogwood trees. Field collections will be used to assess the occurrence of *Discula* conidia dispersal in forest environments. Also, scanning electron microscopy will be utilized to reinforce findings from the laboratory and field experiments as to location of spore attachment on insect bodies. Finally, controlled greenhouse experiments using healthy dogwood trees and conidia-infested insects will be used to assess the infective capabilities of spores disseminated by selected insects. Thus far, preliminary research involving adult lady beetles and experiments examining spore transporting abilities on and within the insects body and also the duration of spore viability on the body has been completed.

Two isolates of *D. destructiva,* TN 1 (Type 1) and VA 17b (Type 2), and two insect species will be used for both laboratory and greenhouse research. The first insect selected was the convergent lady beetle, *Hippodamia convergens* Guerin-Meneville (Coleoptera: Coccinellidae), found throughout the United States and Canada. The convergent lady beetle is the most common species of lady beetle and is characterized by approximately 12 black spots on reddish elytra with two converging white lines on the thorax. Classified as a beneficial insect, lady beetles spend most of their lives on plant foliage and prey on aphids and scale insects (1,3,4,12). The second insect species chosen for evaluation in this study will be determined after field collections are completed and processed. Selections will be based on feeding habits and abundance of insects collected from sampled trees.

Sporulating *Discula* thalli growing on autoclaved dogwood leaves were placed in petri dishes. Lady beetles, obtained from laboratory cultures, were placed in the dishes and allowed to walk on the leaves for 24 hours. Insects were then removed and dropped into a small vial containing sterile water. One ml aliquots of the surface wash were then incubated on PDA plates. After washing, beetles were surface sterilized in clorox, rinsed, and macerated in sterile water. One ml dilutions were plated and incubated for *Discula* growth.

To determine the length of time that these insects can carry the spores, lady beetles were allowed to walk over sporulating *Discula* thalli growing on autoclaved dogwood leaves. After 4 hours, beetles were placed into individual, empty petri dishes. Beetles were than removed at selected intervals (e.g., 6,12,24,48,96, and 192 hrs) after exposure to the sporulating thalli and transferred to PDA plates. After 4 hours, insects were removed and the plates were incubated.

Results and Discussion: All lady beetles subjected to the contaminated leaves disseminated viable *Discula* spores, both externally and internally, to the PDA plates. Also, lady beetles exposed to contaminated leaves carried viable spores up to 8 days after inoculation. The experiment was terminated prior to the 16 day time interval due to the death of all specimens.

Although these data were obtained from preliminary studies, our results have demonstrated that the convergent lady beetle is capable of disseminating *Discula destructiva.* Other insect species, based on their feeding habits and occurrence in wooded areas, also may serve as disseminators of this fungus. Further research will address their role in dissemination, as well as assess the occurrence of *Discula* spore dissemination by insects collected from dogwoods.

Significance to Industry: In the eastern United States, dogwood sales reach approximately 100 million dollars per year, contributing 35-40 million to the Tennessee nursery economy alone (M. Windham, personal communication). No estimate as to the economic loss that dogwood anthracnose has cost the nursery industry has been made available. Most of the loss may be attributed to the unfavorable publicity that the disease has received. Aside from the beneficial predatory insects, other plant-feeding pests on dogwoods have not been examined as possible fungal disseminators and may be deemed necessary to control. Nurseries located near wooded areas where disease is severe may have to incorporate insecticides as part of a disease prevention regime. Insects as possible disseminators of dogwood anthracnose may pose a serious threat to the production of dogwoods. Homeowners are urged to plant only trees purchased from a nursery. Also, prune and destroy all dead or infected tree parts to reduce the risk of spreading the disease while at the same time maintaining the tree's vigor (2).

Literature Cited

1. Arnett, R.H. Jr., N.M. Downie and H.E. Jaques. 1980. How to know the beetles. Pg. 251. Wm. C. Brown Company, Iowa.

2. Bailey, K.R. and E.A. Brown II. 1991. Growing and maintaining healthy dogwoods. USDA Forestry Report R8-FR 14. March 1991.

3. Borror, D.J. and R.E. White. 1970. A field guide to the insects of America and New Mexico. Pp. 5-8. Houghton Mifflin Co., Boston.

4. Borror, D.J., C.A. Triplehorn and N.F. Johnson. 1989. An introduction to the study of insects. Pp. 875. Saunders College Publishing, Philadelphia.

5. Brown, D.A., M.T. Windham, A.S. Windham and E.T. Graham. 1991. Dogwood anthracnose: Questions and answers. The Univ. of Tennessee Agric. Exp. Sta. Res. Report 91-06. March 1991. 7 pp.

6. Daughtrey, M.L., C.R. Hibben and G.W. Huder. 1989. Cause and control of dogwood anthracnose in northeastern United States. Journal of Arboriculture 14: 159-164.

7. Gould, A., J. Hartman and M. Daughtrey. 1992. Summary of the 6th annual dogwood (anthracnose) workshop. Proceedings of the 6th Regional Dogwood Workshop. April 14-16, Pipestem, WV.

8. Hibben, C.R. and M.L. Daughtrey. 1988. Dogwood anthracnose in northeastern United States. Plant Disease 72: 199-203.

9. Redlin, S.C. 1991. Characteristics of the *Discula sp.* on *Cornus florida.* Proceedings of the 1991 Dogwood Anthracnose Working Group. January 9-11, Athens, GA.

