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ALABAMA AGRICULTURAL EXPERIMENT STATION AUBURN UNIVERSITY
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FOREWORD

We at the Alabama Agricultural Experiment Station present this update of current Auburn University research being done to support Alabama's important ornamentals industry. This is the fourth in a series of reports that are published every two years to deal with the many aspects of ornamental crop production research being conducted at the Alabama Agricultural Experiment Station. Indications from people involved in Alabama's nursery industry are that previous reports have been useful, and we hope this year's edition will be even more helpful.

This year's publication consist of 19 separate research reports written by 20 different faculty, staff, and students from three academic departments, two Alabama Agricultural Experiment Station Substations, and the Alabama Cooperative Extension Service. Once again, this report is truly a team effort.

The authors for this year's report are listed below in alphabetical order:

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Effect of Spray Interval and Rate of New Fungicides on Blackspot Control on Roses

Austin Hagan, Charles H. Gilliam, and Donna C. Fare

BLACKSPOT REMAINS the most common and destructive disease of cultivated roses, but a new generation of sterol biosynthesis inhibiting fungicides may soon give growers additional tools with which to fight this disease. However, the efficacy of many sterol-biosynthesis inhibiting fungicides for the control of blackspot on roses has not been assessed, so a study was designed to evaluate these new fungicides over a range of application rates and application intervals.

Rosa sp. cv. Mister Lincoln roses were planted in February 1986 in a sandy-loam soil amended with peat moss (1:1 v/v). Every 3 months, 1 cup (8 ounces) of 8-8-8 fertilizer was spread around the base of each plant. Water was applied as needed with overhead sprinklers. Plants were pruned regularly to remove suckers and spent flowers. Fungicides were applied to run-off on leaf surfaces with a hand-pump compressed air sprayer. Activate adjuvant was included with all wettable powder fungicides at a rate of 0.5 pint per 100 gallons of water.

In 1987, several sterol inhibiting fungicides were compared to a popular, registered compound (for blackspot control on roses); Lynx 1.2E at 0.4, 0.8, and 1.6 fluid ounces per 100 gallons of water, Nova 40W at 2.5, 5.0, and 10.0 ounces per 100 gallons of water, and Nustar 3.3E at 1.3, 2.5, and 10.0 fluid ounces per 100 gallons of water were compared to Daconil 2787 4.17F at 2 pints per 100 gallons water. Lynx was applied at 1-, 2-, and 4-week intervals from March 19 to August 13, while Nova, Nustar, and Daconil were applied weekly. Visual disease severity was evaluated on August 28, using a scale of 1 = no disease to 5 = severe defoliation.

The trials were repeated in 1988 with Lynx 1.2E at 0.8, 1.6, and 3.2 fluid ounces per 100 gallons of water, Nustar 3.3E at 1.25, 2.5, and 5.0 fluid ounces per 100 gallons of water, Triforine 1.6E at 12 fluid ounces per 100 gallons of water, and Daconil 2787 at 2 pints per 100 gallons of water. Nustar was applied at 1-, 2-, and 4-week intervals, while all other treatments were applied at weekly intervals from April 5 through September 2. Disease severity was evaluated using the previously described scale on September 26.

In 1987, all fungicide treatments except Lynx maintained good disease control, table 1. Lynx at all application rates and spray intervals did not reduce blackspot severity compared with the nonsprayed control. Nova and Nustar which generally gave excellent season-long disease control proved equally effective as Daconil 2787 against blackspot. Little if any spotting of the leaves was seen on the plants treated with the high rates of both Nova and Nustar as well as Daconil 2787. The lowest rate of Nustar reduced disease but was not as effective controlling blackspot as the two higher rates. Although some light spotting of the foliage was noted at the two lower rates of Nova, differences in blackspot severity across Nova application rates were not significant.

By late September, 1988, significant differences in disease control were seen among the fungicide treatments, table 2. Numerous blackspot lesions on the leaves as well as light to moderate defoliation was observed on the plants in many treatments.

Weekly applications of all rates of Nustar significantly reduced blackspot severity compared with the non-sprayed control. Applied weekly, the highest rate of Nustar controlled blackspot better than the two lower rates or Daconil 2787. The level of disease control obtained with the two lower rates of Nustar applied weekly generally was similar to that seen on the Daconil 2787-treated plants. A significant increase in disease severity was seen when all rates of Nustar were applied at spray intervals exceeding 1 week; some treatments did reduce disease below that seen on the non-sprayed control. Although a significant reduction in disease was noted at the highest rate of Lynx, the level of control did not compare with that obtained with weekly applications of Nustar or Daconil 2787. Blackspot ratings on the plants treated with the two lower rates of Lynx were similar to those of the non-sprayed control.

Nustar and Nova protected roses from blackspot. Over a 2-year period, Nustar at the 5.0 fluid ounce rate proved equally as effective controlling this disease as Daconil 2787. Effective

TABLE 1. CONTROL OF BLACKSPOT OF ROSES WITH FOLICUR, NUSTAR, AND SYSTHANE, 1987

Fungicide and rate/100 gal.	Disease severity[1]
Lynx 1.2E, 0.4 fluid ounce	
Sprayed weekly	3.8
Sprayed every 2 weeks	3.6
Sprayed every 4 weeks	4.1
Lynx 1.2E, 0.8 fluid ounce	
Sprayed weekly	3.5
Sprayed every 2 weeks	3.9
Sprayed every 4 weeks	3.9
Lynx 1.2E, 1.6 fluid ounces	
Sprayed weekly	3.4
Sprayed every 2 weeks	4.0
Sprayed every 4 weeks	3.9
Systhane 40W, 2.5 ounces	
Sprayed weekly	1.6
Systhane 40W, 5.0 ounces	
Sprayed weekly	1.6
Systhane 40W, 10.0 ounces	
Sprayed weekly	1.0
Nustar 3.3E, 1.3 fluid ounces	
Sprayed weekly	2.3
Nustar 3.3E, 2.5 fluid ounces	
Sprayed weekly	1.5
Nustar, 3.3E, 5.0 fluid ounces	
Sprayed weekly	1.0
Daconil 2787 4F, 2.0 pints	
Sprayed weekly	1.1
Unsprayed control	4.1
LSD (P = 0.05)	.6

[1]Disease severity was rated on a 1 to 5 scale, 1 = no disease, 5 = severe defoliation. Ratings were made on August 28.

TABLE 2. EFFECT OF APPLICATION RATE AND SPRAY INTERVAL ON BLACKSPOT CONTROL ON ROSE WITH NUSTAR

Treatment and rate/100 gal.	Disease severity[1]
Nustar 3.3E, 1.25 fluid ounces	
Sprayed weekly	2.8
Sprayed every 2 weeks	3.9
Sprayed every 4 weeks	4.0
Nustar 3.3E, 2.5 fluid ounces	
Sprayed weekly	2.5
Sprayed every 2 weeks	3.5
Sprayed every 4 weeks	3.8
Nustar 3.3E, 5.0 fluid ounces	
Sprayed weekly	1.5
Sprayed every 2 weeks	3.1
Sprayed every 4 weeks	3.8
Lynx 1.2E, 0.8 fluid ounce	
Sprayed weekly	4.5
Lynx 1.2E, 1.6 fluid ounces	
Sprayed weekly	3.8
Lynx 1.2E, 3.2 fluid ounces	
Sprayed weekly	3.5
Daconil 2787 4.17F, 2 pints	
Sprayed weekly	2.3
Non-sprayed control	4.5
LSD (P = 0.05)	.7

[1]Disease severity scale was 1 = no disease, 5 = severe defoliation. Disease ratings were made on September 26.

disease control also was noted with the 2.5 fluid ounce rate of Nustar in one of two years. As seen in previous studies, Nustar provided good disease control only when applied at weekly intervals. Although some reduction in disease was obtained with Nustar at the longer spray schedules, considerable spotting of the foliage and defoliation was noted. Nova at all rates tested gave disease control similar to that obtained with Daconil 2787. Following a 5-month spray program, no blackspot symptoms were seen on the plants treated with the 10.0 ounce rate of Nova. Lynx displayed little efficacy for the control of blackspot on roses. When applied weekly, little difference in disease severity was noted between any rate of Lynx and the non-sprayed control.

Efficacy of New Fungicides for the Control of Entomosporium Leaf Spot on Photinia

Austin Hagan, William J. Foster, and Leonard Parrott Jr.

ENTOMOSPORIUM LEAF spot is a widespread and damaging disease of container and field-grown red tip photinia (*Photinia* x *fraseri*) and India hawthorn (*Rhaphiolepis indica*). Chemical control of Entomosporium leaf spot often has proven difficult. Frequent rain showers and daily overhead irrigation coupled with close spacing of containers favor rapid disease spread and interferes with the application and retention of fungicides to the foliage, thereby reducing the effectiveness of available contact fungicides. Several new systemic fungicides, commonly classified as sterol-biosynthesis inhibitors, were recently tested to determine their efficacy over a range of application rates and spray intervals for the control of Entomosporium leaf spot.

In March 1987, healthy red tip photinia liners were planted in pine bark amended with 6 pounds of dolomitic limestone, 2 pounds of gypsum, 1.5 pounds of Micromax, and 12 pounds of 17-7-12 Osmocote per cubic yard of potting media in trade gallon containers. The plants were watered daily with overhead impact sprinklers. Inoculum was provided by placing diseased photinia in close proximity to the fungicide-treated plants. Rates per 100 gallons of water of the sterol-inhibiting fungicides were used with the sterol biosynthesis-inhibiting fungicides Lynx 25W at 1.0, 2.0, and 4.0 ounces; Nova 40W at 2.5, 5.0, and 10.0 ounces; and Nustar 3.3E at 1.3, 2.5, and 5.0 fluid ounces, table 3. These were compared to the fungicide standards Daconil 2787 4.17F at 2 pints and Triforine 1.6E at 12 fluid ounces. Both groups of fungicides were applied with a hand pump compressed air sprayer at 7-day intervals from March 15 to June 15. Penetrator 3 adjuvant was included in all wettable powder tank-mixes at the rate of 1/2 percent (v/v). Entomosporium leaf spot incidence was measured on June 22, using the Horsfall and Barratt rating system (1 = 0 percent, 2 = 0-3 percent, 3 = 3-6 percent, 4 = 6-12 percent, 5 = 12-25 percent, 6 = 25-50 percent, 7 = 50-75 percent, 8 = 75-87 percent, 9 = 87-94 percent, 10 = 94-97 percent, 11 = 97-100 percent, 12 = 100 percent of the leaves diseased).

In February 1988, healthy red tip photinia liners were potted in an amended pine bark medium as in 1987. Cultural practices were similar to those employed the previous year.

To determine the optimum application rate for disease control, Spotless 25W at 0.25, 0.5, 1.0, and 2.0 pounds, Lynx 1.2E at 0.2, 0.4, 0.8, and 1.6 fluid ounces, and Nova 40W at 1.25, 2.5, 5.0, and 10.0 ounces in 100 gallons of water were applied at 2-week intervals. The industry standards, Daconil 2787 4.17F at 2 pints and Triforine 1.6E, were also applied at the same time and water volume.

The impact of spray interval was also evaluated. Lynx 1.2E at 0.8 fluid ounce, Nova 40W at 5 ounces, and Daconil 2787 4.17F at 2 pints were applied at 1-, 2-, and 4-week intervals. These materials, along with Triforine 1.6E at 12 fluid ounces and Bravo 90DF at 1.25, were applied using 100 gallons of water on a 1-week spray interval only. Fungicides were applied with a pump-up compressed air sprayer from April 7 to August 28. Penetrator 3 adjuvant at a rate of 1/2 percent (v/v) was included in all Nova and Spotless tank mixes. Canopy heights and widths were recorded on September 7. The growth index was calculated as follows: (height + width 1 + width 2) ÷ 3. Widths were measured perpendicular to each other. Disease incidence was again assessed using the previously described Horsfall and Barratt rating system on September 19.

Leaf spot pressure in 1987 was light due to an unusually dry spring. All fungicides greatly reduced disease incidence when compared with the non-sprayed control. Entomosporium leafspot symptoms were seen only on the plants treated with the 2.5 ounce rate of Nova, Daconil 2787, and Triforine. Spotting on the leaves of each of these treatments was light though significant differences in disease were noted between Triforine and all rates of Lynx and Nustar as well as the two higher rates of Nova. Disease control obtained with Nova, Nustar, and Lynx was similar to that provided by Daconil 2787. Some leaf distortion and discoloration were noted on the Nustar-treated plants.

Entomosporium leaf spot incidence in 1988 remained low on all fungicide treatments until heavy rains in July and August. All fungicide treatments except Triforine gave some disease control, table 4. The lowest disease incidence was noted

TABLE 3. COMPARISON OF LYNX, SYSTHANE, AND NUSTAR AT SEVERAL RATES WITH TRIFORINE AND DACONIL 2787 FOR THE CONTROL OF ENTOMOSPORIUM LEAF SPOT ON RED TIP PHOTINIA

Treatment and rate/100 gal.	Disease incidence[1]
Lynx 25W, 1.0 ounce	1.0
Lynx 25W, 2.0 ounces	1.0
Lynx 25W, 4.0 ounces	1.0
Systhane 40W, 2.5 ounces	1.3
Systhane 40W, 5.0 ounces	1.0
Systhane 40W, 10.0 ounces	1.0
Nustar 3.3E, 1.3 fluid ounces	1.0
Nustar 3.3E, 2.5 fluid ounces	1.0
Nustar 3.3E, 5.0 fluid ounces	1.0
Daconil 2787 4.17F, 2.0 pints	1.2
Triforine 1.6E, 12.0 fluid ounces	1.8
Unsprayed control	7.6
LSD (P = 0.05)	.6

[1]Disease was evaluated using the Horsfall and Barratt System: 1 = 0%, 2 = 0-3%, 3 = 3-6%, 4 = 6-12%, 5 = 12-25%, 6 = 25-50%, 7 = 50-75%, 8 = 75-87%, 9 = 87-94%, 10 = 94-97%, 11 = 97-100%, 12 = 100% of the leaves diseased. Disease ratings were made on June 22.

TABLE 4. EFFICACY OF SEVERAL NEW FUNGICIDES FOR THE CONTROL OF ENTOMOSPORIUM LEAF SPOT AND GROWTH OF RED TIP PHOTINIA

Treatment and rate/100 gal.	Growth index[1]	Disease incidence[2]
Spotless 25W, 0.25 pound	28.2	4.5
Spotless 25W, 0.50 pound	24.6	3.4
Spotless 25W, 1.00 pound	20.8	2.8
Spotless 25W, 2.00 pounds	19.0	3.1
Lynx 1.2E, 0.2 fluid ounce	61.5	5.1
Lynx 1.2E, 0.4 fluid ounce	53.8	4.5
Lynx 1.2E, 0.8 fluid ounce	56.1	6.0
Lynx 1.2E, 1.6 fluid ounces	46.0	3.1
Systhane 40W, 1.25 ounces	66.6	2.1
Systhane 40W, 2.5 ounces	68.6	1.9
Systhane 40W, 5.0 ounces	62.3	2.1
Systhane 40W, 10.0 ounces	56.1	2.0
Daconil 2787 4.17F, 2.0 pints	49.1	3.6
Triforine 1.6E, 12 fluid ounces	67.1	6.5
Non-sprayed control	58.5	8.5
LSD (P = 0.05)	5.3	2.0

[1]Growth index was calculated as follows: height + width + width 2÷3.
[2]Disease was evaluated using the Horsfall and Barratt System: 1 = 0%, 2 = 0-3%, 3 = 3-6%, 4 = 6-12%, 5 = 12-25%, 6 = 25-50%, 7 = 50-75%, 8 = 75-87%, 9 = 87-94%, 10 = 94-97%, 11 = 97-100%, 12 = 100% of the leaves diseased. Disease ratings were made on September 19.

on the Nova-treated plants. Nova proved equally effective over application rates from 1.25 to 10 ounces against leaf spot without any phytotoxicity. Spotless at the three higher rates controlled this disease nearly as well as Nova and was equally as effective as Daconil 2787. However, plant growth at all rates of Spotless was severely restricted. With the exception of the 1.6 fluid ounce rate, Lynx did not control Entomosporium leaf spot as effectively as Nova. Slight reductions in plant growth compared with that on the non-sprayed control were seen on the plants treated with the 1.6 fluid ounce rate of Lynx and Daconil 2787.