10. Redlin, S.C. 1991. *Discula destructiva sp. Nov.,* cause of dogwood anthracnose. Mycologia 83: 633-642.

11. Windham, A.S., M.T. Windham and C.H. Hadden. 1991. Diseases of flowering dogwood. The Univ. of Tennessee Agric. Ext. Service Report SP 370F. July 1991.

12. White, R.E. 1983. Peterson field guides: Beetles. Pg. 5. Houghton Mifflin Co., Boston.

Turf Herbicide Damage to Bradford Pear and Eastern Redbud as Influenced by Landscape Mulches

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Nature of Work: Environmental awareness regarding the use of herbicides is on the increase. Concern exists particularly on the issue of non-target damage by herbicides. This study examines the potential for damage to landscape trees by root uptake of turf herbicides as influenced by different mulch regimes.

On May 2, 1990 landscape size plant material (1" caliper, 7' pears and 1" caliper, 5' redbuds) was obtained and planted in raised beds with plot size 6' X 22'. Bradford pear was chosen because of reported sensitivity to Banvel (dicamba) (1). Redbud was chosen because it is in the Leguminosae family. Plants in this family are known to be highly sensitive to Stinger (clopyralid) (2). One of each species was included in each plot and then each plot was assigned one of four groundcover variables (hardwood, pine bark, or pine straw mulch, or no mulch). The mulches were spread to a uniform depth of 3" over the respective plots. A one year establishment period was provided prior to herbicide application. Experimental design is a randomized complete block with five replications.

Mulches were replenished to their original status in February of 1991. In early March corrective pruning was done, and the lower 18" of stem were stripped to eliminate the potential for chemical uptake from contact with basal foliage. On April 11, chemical treatments were applied as directed sprays at 29 gallons per acre (GPA) with a K-5 flooding nozzle in 36" bands on each side of the plot. Banvel and Stinger were applied at the standard rates of 0.125 LBai/A and 0.25 LBai/A respectively.

A visual rating of percent damage was taken on May 10, thirty days after treatment (DAT). Subsequent ratings were taken at 60, 90, 120,and 150 DAT. A rating scale of 0%-100% was used with 0% and 100% representing no damage and plant kill respectively. Data from these ratings were analyzed using analysis of variance. Percent damage was calculated as a mean for each treatment across the five replications .

Results and Discussion: Pear injury data averaged across mulches by date, showed a 5% damage rating from Banvel on Bradford pear at 30 DAT. Damage approached 10% at 60 DAT, and persisted across the subsequent rating dates. Pear injury compared across mulches and dates revealed a highly significant difference in damage ratings in plots with mulch versus plots without mulch. The three mulches had mean damage ratings in the 2-5% range, where the no mulch plots had a mean damage rating of 24%, [LSD(0.05) = 3.13%]. Pear injury data on Stinger was much less severe ,but followed a similar pattern of significant difference between mulched and non mulched plots.

Redbuds in mulched plots treated with Stinger generally had significantly less damage than those in plots with no mulch. Differences were observed in damage ratings between rating dates. Overall damage ratings increased through the 120 DAT date, then began to decline. When mulch and chemical data were averaged over rating dates, damage ratings for pine straw, hardwood, pine bark, and no mulch were 29%, 43%, 43%, and 63% respectively; [LSD (0.05) = 11.5%], illustrating not only the differences between mulched and non-mulched plots, but between the individual mulches. Significant damage was not observed on redbuds from Banvel.

Significance to Industry: Stinger, a promising new turf herbicide for broadleaf weed control, has been compared to Banvel, an old standard in the industry. The data show clear differences in species sensitivity to the above mentioned herbicides. The data also show that mulch reduces the severity of chemical injury. These data verify the importance that herbicide users be knowledgeable about landscape species, and heed label warnings about applying herbicides under driplines of sensitive species.

Literature Cited

1. Decker, H.F. and J. Decker. 1988. Lawn Care, Handbook for Professionals. Prentice-Hall, Inc. Englewood Cliff, NJ, pp. 270.

2. Herbicide Handbook of the Weed Science Society of America, Sixth Edition, 1989, pp. 67-68.

Root Control Techniques for the Urban Landscape

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Nature of the Work: Root encroachment into unwanted areas of the landscape, such as hardscapes and ornamental beds, is a serious problem for the landscape industry. Current methods of restricting roots, usually involving cutting roots, are expensive and tend to provide short-term solutions. Physical and/or chemical barriers that prevent roots from growing into unwanted areas are being investigated as a more economical and permanent alternative to current root control methods. Based on previous work, Typar Biobarrier (Remay, Inc., Old Hickory, TN) and DeWitt Pro-5 (DeWitt Co., Inc., Sikeston, MO) were chosen as potential root barriers for this work (1,2).

Typar Biobarrier is a time-released, trifluralin-containing material that was first developed as a method for controlling root encroachment into hazardous waste sites. The material is comprised of 0.35 inch spheres that are 24% trifluralin, 18% carbon black, and 56% polyethylene. The herbicide impregnated nodules are then bonded to a permeable geotextile fabric (1). DeWitt Pro-5 Weed Barrier is a woven polypropylene fabric that provides excellent weed control in the landscape (2). The objectives of this study were to evaluate two methods of root control in the urban landscape, and to determine the influence of those root control methods on the growth of two tree species.