All fungicide treatments reduced the incidence of Entomosporium leaf spot compared with the non-sprayed control although significant differences in disease control were noted among the treatments, table 5. Nova provided the best overall disease control across all application rates. Even at 2- and 4-week spray intervals, this fungicide controlled leaf spot as effectively as weekly sprays of Daconil 2787 and Bravo 90DF. Disease control with Nova did significantly improve as the spray interval was reduced from 4 weeks to 1 week. An increase in disease was seen among the Daconil 2787-sprayed plants when the spray interval was raised from 1 to 2 weeks. Lynx did not give effective disease control at any of the spray intervals evaluated.

Of the new sterol-biosynthesis inhibiting fungicides evaluated, Nova, across a range of application rates, provided the best protection from Entomosporium leaf spot without any reduction in plant growth. Under ideal conditions for disease spread, leaf spot control with Nova equaled that obtained with Daconil 2787 and was superior to Triforine. A significant reduction in disease was provided by Spotless but with severe reductions in plant growth. Phytotoxicity similar to that encountered with Spotless was also seen on the Nustar-treated plants. Although significant disease reductions were seen under light disease pressure in 1987, Lynx did not provide satisfactory late season protection from Entomosporium leaf spot the following year.

TABLE 5. THE EFFECT OF SPRAY INTERVAL ON THE CONTROL OF ENTOMOSPORIUM LEAF SPOT ON PHOTINIA WITH LYNX, SYSTHANE, AND DACONIL 2787

Treatment and rate/100 gal.	Disease rating[1]
Lynx 1.2E, 0.8 fluid ounce	
Sprayed weekly	5.0 b
Sprayed every 2 weeks	5.1 b
Sprayed every 4 weeks	5.6 b
Systhane 40W, 5.0 ounces	
Sprayed weekly	1.8 d
Sprayed every 2 weeks	2.9 cd
Sprayed every 4 weeks	3.1 c
Daconil 2787 4.17F, 2.0 pints	
Sprayed weekly	2.9 cd
Sprayed every 2 weeks	4.4 b
Sprayed every 4 weeks	4.8 b
Bravo 90DF, 1.25 pounds	
Sprayed weekly	2.4 cd
Triforine 1.6E, 12 fluid ounces	
Sprayed weekly	4.4 b
Non-sprayed control	8.6 a
LSD (P = 0.5)	1.2

[1]Disease was evaluated using the Horsfall and Barratt System: 1 = 0%, 2 = 0-3%, 3 = 3-6%, 4 = 6-12%, 5 = 12-25%, 6 = 25-50%, 7 = 50-75%, 8 = 75-87%, 9 = 87-94%, 10 = 94-97%, 11 = 97-100%, 12 = 100% of the leaves diseased. Disease ratings were made on September 19.

Control of Southern Red Mites on Azalea

Jimmy Stephenson, Gary L. Miller, Harlan H. Hendricks, and Michael L. Williams

THE SOUTHERN red mite, *Oligonychus ilicius* (McGregor), is a persistent cool weather pest of azaleas, camellias, and Japanese hollies in south Alabama. Symptoms of infestation include brownish or bronzed plant appearance becoming more pronounced with cooler temperatures. These symptoms reflect leaf damage caused by the piercing mouth parts of the mite that ruptures cells and extracts the cellular contents. Leaf drop followed by plant death occurs in severe infestations unless treated with an effective miticide. This test was initiated to evaluate efficacy of several new unregistered and several registered pesticides and to gain information on persistence of these materials on dormant plants during late winter and early spring.

Mite infested *Rhododendron* X Snow azaleas were selected for single foliar applied treatments, table 6. These plants were growing in trade gallon (6.5 inch), black, plastic containers of an amended pine bark medium. Sprays were applied covering all leaf surfaces to run-off on January 12, 1988. Chevron Spray Sticker was added to all spray treatments at 0.5 pint per 100 gallons of water. Plants were held in an open, unheated glass greenhouse for the duration of the study. Evaluations were conducted at 7, 21, 35, and 63 days after treatment (DAT).

Seven days after application, Karate 1EC, Danitol 2.4EC, Savey 50WP, Dibeta 1.5 percent, and the high rate of Avid 0.15EC provided significant southern red mite control. Twenty-one DAT, Karate 1EC, Danitol 2.4EC, Savey 50WP, both Dibeta formulations, ABG-6228 50WP, Mavrik 2F, and Pentac Aquaflow 4F provided significant control. Karate 1EC, Danitol 2.4EC, and Savey 50WP again had the lowest mean number of mites per sample. Thirty-five DAT, similar results to those seen 21 DAT were observed. At the final evaluation, 63 DAT, no significant mite reduction was observed compared with the control. Few leaves suitable for sustaining large numbers of mites remained on the controls. This was primarily due to excessive leaf drop from heavy mite feeding. Also responsible, but to a lesser extent, was the periodic removal of leaf samples for mite counts. This disguised the actual efficacy of some materials. Along with the control, Karate 1EC, Danitol 2.4EC, Savey 50WP, ABG-6228 50WP, Mavrik 2F, and Pentac Aquaflow 4F had low numbers of mites.

In summary, Karate 1EC at 0.4 and 1.6 pint, Danitol 2.4EC at 0.3 and 0.7 pint, Savey 50WP at 1.0 and 2.0 ounces, DiBeta 1.5 percent at 6.0 pints, DiBeta 3.0 percent at 3.0 pints, ABG-6228 50WP at 3.5 and 4.2 ounces, Mavrik 2F at 0.8 pint, and Pentac Aquaflow 4F at 0.5 pint per 100 gallons of water provided control of Southern red mite on Snow azalea during at least half of the study. Avid 0.15EC at 0.5 pint provided some control at 7 DAT. Karate 1EC, Danitol 2.4EC, and Savey 50WP consistently had the lowest mean number of mites per sample during the study.

Pentac 4F, Mavrik 2F, and Avid 0.15EC currently hold an ornamentals label for spider mite control. A label is expected soon for Savey 50WP and Danitol 2.4EC. Other materials used are still experimental.

Controlling Some Insect Pests of Common Gardenia

Gary L. Miller and Michael L. Williams

GARDENIAS ARE often susceptible to many kinds of insect problems, including the melon aphid, *Aphis gossypii* Glover, the citrus whitefly, *Dialeurodes citri* (Ashmead), and the citrus mealybug, *Planococcus citri* Risso. A test was recently initiated to determine the efficacy of various insecticides on these commonly encountered pests of common gardenia.

Nearly every grower has encountered problems with the citrus mealybug. This insect has a broad range of host plants and eradication is difficult, if not impossible. Control problems may be compounded because many host plants exhibit phytotoxic symptoms to the insecticides that effectively kill the mealybug. Females produce a cottony wax ovisac, which can protect up to 600 eggs. Eggs hatch in 6-10 days and emerging crawlers disperse, settle, and begin feeding at a suitable site. Colonies will often develop on young tender plant growth, producing noticeable amounts of cottony wax. Infestations often begin when incoming plant stock harbors unnoticed crawlers. Mealybug feeding can cause wilting, leaf drop, or even plant death.

Aphids or plant lice can sometimes be a problem in the closed and controlled environment of a greenhouse. With an ample supply of lush vegetation and a lack of natural enemies, aphid populations can build quickly. Aphids feed by piercing plant tissue with their sharp stylet mouthparts and sucking out plant fluids. Large numbers of feeding aphids can cause wilting, curling, and stunting of plants. In addition, aphids can serve as vectors for a number of plant diseases.