Two-inch caliper Acer rubrum, red maple, and Platanus occidentalis, American sycamore, were planted at the E.V. Smith Research Center on March 26. The planting holes were 8 foot x 8 foot and 19 inches deep. Sides of each hole were lined to a depth of 18 with either Typar Biobarrier, DeWitt Pro-5 or left unlined. One-inch of the fabric was left above the soil surface to prevent roots from growing over the vertical barriers. Trees were placed in the center of the hole and holes were backfilled. After planting, trees were mulched with 2-3 inches of pinebark, watered as needed during the first year, and fertilized annually with 1 lb of 13-13-13 per inch of caliper. Roundup was used for postemergence weed control around the edge of the planting hole. Each tree species was evaluated as an individual experiment with six single tree replications in a randomized complete block design.

Root penetration, height, and caliper were determined following the 1990 and 1991 growing seasons. Three single-plant replicates per treatment per tree species were randomly selected for evaluation of root penetration through the vertical barriers. One side of the planting hole was excavated with a backhoe 4 inches outside the plane of the root control treatments. The extra soil was removed by hand, and the number of roots penetrating the root control treatments was counted.

Results and Discussion: There was little or no root penetration by either species through the Typar Biobarrier following the 1990 and 1991 growing seasons (Table 1). At the end of 1990, the control and the DeWitt Pro-5 treatments had similar root penetration. In contrast, by the end of 1991, the DeWitt Pro-5 treatment had more root penetration than did the control treatment for red maple. Roots that penetrated the DeWitt Pro-5 treatment tended to branch as they penetrated the barrier, resulting in many small roots that grew along the vertical barrier.

There were no treatment differences in height or caliper of red maple or American sycamore either year among treatments. Average height and caliper for red maples across the three root control treatments were 13.3 feet and 2.2 inches in 1990 and 17.2 feet and 3.5 inches in 1991, respectively. For American sycamore, average height and caliper across the three root control treatments were 15.6 feet and 2.5 inches in 1990 and 17.8 feet and 3.8 inches in 1991.

In May of 1991, soil samples were taken horizontally from the area surrounding a Typar Biobarrier treatment to evaluate trifluralin movement in the soil. Trifluralin levels were highest, 24.1 ppm, 0-1/8 inches from the nodule and decreased in concentration as distance from the nodule increased. At a distance of 2 inches, the trifluralin concentration had decreased to 0.1 ppm. The nodule trifluralin content was comparable to the original herbicide content of the nodule.

Siqnificance to Industry: Tree root encroachment poses several problems to the landscape industry. Trees that are planted too close to walks, parking lots, or streets can often cause those hard surfaces to buckle. Root encroachment may also cause aesthetic problems by surfacing in ornamental landscape beds. Repairing hardscape damage and preventing root regrowth or removing roots from ornamental beds are expensive processes that must be repeated often. Typar Biobarrier has effectively controlled root growth of both red maple and American sycamore without producing negative effects on tree growth and development during the first two years of this study. In comparison, DeWitt Pro-5 failed to provide root growth control.

Literature Cited

1. Burton, F.G., W.E. Skiens, J.F. Cline, D.A. Cataldo, and P. Van Voris. 1986. A controlled-release herbicide device for multiple-year control of roots at waste burial sites. Journal of Controlled Release 3:47-54.

2. Martin, C., H.G. Ponder, and C.H. Gilliam. 1991. Evaluation of landscape fabrics in suppressing growth of weed species. J. of Environ. Hort. 9:38-40.

Table 1. Root penetration of the planting wall outside vertical root control treatments.

	Number of Roots			
	Redmaple		American sycamore	
Treatment:	1990	1991	1990	1991
Biobarrier	0.0b*	0.0c	0.0b	1.0b
DeWitt Pro-5	11.7a	58.7a	16.3a	58.0a
Control	17.0a	28.3b	22.0a	53.7a

* Means followed by the same letter are not significantly different according to LSD at a = 0.05.

Low Water Application Rate and Intermittent Irrigation Increase Irrigation Efficiency of Sprinkler-Irrigated Container-Grown Plants

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Nature of Work: Nurseries irrigate container-grown crops with overhead sprinkler systems and apply approximately 2.6 million gallon $\cdot$acre $^{-1}$ (24 million liters $\cdot$ha $^{-1}$) per growing season (Rathier and Frink, 1989). As much as 80% of applied water may fall between or leach from containers (Beeson and Knox, 1991). Highly porous soilless media and relatively high water application rates cause a rapid downward movement of water through and out of the medium. Nurseries apply the daily water allotment to plants in a single application at rates ranging trom 0.24 to 0.9 inch$\cdot$ h^{-1} (0.6 to 2.2 cm$\cdot$ h$^{-1)}$ (Fare et al., 1990). A possible solution to reduce water and N loss from containers is the use of relatively low water application rates or intermittent irrigation (II). There are no reports which document the influence of application rate on irrigation efficiency for soilless media. With II, the daily water allotment is applied in a series of cycles, each cyde composed of an irrigation application and a resting interval (Karmeli and Peri, 1974). Water is applied at a conventional rate while the irrigation system is operating, but the actual time-averaged application rate (Zur, 1976) is relatively low when the resting interval is taken into account (Karmeli and Peri, 1974). Reports have documented increased irrigation efficiency using II in mineral soils but not in soilless media. The objective of this study was to determine it relatively low application rate and II increase irrigation efficiency for plants grown in a pine bark medium.