Gardenias also are especially susceptible to whitefly infestations. Whitefly populations often go unnoticed until a host plant is disturbed and clouds of small white insects are seen flying from the undersides of the leaves. Newly hatched whiteflies resemble crawlers of scale insects. Settled nymphs and pupae appear quite differently. They are disk-shaped and nearly transparent. Adults superficially resemble small flies and are covered with a fine white wax. Both adults and immatures feed on plant fluids through piercing-sucking mouthparts.

TABLE 6. CONTROL OF SOUTHERN RED MITE ON AZALEA

Treatment	Rate/100 gal.	Mean number of mites/sample			
		7 DAT	21 DAT	35 DAT	63 DAT
Karate 1EC	0.4 pt.	6.3 a[1]	3.0 a	0.5 a	0.0 a
Karate 1EC	1.6 pt.	6.0 a	3.5 a	.3 a	.0 a
Danitol 2.4EC	.3 pt.	8.0 a	.5 a	.0 a	.0 a
Danitol 2.4EC	.7 pt.	7.0 a	1.0 a	.3 a	.0 a
Savey 50WP	1.0 oz.	21.0 ab	15.5 a	7.0 a	1.3 a
Savey 50WP	2.0 oz.	20.8 ab	11.5 a	3.3 a	5.0 a
DiBeta 1.5%	6.0 pt.	28.0 ab	59.0 ab	26.3 a	99.3 d
DiBeta 3.0%	3.0 pt.	72.3 bcde	59.3 ab	11.8 a	62.0 bcd
Avid 0.15EC	.3 pt.	94.8 cde	183.8 cd	83.5 c	46.0 abc
Avid 0.15EC	.5 pt.	38.5 abc	187.0 cd	54.5 b	85.5 cd
ABG-6228 50WP	3.5 oz.	93.0 cde	125.0 bc	7.0 a	25.0 ab
ABG-6228 50WP	4.2 oz.	122.0 e	151.5 bc	8.8 a	37.3 abc
Mavrik 2F	.8 pt.	41.8 abcd	82.5 ab	16.0 a	35.5 abc
Pentac 4F	.5 pt.	47.0 abcd	59.3 ab	16.0 a	16.0 ab
Control	–	100.5 de	256.0 d	138.8 d	29.3 ab

[1]Mean separation within columns by Duncan's multiple range test, 5% level; values followed by the same letter are not statistically different.

As with many of the Homoptera, aphids, whiteflies, and mealybugs secrete honeydew. Honeydew is rich in sugars which serve as an attractant for ants which tend and farm these pests. The presence of honeydew is also a problem because it serves as a substrate for sooty mold growth. Sooty mold makes plants unsightly, unmarketable, and can reduce general plant vigor.

Three insecticides were evaluated for control of these three pests attacking common gardenia, *Gardenia jasminoides* Ellis. Test materials were applied August 13, 1987. A single foliar spray of each insecticide was applied to run-off using hand-held compressed air sprayers. Chevron spray sticker was added to all spray mixtures at the rate of 0.5 pint per 100 gallons of water. Plants were allowed to air dry before being returned to the greenhouse. Efficacy of test materials was determined 1, 4, and 7 days after treatment (DAT) for aphids; 14 days after treatment for whiteflies; and 1 and 4 days after treatment for mealybugs.

All treatments of insecticides significantly reduced the mean number of aphids as early as one day after treatment, table 7. Seven days posttreatment, all treated plants still had significantly fewer aphids when compared to the untreated check.

All treatments also significantly reduced whitefly populations when compared to the untreated check, table 8. Although the highest mean percent mortality of whiteflies occurred in the Danitol and the higher rate of Karate (0.20 pound active ingredient per 100 gallons of water) treatments, all of the treatments were statistically equivalent.

With citrus mealybug, there was no significant difference between any of the treatments and the untreated check 1 day after treatment, table 9. At 4 days after treatment, Danitol and the lower rate of Karate (0.05 pound active ingredient per 100 gallons of water) significantly reduced the mean number of citrus mealybugs when compared to the untreated check, table 9. Although both compounds demonstrated significant reductions in mean mealybug numbers, none of the treatments completely eliminated *P. citri*. In this test, some mealybugs were inside the empty pupal covers of whiteflies. This unusual behavior undoubtedly protected those mealybugs from the insecticides.

TABLE 7. CHEMICAL CONTROL OF MELON APHID INFESTING COMMON GARDENIA

Treatments[1]	Lb. (ai)/ 100 gal.	Mean no. live aphids/2 leaves		
		1 DAT[2]	4 DAT[2]	7 DAT[2]
Karate 1E	0.05	0.4 a	0.0 a	0.0 a
Karate 1E	.20	.5 a	.0 a	.0 a
Danitol 2.4EC	.30	2.6 a	.1 a	.0 a
Tempo 2C	.03	1.3 a	.0 a	5.6 a
Untreated	–	53.1 b	109.8 b	65.5 b

[1]Treatments applied August 13, 1987.
[2]Values followed by the same letter are not significantly different (P = 0.05, DMRT).

TABLE 8. CHEMICAL CONTROL OF CITRUS WHITEFLY INFESTING COMMON GARDENIA

Treatments[1]	Lb. (ai)/100 gal.	(14 DAT) Mean % mortality[2]
Karate 1E	0.05	72.25 a
Karate 1E	.20	99.00 a
Danitol 2.4EC	.30	97.50 a
Tempo 2C	.03	68.00 a
Untreated	–	15.00 b

[1]Treatments applied August 13, 1987.
[2]Values followed by the same letter are not significantly different (P = 0.05, DMRT).

TABLE 9. CHEMICAL CONTROL OF CITRUS MEALYBUG INFESTING COMMON GARDENIA

Treatments[1]	Lb. (ai)/100 gal.	Mean no. live mealybugs/2 leaves	
		1 DAT[2]	4 DAT[2]
Karate 1E	0.05	20.50 a	11.00 a
Karate 1E	.20	24.87 a	48.00 ab
Danitol 2.4EC	.30	23.37 a	5.25 a
Tempo 2C	.03	62.62 a	81.25 b
Untreated	–	59.87 a	101.75 b

[1]Treatments applied August 13, 1987.
[2]Values followed by the same letter are not significantly different (P = 0.05, DMRT).

Better control may be achieved by dislodging mealybug colonies with a strong jet of water and by addition of a spreader-sticker or detergent to help penetrate the cottony wax of the mealybugs. This test also demonstrated the importance of reducing populations of whiteflies to avoid the presence of their pupal cases which can serve as protective covering for developing mealybugs.

Additional care should be taken to remove any weeds around the plants, which may serve as harborage for mealybugs, whiteflies, or aphids. No phytotoxicity was observed in any of the treatment replications.

See color plates numbers 1-3, page 14.

Chemical Control of Sweetpotato Whitefly on Hibiscus

Michael L. Williams and Gary L. Miller

THE SWEETPOTATO whitefly, *Bemisia tabaci* (Gennadius), has been a serious problem in California and Florida for a number of years, but in 1987 this pest became a problem to the ornamentals industry in Alabama, Georgia, and North Carolina. The first confirmed identification of sweetpotato whitefly in Alabama was from greenhouses in the Mobile area. Primary hosts in Alabama have been poinsettia, gerbera daisy, and hibiscus, but its known hosts include over 500 different plants. Sweetpotato whitefly has an amazing ability to tolerate pesticides, adapt to new host plants, and reproduce rapidly. Potential for the sweetpotato whitefly damaging greenhouse crops is great because it is more difficult to control than either citrus or greenhouse whiteflies.

In August 1988, seven pesticides and one pesticide combination were evaluated for control of sweetpotato whitefly populations on hibiscus. Chevron Spray Sticker was added to all treatments at the rate of 0.5 pint per 100 gallons of spray mixture. Test materials were applied to run-off using hand-held compressed air sprayers. Efficacy was determined 7 and 14 days after treatment.

As can be seen from the results presented in table 10, the sweetpotato whitefly continues to be difficult to control with many of the materials that have proven effective for control of citrus and greenhouse whiteflies. Only Safer's Soap and the combination Danitol plus Orthene provided control significant from the other materials and the untreated check 7 days after treatment. At 14 days posttreatment, only the combination of Danitol plus Orthene remained effective. No phytotoxic effects were observed from any test materials.