Materials and Methods: Marigold seedlings (Taaetes erecta L. 'Apollo') were greenhouse-grown in one gallon (3.8 liter) pine bark-filled containers (Pinus taeda L.) amended with 0.19 lb dolomitic lime• ft^{-3} (3 kg •m^{-3}). Osmocote (Grace-Sierra Chemical Co. Milpitas, Calit.) 14-14-14 was surface applied at 0.7 oz (20 g) per container. Bark had a bulk density ot 0.11 oz• $inch^{-3}$(0.19 g• cm^{-3}) total porosity of 84%, container capacity of 64%, air space of 20%, available water of 24%, and drainage of 0.074 qt (70 ml) (after saturation and before container capacity was reached). The particle size distribution of bark was: 10% > 0.252 inch (6.4 mm), 26% > 0.110 inch (2.8 mm), 21% .> 0.055 inch (1.4 mm), 27% > 0.020 inch (0.5 mm), and 16% < 0.020 inch (0.5 mm). Plants were watered by hose as needed. When plants were approximately 30 days old (following transplanting), bark was irrigated thoroughly by hose and drained for 2 h. Weight of bark (gravimetric basis) after drainage was similar to bark weight at container capacity in the same size container (preliminary experiment). Medium was allowed to dry via evapotranspiration to a 0.32 qt (300 ml) water deficit after which plant shoots were severed at the medium surface and experiments commenced.

To simulate overhead sprinkler irrigation, a peristaltic pump was used to apply water via three tubes hanging over the radius of each container. Containers fitted with leachate collection vessels were seated on pedestais which rotated at 13 rpm. After irrigation treatment, bark in each container was allowed to drain for 2 h and collected leachate was measured. Leachate N (NO_3 -N and NH_4 -N) was determined using ion-selective electrodes. Analysis of variance was conducted for all main effects and means separation performed with Duncan's Multipie Range Test (0.05 level) . Experimental design was a randomized complete block design.

Experiment 1: After plants extracted 0.32 qt from bark, 0.32 qt water (moisture deficit) was applied at three application rates: 0.28, 0.55, and 0.83 inch• h^{-1} (0.7, 1.4, and 2.1 cm •h^{-1}, respectively). There was one container per application rate in each of six blocks.

Experiment 2: After plants extracted 0.32 qt from bark, 0.32 qt water was applied at three application rates: 0.04, 0.1 6, and 0.28 inch• h $^{-1}$ (0. 1, 0.4, and 0.7 cm •h^{1,} respectiveiy). There was one container per appiication rate in each of six blocks.

Experiment 3: After plants extracted 0.32 qt from bark, 0.32 qt water was applied at 0.28 inch •h $^{-1}$ either continuousiy (total volume of water applied in one application) or in three 0.11 qt (100 ml) applications with 45 min interval between applications (II). There was one container per treatment in each of 10 blocks.

Results and Discussion: There were no differences in the amount ofwater or N leached at application rates ranging from 0.28 to 0.83 inch• h $^{-1}$ (Expt. 1) (Table 1). In Expt. 2, leachate volume was lower at 0.04 inch •h $^{-1}$ than at 0.28 inch• h^{-1} but with no differences in the amount of N leached (Table 2). For II, 32% less water was leached compared to continuous irrigation (Table 3). As with the lower irrigation rate, method of irrigation had no influence on the amount of N leached. Since the time-averaged application rate for the II treatment is 0.14 inch• h $^{-1}$ (0.36 cm •hr $^{-1}$) and, as with data of Expt. 2, it is evident that a much lower application rate than conventionally used (0.24 to 0.9 inch •h $^{-1}$) is required to reduce the amount of water lost. When water is applied at a relatively low rate either continuously or via II, the duration of the wetting period is extended. As a result, water is more likely to be adsorbed by the medium resulting in less channeling and downward movement of water through and out of the medium.

Significance to Industry: The use of low water application rates and II result in less water leaving containers than current irrigation rates. However, the low rates used in this experiment are not commercially feasible. II is a commercially feasible method of increasing irrigation efficiency and can be accomplished by using irrigation time clocks capable of short interval applications. A few U.S. nurseries are successfully using II with significant reductions in water and fertilizer use.

Literature Cited

1. Beeson, Jr., R. C. and G. W. Knox. 1991. Analysis of efficiency of overhead irrigation in container production. HortScience 26:848-850.

2. Fare, D. C., C. H. Gilliam, and G. J. Keever. 1990. Irrigation monitoring at container nurseries. Proc. SNA Res. Conf. 35:57-58.

3. Karmeli, D. and G. Peri. 1974. Basic principles of pulse irrigation. J. Irr. Drain. Div. 100(1R3):309-319.

4. Rathier, T. M. and C. R. Frink. 1989. Nitrate in runoff water from container grown juniper and Alberta Spruce under different irrigation and N fertilization regimes. J. Environ. Hort. 7:32-35.

5. Zur, B. 1 976. The pulsed irrigation principle for controlled soil wetting. Soil Sci. 1 22:282-291.

Table 1. Influence of application rate on the amount of water and N leached (Expt. 1)

Application rate cm•h -1 (inch• h -1)	Leachate volume (ml)	Leachate N (mg)
0.7 (0.28)	90a[z]	7.2a
1.4 (0.55)	1 06a	9.9a
2.1(0.83)	105a	10.1a

z Means within columns separated by Duncan's Multiple Range Test at P=0.05. N=6.

Table 2. Influence of application rate on the amount of water and N leached (Expt. 2).

Application rate cm•h -1 (inch•h -1)	Leachate volume (ml)	Leachate N (rng)
0.1(0.04)	65b[z]	3.5a
0.4 (0.16)	73ab	2.1 a
0.7 (0.28)	80a	3.8a

z Means within columns separated by Duncan's Multiple Range Test at P=0.05. N=6.

Table 3. Influence of continuous and II on the amount of water and N leached (Expt. 3).

Irrigation method (ml)	Leachate volume (mg)	Leachate N
Continuous	57a[z]	2.9a
Intermittent	39b	1.5a

z Means within columns separated by Duncan's Multiple Range Test at P=0.05. N=10.

Effect of Application Method on Herbicide Loss in Surface Runoff from Container Production Sites

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Nature of the Work: Herbicide loss in surface runoff from row crop production sites has been extensively researched, however, little attention has been given to herbicide loss in surface runoff from container production sites until recently. Some practices used in container nurseries may make these sites vulnerable to herbicide loss in surface runoft. Overhead irrigation may be applied several times a week during the summer months, so herbicide application may be closely followed by an irrigation event. The greatest herbicide concentrations in runoff from row crop fields are usually found when the first precipitation event occurs within 2 weeks of herbicide application (4). The short time between application of herbicide and application of water decreases the effects of processes such as volatilization, photodegradation, chemical degradation, or biological degradation on herbicide loss from the treated area. The soil beneath containers may be covered with groundcloth, gravel, or plastic, and some of these covers limit infiltration of water and herbicide into the soil profile so that more water and herbicide are available for loss through surface runoff. Several herbicide applications may be made to container production sites during a growing season. A survey of nursery owners in Alabama found that an average of 2.9 to 3.2 applications were made per year (2). Frequent applications increase the frequency of herbicide detections in runoff water and may increase the amount of herbicide detected depending on the persistence of the herbicide and the length of time between applications.

Some research on herbicide runoff losses from container nurseries was recently initiated. Keese et al. (3) analyzed runoff water from nurseries in the Coastal Plain and Piedmont regions of South Carolina. Pendimethalin was detected in samples from the Piedmont nursery; and oryzalin, pendimethalin, and oxyfluorfen were detected in samples from the Coastal Plain nursery. The detections appeared related to the time elapsed between herbicide application and sample collection. In a study conducted at an Alabama nursery, oxyfluorfen was detected in water leaving container pads and water leaving the nursery property soon after oxyfluorfen application (1).

The objective of this study was to determine the losses of metolachlor and simazine from a simulated container production site. The study was conducted at Raleigh, North Carolina, using 16 plotson a 2% slope. Eight of the plots were covered with woven groundcloth, and eight plots were covered with woven groundcloth beneath 2 inches of gravel. Metolachlor (4 formulations used were Pennant (metolachlor) and Princep (simazine), and the granular formulation used was Derby, which contained both herbicides. Check plots were also included in the study. The plots received 1 to 1.25 inches of water per day through overhead irrigation. Runoff was collected in polyethylene barrels, and runoff volumes were measured and recorded daily. Samples were collected 0, 1 , 2, 4, 8,1 6, 32, and 56 days after application. Samples were extracted using C18 solid phase extraction cartridges. Samples were analyzed using gas chromatography with nitrogen detection. Detection limits were 0.001 ppm (μg/ml) for simazine and 0.01 ppm (μg/ml) for metolachlor. The experiment was conducted in 1990 and 1991, and two herbicide applications were made per year.

Results and Discussion: The concentrations of metolachlor and simazine in runoff water were relatively high in water from the first irrigation following herbicide application, especially in treatments in which herbicides were broadcast applied. When averaged across groundcovers, metolachlor concentrations were 4.95 ppm in the broadcast granule application and 6.02 ppm in the broadcast spray application. Simazine concentrations were 0.32 ppm in the broadcast granule application and 1.92 ppm in the broadcast spray application. For both herbicides, concentrations in water from the per container treatments were 3 to 4 times the detection limit concentrations. The much higher concentrations from the broadcast applications may have been the result of two factors. Approximately 80% of the plot area was not covered by containers so that much of the herbicide applied to the broadcast plots fell in this space. Herbicide that fell between containers may have been easily removed by surface water running from the plots resulting in higher concentrations in runoff from these treatments. Secondly, the plots receiving per-container applications received only one-fifth the amount of herbicide applied to the broadcast treated plots since application rates were calculated on a treated-area basis.

By the fourth day after treatment, concentrations of metolachlor and simazine had decreased significantly in the broadcast application plots, and in the per container treatment, metolachlor concentrations were below the detection level. By the thirty-second day after application, simazine was detected at low concentrations in plots receiving the broadcast treatments, and metolachlor was below the detection level concentration in all treated plots.

Significance to the Industry: Data from studies such as this one may help nursery operators manage herbicide runoff losses more effectively. The study indicates that herbicide runoff from container production sites can occur with the highest concentrations detected in the first nunoff events following application. In nurseries where irrigation water is recycled, the presence of herbicides in recycled water might pose a hazard to susceptible, non-target species located in other areas of the nursery. Nursery operators who recycle water need to dilute it so that phytotoxic concentrations will not be present, or operators must develop other treatment strategies so that herbicides present in recycled water will be degraded to harmless products before the water is reused. A per container application decreases the possibility of herbicide injury to sensitive species through recycled water.

Literature Cited

1. Gilliam, C., D.Fare, G. Keever, G. Wehtje, and D. Lacompte. 1991. Movement of herbicides in container media. Southern Nurserymen Assoc. Res. Conf. - Proc. 36:273-274.

2. Gilliam, C. H., W. J. Foster, J. L. Adrain, and R. L. Shumack. 1990. A survey of weed control costs and strategies in container production nurseries. J. Environ. Hort. 8:133-135.

3. Keese, R. J., T. Whitwell, N. D. Camper, and M. Riley. 1991. Ornamental herbicide detection in nursery irrigation and containment water. Southern Nurserymen Assoc. Res. Conf. - Proc. 36:21-23.