TABLE 10. EFFECT OF PESTICIDES ON SWEETPOTATO WHITEFLY INFESTING HIBISCUS

Treatment[1]	Lb. (ai)/100 gal.	Mean no. alive whiteflies	
		7 DAT[2]	14 DAT[2]
Danitol 2.4EC	0.30		
+ Orthene 75S ...	.50	11.0 a	3.8 a
Safer's Soap 49% EC	6.25	15.5 a	56.3 bcd
Tempo 2F	.38	53.8 b	44.8 bc
Danitol 2.4EC	.30	61.4 bc	68.0 bcd
Morestan 4F	.13	62.8 bc	61.0 bcd
Morestan 4F	.25	63.0 bc	62.0 bcd
Tempo 2F	.19	67.8 bc	41.5 b
Oftanol 2F	.38	75.0 bc	69.7 bcd
Karate 1EC	.20	75.3 bc	38.8 b
Orthene 75S	.50	77.5 bc	68.8 bcd
Oftanol 2F	.19	87.3 bc	82.0 cd
Untreated check	–	99.0 c	92.8 d

[1]Treatments applied August 15, 1988; relative humidity = 99%.
[2]Values followed by the same letter are not significantly different (P = .05, DMRT).

See color plate number 4, page 14.

Low vs. High Volume Sprays for Control of Nantucket Pine Tip Moths on Christmas Trees

Patricia Cobb

VIRGINIA PINE (*Pinus virginiana*) is grown extensively in the Southeast, and sold nationwide for Christmas trees. The Christmas tree shape can be destroyed or made more time consuming to maintain, by tunnelling larvae of Nantucket pine tip moths. Several insecticides were recently tested for efficacy at different times of application. The objective of tip moth control programs, once trees are shaped, is to protect the main terminal, thus maintaining the "Christmas tree" shape.

Currently growers apply insecticides three to six times a season depending upon the number of tip moth generations that occur in their area of the State. Proper timing of applications is critical, and is best accomplished by use of pheromone trap data.

Cygon, Orthene, Dursban 50W, Dimilin 25W, and Mavrik Aquaflow are all registered for tip moth control. During the past few seasons, Dimilin 25W, an insect growth regulator, has become a primary component of seasonal tip moth control programs for many growers. It is registered in Alabama as a Special Local Need (24C) for multiple applications. Mavrik Aquaflow is highly effective but its use is recommended for once or twice late season application only. Used earlier, disruption of beneficial parasite-predator complexes results in increases in pine tortoise scale and bark aphids.

Spray applications for tip moth control are often time consuming and expensive. Previous studies indicated excellent tip moth control with properly timed insecticide applications made over the tops of trees as a mist. This procedure, as opposed to the usual "point or drip," whole tree applications, reduced spray gallons per acre and application time.

During 1987, a study was conducted in Lee County to compare the effectiveness of Dimilin and Mavrik treatments for tip moth control made on second-year Virginia pine Christmas trees as "over-the-top only" or "point-of-drip" applications. Treatments directed at tip moth generations 1-3 were timed with pheromone trap data and applied March 25, May 19, and June 26. Treatments were applied with hand-pumped compressed air sprayers. Low volume, "over-the-top" sprays were applied as 1 gallon per 840-tree acre. High volume, "point-of-drip" sprays were applied as 16 gallons per 840-tree acre. Tree height averaged 2 feet in March, and 2.75 feet in July. Counts of infested terminals were made May 19, June 26, and July 29, table 11.

All treatments in this test controlled tip moths. Therefore, the lower volume, "over-the-top" sprays were as effective as the higher volume, "point-of-drip" sprays. Application time was reduced by the lower volume sprays. No phytotoxicity or secondary pest problems were observed. The grower substituted shearing for the fourth (final) tip moth treatment.

See color plate number 5, page 14.

TABLE 11. AVERAGE NUMBERS OF DAMAGED TERMINALS PER AVERAGE 10-TREE PLOTS OF SECOND-YEAR. VIRGINIA PINE CHRISTMAS TREES TREATED WITH DIMILIN[1] OR MAVRIK AQUAFLOW AT LOW OR HIGH VOLUMES OF WATER

Treatment	Rate/840-tree acre	Water acre	Average no. damaged terminals[2]		
			5/19	6/26	7/29
	Oz.	*Gal.*			
Dimilin 25W	2	1	0.00 b	0.00 b	0.00 b
Dimilin 25W	4	1	.00 b	.30 b	.00 b
Dimilin 25W	2	16	.00 b	.00 b	.00 b
Dimilin 25W	4	16	.30 b	.00 b	.80 b
Dimilin 4F	1	1	.00 b	.30 b	.30 b
Dimilin 4F	2	1	.00 b	.00 b	.30 b
Dimilin 4F	1	16	.30 b	.30 b	.30 b
Dimilin 4F	2	16	.00 b	.00 b	.30 b
Mavrik AF	3.3	1	.00 b	.30 b	.30 b
Mavrik AF	6.6	1	.00 b	.00 b	.00 b
Mavrik AF	3.3	16	.00 b	.30 b	.30 b
Mavrik AF	6.6	16	.00 b	.00 b	.30 b
Control (untreated)	–	–	4.00 a	6.00 a	5.50 a

[1]Dimilin 4F is an unregistered, experimental formulation.
[2]Numbers followed by the same letter are not significantly different at P = .05, DMR.

Soil Sterilants for Use Under Container-Grown Ornamentals

Charles H. Gilliam and William J. Foster

LIMITED INFORMATION is available on the efficacy of soil sterilants used under containers. Once containers are placed on a container bed, weed control of the bed is dependent on the weed control practices utilized prior to placement. Those weed control practices may include oyster or clam shell, rock, black plastic, weed mat, herbicides, and numerous combinations. In Alabama, about 54 percent of the container nurseries larger than 10 acres use a soil sterilant under their containers, primarily Princep. The objective of this test was to determine the efficacy and phytotoxicity of several herbicides for possible use as a soil sterilant under containers.

The container area was subdivided into 24 sections, 4 x 8 feet, and covered with 2 inches of clam shell in 1986. Five treatments, table 12, and a nontreated control were initiated April 7, 1988. Immediately after herbicide application, the entire area was overseeded with prostrate spurge and crabgrass. Uniform liners of *Lagerstroemia indica* x *fauriei* Natchez (crapemyrtle) and *Abelia grandiflora* x *schumannii* Edward Goucher (abelia) were potted April, 1988 in a 3:1 (v/v) pine bark:peat moss medium containing Osmocote 17-7-

TABLE 12. EFFECTS OF SELECTED HERBICIDES ON WEED CONTROL UNDER CONTAINER-GROWN ORNAMENTALS

Treatment	Rate	Crabgrass no./plot DAT[1]			Spurge no./plot DAT		
		60	90	120	60	90	120
Benchmark ...	5 lb./A	0	11	10	1	42	104
Arsenal	2 lb./A	18	89	43	10	37	126
Zorial	5 lb./A	10	13	14	0	35	125
Oust	3 oz./A	13	131	103	2	10	105
Princep	20 lb./A	0	10	13	0	5	113
Check	–	120	187	107	42	121	109

[1]DAT = days after treatment.

12, dolomitic limestone, gypsum, and Micromax (14, 6, 2, and 1.5 pounds per cubic yard, respectively) and subsequently placed on top of the beds. Data were collected 60, 90, and 120 days after treatment.

Princep has long been the standard soil sterilant used in container-grown ornamentals. Results from this test demonstrate that it is still one of the best soil sterilants for extended control of crabgrass and spurge. Princep provided more than 120 days of crabgrass control and 90 days of spurge control. No other herbicide evaluated provided equivalent control for both weed species. Benchmark and Zorial both provided excellent crabgrass control but were weak on spurge control. Oust provided spurge control similar to Princep but was weak on crabgrass.

Also, some phytotoxicity occurred with Natchez crape myrtle with Zorial. This injury was characterized by interveinal chlorosis. After about 30 days, all plants grew out of these injury symptoms.

Use of Preemergence Applied Herbicides In Propagation

Mack Thetford, Charles H. Gilliam, and William J. Foster

LINER PRODUCTION is often accomplished by direct sticking of cuttings in open greenhouses or groundbeds. Weed control can be a serious problem in these areas and is currently addressed by hand weeding. Though many growers would like to use herbicides to control these weeds, limited information is available concerning the effects of herbicides on rooting and subsequent root growth of cuttings.

The objective of this test was to determine if a pre-propagation application of preemergence herbicide would have a negative effect on rooting or subsequent root growth of woody ornamentals.

Experiment 1. Abelia X *grandiflora* Edward Goucher (abelia), *Buxus microphylla koreana* (boxwood) and *Ilex crenata* Compacta (Compacta holly) were propagated in media treated with preemergence applied herbicides. Three-inch rose pots were filled with a pinebark:sand medium (1:1 by volume) amended on a cubic yard basis with 7 pounds Osmocote 18-6-12, 3 pounds dolomitic limestone, and 1.5 pounds Micromax. Herbicide treatments were applied over the top of the 3-inch pots at the manufacturers recommended use rates of 3 pounds active ingredient (a.i.) per acre for Rout 3G, OH-2 3G, Surflan 4AS, and Prowl 4L and 4 pounds a.i. per acre for Ronstar 2G. Granular formulations were applied with a hand-held shaker. Surflan and Prowl were applied with a CO_2 sprayer at 40 pounds of pressure per square inch (psi) in 20 gallons of water per acre (gpa) of water. Herbicides were applied outdoors and watered in, and pots were then placed in a glass house with 50 percent shade prior to sticking the cuttings.

Boxwood rooting percentage and initial root ratings were suppressed with Surflan, table 13. Growth indices measurements (plant size) were taken 4, 7, and 14 months after potting, tables 14 and 15. Suppression of boxwood shoot growth with Surflan compared to nontreated controls continued throughout the test. Boxwood root growth also was suppressed throughout the test with Surflan, and 14 months after potting, boxwood root ratings were suppressed with Rout, OH-2, and Prowl, tables 14 and 15.

Compacta holly rooting percentage and initial root ratings were suppressed with Surflan and 14 months after potting, Compacta holly continued to exhibit a suppression of root ratings with Surflan, tables 13 and 14. Fourteen months after potting, root fresh weight values were numerically lower with Surflan treated cuttings compared to nontreated Compacta holly control (2.0 and 3.5 ounces, respectively).

With abelia, initial root ratings were suppressed with Rout and Surflan; however, abelia rooting percentage was suppressed only by OH-2, table 13. Subsequent root ratings and growth indices taken 3 months after potting indicated no further suppression of root growth or plant size with abelia compared to nontreated plants, tables 13 and 14.

Experiment 2. Cuttings of *Berberis* X *mentorensis* Rosey Glow (barberry), *Ilex* X *attenuata* Fosteri (Foster holly), and *Euonymus japonica* (euonymus) were propagated in Auburn, as in Experiment 1. Herbicides were applied at the manufacturers recommended use rates of 3 pounds a.i. per acre for OH-2 3G, Rout 3G, Prowl 60DF, and Southern Weedgrass Control 2.45G and 4 pounds a.i. per acre for Ronstar 2G.

Gardenia jasminoides Radicans (dwarf gardenia) and *Rhododendron* X Trouper (Glenn Dale hybrid, Trouper azalea) were evaluated in Mobile, using standard nursery practices of the area. Liner pots (3 1/4-inch square) were filled with 100 percent milled pinebark medium amended on a cubic yard basis with 6 pounds dolomitic limestone, 2 pounds gypsum

TABLE 13. EXPERIMENT 1, INITIAL ROOTING RESPONSE OF ABELIA, BOXWOOD, AND HOLLY PROPAGATED IN HERBICIDE TREATED MEDIA

Herbicide	Rate[2]	Abelia[1]		Boxwood		Compacta holly	
		Rooted	Rating[3]	Rooted	Rating	Rooted	Rating
		Pct.		*Pct.*		*Pct.*	
Rout	3	100 a	2.5 b	82 a	2.7 a	98 abc	1.5 c
OH-2	3	94 b	4.1 a	92 a	2.6 a	92 abc	3.4 ab
Ronstar ...	4	100 a	4.2 a	92 a	2.8 a	100 a	3.5 ab
Surflan	3	98 ab	1.4 c	75 b	1.2 b	78 c	1.1 c
Prowl	3	96 ab	4.1 a	83 a	2.7 a	90 abc	4.0 a
Nontreated	–	100 a	4.4 a	90 a	3.1 a	100 a	3.6 ab

[1]Ed. Goucher Abelia, July 27, 1987 (6 weeks), Korean Boxwood and Compacta Holly August 10, 1987 (8 weeks).
[2]Rate = lb./ai/A.
[3]Root rating scale: 1 = distorted roots < 1 cm; 2 = 1-4 roots 1-5 cm; 3 = 5-10 roots 1-5 cm; 4 = 10-15 roots 1-5 cm; 5 = 16+ roots 1-5 cm.

TABLE 14. GROWTH INDICES[1] OF BOXWOOD, HOLLY AND ABELIA LINERS 4, 7, AND 14 MONTHS AFTER PROPAGATION IN HERBICIDE TREATED MEDIA, EXPERIMENT 1

Herbicide	(Lb. ai/A)	Boxwood			'Compacta' holly			Abelia	
		4[2]	7	14	4	7	14	4	7
Rout	3	10.0 abc[3]	20.2 ab	19.5 abc	10.1 ab	15.1 a	31.2 bc	14.9 ab	35.9 a
OH-2	3	10.0 abc	20.6 ab	20.0 ab	10.6 ab	15.4 a	30.9 bc	14.7 ab	35.9 a
Ronstar	4	10.2 abc	20.8 ab	21.4 a	9.9 b	15.4 a	31.1 bc	15.5 ab	33.8 a
Surflan	3	9.2 c	17.4 b	17.6 c	8.2 c	12.0 b	28.0 c	12.7 b	33.7 a
Prowl 4L	3	10.9 ab	21.9 a	21.6 a	10.6 ab	15.3 a	34.4 a	15.9 ab	39.3 a
Nontreated	–	11.3 a	20.1 a	20.5 ab	10.6 ab	15.8 a	32.6 ab	15.6 ab	36.1 a

[1]Growth index = (height + width 1 + width 2÷3); width 1 = widest plant width, width 2 = perpendicular measurement to width 1.
[2]Months after potting.
[3]Mean separation within columns by Duncan's multiple range test (5% level).

TABLE 15. ROOT RATING[1] OF BOXWOOD, HOLLY AND ABELIA LINERS 4 AND 14 MONTHS AFTER PROPAGATION IN HERBICIDE TREATED MEDIA, EXPERIMENT 1

Herbicide	(Lb. ai/A)	Boxwood		'Compacta' holly	Abelia
		4[2]	14	4	4
Rout	3	4.0 a[3]	2.3 bc	3.8 bc	5.0 a
OH-2	3	4.0 a	2.6 b	3.3 c	4.8 a
Ronstar	4	3.9 ab	2.8 ab	3.6 c	4.6 a
Rout	3	3.7 b	2.0 c	2.8 d	4.6 a
Prowl 4L	3	4.1 a	2.5 bc	4.2 bc	4.9 a
Nontreated	–	4.2 a	3.2 a	4.4 a	4.8 a

[1]Root rating scale: 1 = no roots visible at edge of pot, 2 = root development to edge of pot, 5 = total rootball coverage.
[2]Months after potting
[3]Mean separation within columns by Duncan's multiple range test (5% level).

and 1.5 pounds Micromax; herbicide treatments were the same.

Rosy Glow barberry rooting percentage and root ratings were suppressed with Rout. All root parameters of Foster holly were suppressed with Rout; root length and root ratings also were suppressed by OH-2. Rooting percentage of euonymus was not suppressed by any herbicide tested; however, only Ronstar did not suppress primary root numbers or root ratings.