4. Wauchope, R. D. 1978. The pesticide content of surface water draining from agricultural fields - a review. J. Environ. Sci. 7:459-472.

Media pH as a Factor in an Iron Related Disorder in Cutting Geranium

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Nature of Work: For several years commercial growers of geraniums, both seedling and cutting types, have reported a disorder which affects their crops. The disorder is characterized by marginal/interveinal chlorosis progressing to marginal/interveinal necrosis, and finally to whole leaf necrosis, of lower and older foliage. It is common for affected foliage to exhibit a marginal, downward cupping of the leaves. Affected leaves generally have excessive concentrations of iron and/or manganese (2, 3). This disorder has also been reported to affect marigolds, impatiens, elatior begonias, cabbage and tomato transplants. In 1990, annual sales of cutting and seedling geraniums were $86 million and $42 million, respectively, which amounts to approximately 20 % of the total bedding plant market in the U.S. (6). Thus economic losses in crop quality and production associated with the disorder are significant (2).

Recommendations for control of this disorder are to maintain pH of growing media between 5.8 and 6.2 (3, 4). This limits availability of Fe and Mn because as media pH rises Fe, in particular, will complex with P, and organic matter and form oxides. This complexation renders iron unavailable for plant uptake. The use of chelated Fe and Mn in fertilizers applied to bedding plant crops such as geraniums, however, makes pH adjustment less effective as a method of controlling Fe and/or Mn availability. These "peat-lite" fertilizer formulations, which are used widely in the ornamental industry today, supply chelated forms of micronutrient metals typically as Fe-DTPA and Mn-EDTA. These metal-chelate complexes keep the metal available for plant uptake across a wide pH range. Chelates are also effective extractants of Fe from peat, thus they raise available levels of Fe in media (1).

Objectives of this experiment were (1) to determine the relationship of media pH to the occurrence of this specific disorder in cutting geranium, particularly at media pH within the range recommended to control the disorder, and (2) use a fertilizer regime using a Fe-chelate. The cutting geranium cultivar 'Aurora' was used due to its reported susceptibility to the disorder. Plants were grown with one of four Fe-DTPA concentrations (1, 10, 30, and 60 ppm) applied to two media batches. One batch was amended by dolomite incorporation at a rate of 2.25 Kg/m^3 and the other was unamended. There were six single plant replications of each pH•Fe-DTPA combination. Treatments were assigned in a completely randomized block design within a greenhouse. Nutrients were supplied as a modified Hoagland's solution (5) with Fe-DTPA treatments incorporated in the solution. Nutrient solution was applied at regular intervals to supply adequate moisture and fertility. Plants were grown for 50 days and harvested when 50% were showing fully expanded flowers. Leaves were separated into symptom and non-symptom tissue and dried for weight measurement and Fe analysis. A saturated media extract (7) was performed for pH and Fe analysis after plant harvest.

Results and Discussion: The saturated media extract analysis revealed differences in pH of media associated with dolomite amendment. Dolomite amended media had higher pH (6.0) than that of unamended media (4.25) (Figure 1). Dolomite amended media had pH within the range (pH 5.8 6.2) recommended for prevention of the disorder (3, 4). Iron concentration of media increased significantly with increasing Fe-DTPA treatment (data not shown).

Fe concentrations of symptom and non-symptom tissue generally increased with increasing Fe-DTPA concentration among plants grown in amended or unamended media (Figure 2). Symptom and non-symptom tissue Fe concentrations were similar among plants grown with lower Fe-DTPA concentrations of both media types. Symptom leaves of plants grown in both media types had higher Fe concentrations than non-symptom leaves at higher Fe-DTPA concentrations. Iron concentrations of symptom leaves at 60 ppm Fe-DTPA were higher among plants grown in unamended media than those of the same treatments groups in amended media.

Symptoms occurred in all treatments groups. Number of symptom and non-symptom leaves, increased and decreased, respectively, with increasing Fe-DTPA concentrations in both media treatments (Figure 3). Plants grown in unamended media had more symptomatic leaves than those in amended media among the 30 and 60 ppm FeDTPA treatments. Plants in 1 and 10 ppm FeDTPA concentrations of both media batches had similar amounts of symptom leaves. Number of non-symptom leaves among plants in 30 and 60 ppm Fe-DTPA treatments were similar regardless of media treatment.

Significance to Industry: Results of this study indicate that adjustment of media pH to 5.8-6.2 does not prevent the occurrence of this disorder in cutting geranium cultivar 'Aurora'. Media pH adjustment decreased Fe concentrations in symptom tissue at higher Fe-DTPA concentrations but had no effect on Fe concentrations in symptom and non-symptom tissue at 1 or 10 ppm Fe-DTPA. Geraniums grown at all Fe-DTPA concentrations had some symptoms of the disorder, including those grown with 1 ppm Fe-DTPA which is same rate used in commercial production regimes.

Growers of geraniums need to be aware that while media pH adjustment above 5.8 may alleviate some symptoms of this disorder it will not be effective as a single control measure. Knowledge of the form of micronutrient metals used and amount applied is critical. The use of chelated micronutrients may be associated with the occurrence of this disorder and should be monitored closely. When symptoms are first observed the grower needs to eliminate any additional micronutrient application and have tissue samples analyzed immediately to determine the concentrations of the micronutrient metals. As shown in this experiment, however, tissue concentrations may not be a reliable indicator of Fe toxicity in affected tissue.

Literature Cited

1. Berghage, R.D., D.M. Drauskopf, D.D. Warncke, and 1. Widders. 1987. Micronutrient testing of plant growth media: Extractant identification and evaluation. Commun. Soil Sci. Plant Anal. 18:1089-110.

2. Biernbaum, J.A., C.A. Shoemaker, and W.H. Carlson. 1987. Iron and manganese toxicity of seedling geraniums. HortScience 22(5):118.

3. Biernbaum, J.A., W.H. Carlson, C.A. Shoemaker, and R. Heins. 1988. Low pH causes iron and manganese toxicity. Greenhouse Grower March 1988.

4. Carlson, W.H. 1988. The secret culprit: pH. Greenhouse Grower January 1988.

5. Hoagland, D.R., and D.I. Arnon. 1938. The water-culture method of growing plants without soil. Univ. Calif. Circ. 347.

6. United States Dept. Agriculture. 1991. Floriculture crops: 1990 summary. Sp Cr 6-1(91).

7. Warncke, D.D. 1986. Analyzing Greenhouse Growth Media by the Saturation Extraction Method. HortScience 21 (2) :223-225.

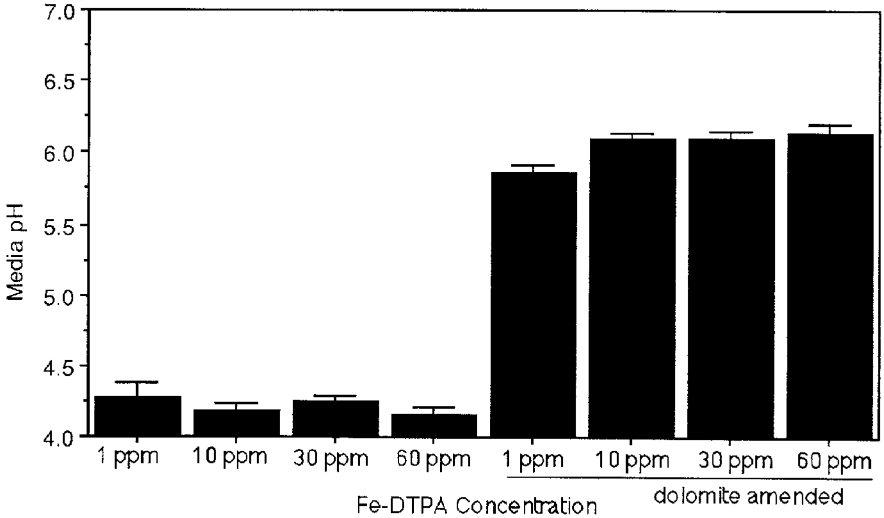

FIGURE 1. pH of unamended and amended media as determined by saturated media extract.

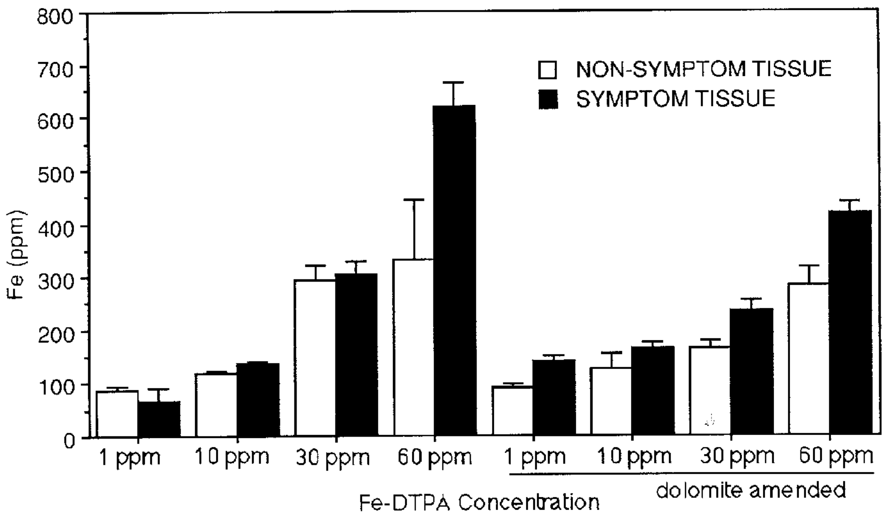

FIGURE 2. Fe concentration in leaf tissue with increasing Fe-DTPA treatments of both media batches

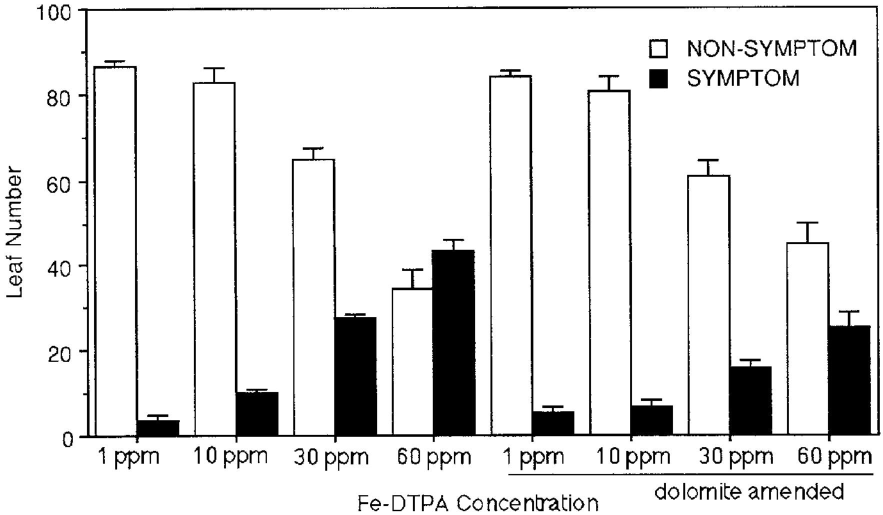

FIGURE 3. Leaf number of unamended and amended media with increasing Fe-DTPA treatments.