Trouper azalea rooting percentage was suppressed only by Ronstar; however, other root parameters were suppressed by all herbicides with the exception of root ratings with Prowl 60DF. Dwarf gardenia exhibited a suppression of rooting percentage, root ratings and root length with Rout when compared to nontreated cuttings. Prowl 60DF and Southern Weedgrass Control also resulted in lower root ratings for Dwarf Gardenia.

These experiments demonstrate several key factors to consider when including a preemergence applied herbicide in the propagation process. In this test, no one herbicide was safe on all species tested. Herbicides ranked according to the number of species affected from least to greatest were: Ronstar, Southern Weedgrass Control, OH-2, Prowl 60DF, and Rout. With some species a suppression of root growth and plant size may continue for long periods of time following the propagation of the liners. This effect also may be species dependent as shown by abelia which outgrew suppression within four months after potting.

Another critical factor demonstrated is that rooting percentage may not be affected but suppression of root length or root numbers may occur.

See color plate number 6, page 14.

Survey of Weed Control in Container Nursery Operations

Charles H. Gilliam, William J. Foster, John L. Adrian, Jr., and Ronald L. Shumack

THE 1980's have seen tremendous changes in herbicide programs for container-grown ornamentals. In the early 1980's, two new preemergence herbicides (Rout and OH-2) were developed primarily because Ronstar herbicide failed to adequately control prostrate spurge. Prior to the development of these two new herbicides, Ronstar was used almost exclusively as the preemergence herbicide in container-grown ornamentals.

A study was designed to survey the container nursery industry in Alabama and determine current practices with respect to preemergence herbicide application, manpower utilization in weed control, and acceptance of postemergence applied herbicides into the weed control program. Herbicide name changes, new herbicides, and herbicide safety also were studied.

The survey was conducted in 1987 and consisted of a questionnaire with approximately 25 questions pertaining to the weed control program at individual nurseries. Thirty-three nurseries representing about 1,000 acres of container-grown nursery stock were surveyed. In each case, personal interviews were conducted by one of the co-authors. Listed below are 10 questions from the survey with nursery responses:

(1) Do you have an established weed control program?
Response: Yes = 88 percent, No = 11 percent

(2) How would you rate your overall weed control program with 5 = excellent and 1 = none?
Response: 2 = 7 percent, 3 = 29 percent, 4 = 61 percent, 5 = 3 percent

(3) What weed control method do you use?
Herbicides only = 6 percent, Herbicide + hand weeding = 92 percent, Hand weed only = 2 percent

(4) Which preemergence herbicide do you use?
OH-2 = 34 percent, Ronstar = 28 percent, Rout = 24 percent, Other = 14 percent

(5) Number of preemergence herbicide applications per year?
1 = 10 percent, 2 = 33 percent, 3 = 30 percent, 4 = 13 percent, 5 = 13 percent

(6) Are some plants handled differently than others?
Yes = 61 percent, No = 39 percent

(6a) If handled differently, how are they handled?

Liriope - 14 percent = Use only Southern Weedgrass Control
5 percent = No OH-2
15 percent = No herbicide or less herbicide
31 percent = Less herbicide or no herbicide

(7) Method of preemergence herbicide application?
71 percent = cyclone seeder, 20 percent = backpack blower

(8) Have you experienced or suspected injury with preemergence herbicide application?
Yes = 39 percent, No = 61 percent

(8a) If so, what plants or under what conditions and with what chemicals?
OH-2 = Liriope, azaleas, juniper, over-wintering houses
Rout = Liriope, Blue Pacific juniper

(8b) What time of year did you apply the chemical and experience injury?
Spring 27 percent, Summer 36 percent, Fall 9 percent, Winter 27 percent

The results of this survey are still being evaluated. However, several interesting items of information are evident. First, the nursery industry has developed to the point where most nurserymen have a good herbicide program for their container-grown nursery stock. While OH-2 and Rout have become major herbicides, Ronstar continues to maintain an important position in the container ornamental market place, especially with some sensitive species like liriope and azaleas. A portion of the container-grown ornamental producers surveyed indicated that they experienced some degree of injury from herbicides (39 percent), primarily on liriope and azalea. This points out a need for efficacy and phytotoxicity data and provides an opening in the market place for new herbicides to fill these needs.

In the near future, several new herbicides are expected to be labelled for ornamentals along with some changes in existing herbicides. During 1990, Elanco has two products planned for the ornamental market. Snapshot 8ODF is a Surflan plus Gallery combination product aimed primarily at the production of field-grown ornamentals. Researchers in the Alabama Agricultural Experiment Station have tested this product for 2 years. It has provided similar weed control to Surflan plus Princep, but with greater safety to the ornamentals. The second product is Snapshot 2.5G which is a combination of Treflan and Gallery, which will be aimed at the container-grown ornamentals and landscape market.

GREENHOUSE CROP AND WOODY ORNAMENTAL PRODUCTION

Adaptation of *Physostegia virginiana* to Greenhouse Production as a Flowering Potted Plant

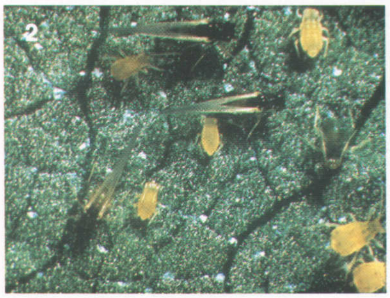
C. Fred Deneke and David J. Beattie

PHYSOSTEGIA VIRGINIANA (Obedient Plant or False Dragonhead) is an easy-to-grow, herbaceous perennial in the Labiatae (mint) family. It thrives in a variety of soils and in either sun or partial shade. In the garden, white to dark rose flowers open on terminal spikes in mid to late summer, suggesting that long days promote flowering. Its vigor, lack of diseases, and long-lasting floral display indicate it would be an excellent flowering potted plant for temporary use indoors. However, no specific information exists on its culture, including greenhouse forcing. The objective of this work was to determine the effects of photoperiod on flower development and plant quality of *P. virginiana* Summer Snow and Vivid.

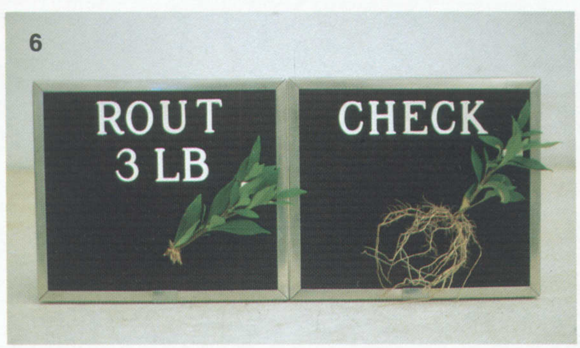
Stock plants were grown in environmental chambers under either short (8:00 a.m. to 5:00 p.m.) or long (8:00 a.m. to 5:00 p.m. with night-break from 10:00 p.m. to 2:00 a.m.) photoperiods. Chamber temperature set points were 70°F day and 61°F night. On August 19, 1987, the basal inch of 3-node, lateral cuttings of Summer Snow were treated with Hormodin #2 and stuck in a medium of equal volumes of sphagnum moss peat and horticultural perlite. Cuttings were maintained in an environmental chamber set at 75°F day and 64°F night. Photoperiods during rooting were the same as those described for the stock plants.