TRANSMISSION OF PHYTOPHTHORA PARASITICA IN AN EBB AND FLOW SUBIRRIGATION SYSTEM

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Nature of Work: Greenhouse crop producers in the southeastern United States face increasingly stringent restrictions in water usage and effluent content. Ebb and flow subirrigation is a technology which partly addresses these issues. This closed recirculating system conserves both water and fertilizer, and also prevents runoff from entering groundwater sources. However, a potential drawback to the system is possible dissemination of plant pathogens in the recycled nutrient solution. Bacteria and fungi which produce motile spores can move freely in water and possibly cause large crop losses (1).

Studies conducted in Europe indicate that disease spread in ebb and flow systems is not a serious threat for most crops, however little quantitative data have been published on the subject in the United States (3). Growers considering subirrigation require information on characteristics of the system which may be unique to southern climates. The objective of this study was to determine both the rate and severity of disease spread in a subirrigation system by a known pathogen on a specific host during the first six weeks of production.

Seeds of Catharanthus roseus 'Peppermint Cooler' (annual vinca) were sown in flats of Fafard No. 2 growing mix and covered with a thin layer of vermiculite. The seeds were kept moist and in darkness at 25ÂC for seven days until germinated. Seedlings were grown in a glass greenhouse for five weeks before being transplanted into 3-inch pots of Fafard No. 2. Plants were then placed on 4 x 6-foot ebb and flow benches in a random block design of six rows of seven pots, with each row representing a block. Pots were spaced 10 cm (4-inches) apart on center beginning at the drain end of the benches. Phytophthora parasitica (a motile spore fungus known to be very destructive to annual vinca in the southeastern U. S., (2)) was cultured for ten days in darkness at 24°C in 100 mm petri dishes on a selective agar medium. Three cultures of the pathogen were each diluted with 200 ml of distilled water and chopped in a blender for five seconds. Plants in block 1 (the first row at the drain end of the bench) were then inoculated at the soil surface with 25 ml of the suspended culture. Block 1 plants on three benches were treated, while a fourth untreated bench served as a control.

Vinca were grown for six weeks using a recycling nutrient solution containing 100 ppm N from Peter's 20-10-20 fertilizer. Soluble salts and conductivity were monitored prior to each irrigation to maintain a constant nutrient concentration. After one week, one plant from each of the inoculated rows was collected and tested to assure survivability of the pathogen. Plants were harvested weekly from each of the five rows of non-inoculated plants. Five sections of root tissue from each plant were cut into 5 mm lengths and placed on a PARPH agar medium selective for Phytophthora (4). Suspected root samples were collected on the basis of appearance, proximity to the bottom of the container, or both.

Results and Discussion: During the first five weeks of the test, presence of Phytophthora parasitica was not detected in root samples of non-inoculated plants. However, in week six the pathogen was detected on one non-inoculated plant (that died during week six) located 10 cm from the inoculated row. Cultures of the pathogen were also recovered at the termination of the experiment from each of the inoculated containers. The nutrient solution from each of four water tanks was also tested for the presence of fungal spores; no evidence of the pathogen was detected during the six week growing period.

The pathogen used in the study contributed to the death of 11 of 18 (61%) inoculated plants by the sixth week, but movement in the system was minimal with only one non-inoculated plant showing evidence of Phytophthora. However, 35% of the non-inoculated plants displayed some degree of root injury which was not attributable to Phytophthora. Also, 12% exhibited an index of injury of 3 or greater. The index of injury was scaled from 1-5 based on the severity of root injury (0- healthy, 1- stunting/ discoloration, 2- 1 to 25% root destruction, 3- 26 to 50% root destruction, 4- 51 to 75% root destruction, 5- 76 to 100% destruction).

The root injury observed was possibly due to the buildup of pathogen populations native to the growing mix. The mix was pre-packaged and was not disinfected or sterilized before use in the study. Though initial native populations were not determined, samples of unused mix were found to contain colonies of Pythium. Several Pythium species were also observed in root samples plated during weeks three to six. Many samples which initially tested negative began to exhibit Pythium growth as the suppressive properties of the selective agar media decreased.

Significance to Industry: Data from this study suggest that the transmission of Phytophthora parasitica in an ebb and flow system is not a serious threat when plants are spaced at a distance of 10 cm (4 inches). Closer plant spacing may yield different results. The observance of a high incidence of root injury not associated with Phytophthora, coupled with significant populations of Pythium, suggests that disinfection or sterilization of the growing media may be necessary if a pre-packaged soilless mix is used in a closed subirrigation system.

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Literature Cited

1. Daughtrey, M. and T. Weiler. 1992. Managing diseases in recirculating systems. Growertalks 55(10):59-71.

2. Hagan, A. 1991. Vinca damage by disease. Something To Grow On. Auburn University Extension Service Newsletter 2(2):5-6.

3. Hoitink, H. 1991. Transmission of plant pathogens in an ebb and flood system. Ohio Florist's Association Bulletin 742:5-9.

4. Jeffers, S. and S. Martin. 1986. Comparison of two media selective for Phytophthora and Pythium species. Plant Disease 70(11):1038-1043.