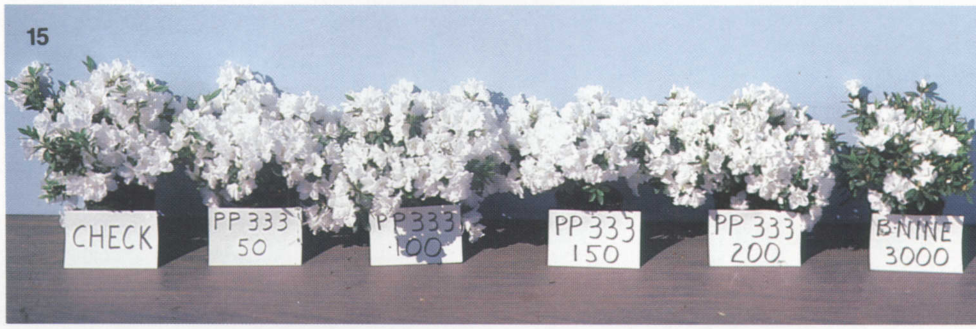
After 15 days of rooting, rooted cuttings were potted in 6-inch pots using a medium of sphagnum moss peat and vermiculite, and were placed in a greenhouse with set points of 75°F for ventilation and 63°F for heating. After growing for 0, 2, 4, or 6 weeks with short-day photoperiods, plants were moved to long days. In two additional treatments, plants were grown under either continuous short or continuous long days. There were 16 plants per treatment per cultivar. Vivid stock plants grew slowly, so cuttings were not taken until August 27; rooted cuttings were potted 23 days later. Otherwise, stock plants and cuttings were treated in the same manner as Summer Snow.

Cuttings from stock plants of Summer Snow and Vivid exposed to long days developed few adventitious roots, and about 20 percent of the cuttings developed visible buds during rooting and were discarded (data not shown). Cuttings from stock plants exposed to short days during rooting did not develop visible flower buds prior to forcing. Therefore, to ensure the development of vegetative meristems and uniform rooting and forcing of cuttings, stock plants must be grown under short days. Short days also should be used during the 2 to 3 weeks of rooting.



(1) Adult citrus mealybug with ovisacs. (2) Adult and immature stages of melon aphids. (3) Adult citrus whitefly on gardenia. (4) Sweetpotato whitefly on hibiscus leaf. (5) Nantucket pine tip moth injury to Virginia pine. (6) Root suppression of dwarf gardenia with Rout herbicide. (7) *Physostegia virginiana* Vivid about one week after first flowering. (8) Crapemyrtle treated with 0.75 percent NAA to control regrowth on basal shoots. (9) Regrowth of basal shoots on pruned crapemyrtle.





(10) Armstrong red maple at the Piedmont Substation in Camp Hill. (11) Red Sunset red maple at the Piedmont Substation in Camp Hill. (12) Autumn Flame red maple at the Piedmont Substation in Camp Hill. (13) Cleyera grown under three different production light levels following 15 weeks in an interior environment. (14) Wood's Dwarf nandina grown under three different production light levels following 15 weeks in an interior environment. (15) Rhododendron X Alaska azalea treated with 0, 50, 100, and 150 parts per million Bonzi (paclobutrazol) and 3000 p.p.m. B-nine (daminozide). Note the bypass shoots on the check plant and the delayed flowering of the daminozide-treated plant. (16) Continuous irrigation of nursery stock during subfreezing conditions. (17) Bark splitting of Duc de Rohan azalea after subfreezing conditions. (18) Woody landscape plants exposed to altered photoperiod at the Ornamental Horticulture Substation in Mobile.

Although plants exposed to long days during rooting and forcing began flowering sooner than any other treatment, plant quality (number of inflorescences and plant size) was reduced. The highest quality plants were obtained when exposure to long days began at forcing. Delaying exposure of rooted cuttings to long days delayed flowering and suppressed plant quality and flowering, table 16.

Forcing time was about 11 weeks for Summer Snow and 12 to 14 weeks for Vivid. Flowering continued for several weeks because *P. virginiana* readily forms lateral shoots, each with a terminal spike of flowers. Plant heights were too tall and will have to be controlled with either growth retardants, manipulation of the forcing environment, or selection of shorter clones. The primary disadvantages for using Vivid were the longer propagation and forcing times required as compared to Summer Snow. With height control, *P. virginiana* has the potential to be an excellent flowering potted plant for greenhouse production because of the short production schedule and quality of flowering.

See color plate number 7, page 14.

TABLE 16. EFFECTS OF PHOTOPERIOD ON *P. VIRGINIANA* SUMMER SNOW AND VIVID

Photoperiod: Rooting	Photoperiod: Forcing	Days to flowering[1]	Flowering	Plant height
			Pct.	*In.*
Summer Snow				
LD[3]	LD	37 e[2]	88	5 d
SD[4]	LD	75 d	100	16 c
SD	2 weeks SD, then LD	90 c	100	19 b
SD	4 weeks SD, then LD	105 b	94	19 b
SD	6 weeks SD, then LD	122 a	62	22 a
SD	SD	–	0	
Vivid				
LD	LD	41 c	100	7 b
SD	LD	81 b	100	12 ab
SD	2 weeks SD, then LD	102 ab	100	16 a
SD	4 weeks SD, then LD	109 a	75	18 a
SD	6 weeks SD, then LD	111 a	19	19 a
SD	SD	55 c	19	7 b

[1]Time after rooting.
[2]Mean separation within columns for each cultivar by Waller-Duncan Bayesian k-ratio t test, k = 100.
[3]LD = long days (8:00 a.m. - 5 p.m., 10:00 p.m. - 2 a.m.).
[4]SD = short days (8:00 a.m. - 5 p.m.).

Growth Medium Amendment Effects on Water-Absorbing Polymer Activity

William J. Foster and Gary J. Keever

HYDROGEL IS a generic term encompassing many hydrophilic polymers. Hydrogels also are known as gel-forming synthetic polymers, superabsorbents, water-absorbing polymers, and moisture-holding enhancers. In general, hydrogels are synthetic or starch-based polymers that absorb 20 to 1,000 times their weight in water. Hydrogels have been reported to increase nutrient availability, improve aeration and drainage, increase shelf life in container-grown plants, improve growth and flowering, and enhance root growth.

This study was conducted to determine the water-holding capacities of four hydrogels in response to growth medium amendments used in the production of container-grown ornamentals.

Liqua-Gel (starch-acrylate potassium polymer), Mizuace (starch-acrylate sodium polymer), Agrosoke (polyacrylamide polymer), and Terra-sorb HB (acrylamide copolymer) were used at manufacturers' suggested incorporation rates of 5.1, 3.0, 2.3 and 2.0 pounds per cubic yard, respectively. Four commonly used growth medium amendments and the combination of the four amendments at recommended incorporation rates, table 17, along with each hydrogel, were placed in 250-ml beakers with 200 ml of deionized water. Beakers were shaken gently for 4 hours and excess water filtered through a sieve and weighed. The difference between the weight of water added and the weight of water filtered off was determined as absorbed water.

Dolomitic limestone, gypsum, Micromax and the combination of the four amendments significantly reduced absorbency of the four hydrogels, table 17, compared to the check which contained deionized water and the hydrogel. In general, hydrogel absorbency was decreased to a greater magnitude by the addition of Micromax (87.9 percent reduction), followed by the combination of amendments (83.8 percent), gypsum (77.0 percent), Osmocote (40.3 percent), and dolomitic limestone (32.6 percent). Micromax and Gypsum had the greatest effect on hydrogel absorption.

In all hydrogels, gypsum reduced absorbency more than dolomitic limestone. This can partially be explained by the differing solubilities of these two amendments. Gypsum is 7.5 times more soluble in water than dolomitic limestone.

Divalent cations (positively charged electrical units) are reported to effectively disrupt hydrogel integrity and reduce absorbency. Gypsum (calcium sulfate) and Micromax (ferrous, manganese, zinc and copper sulfates, sodium molybdate, and sodium borate), when mixed with water, produce divalent cations which replace water at certain sites of the hydrogel and reduce absorbency.

While this was a confined system and the hydrogels were in immediate contact with the growth medium amendment, reduced absorbency of the hydrogels could be expected when mixed with growth medium in a container.

TABLE 17. HYDROGEL ABSORBENCY INFLUENCED BY GROWTH MEDIUM AMENDMENTS

Amendment	Lb./ cu. yd.	Hydrogel (g H_2O absorbed/g hydrogel): Agrosoke	Liqua-Gel	Mizuace	Terra-sorb HB
Micromax	1.5	21.7 de[1]	20.2 d	30.3 e	29.9 e
Osmocote 18-6-12	12.0	24.9 cd	272.9 a	485.7 b	121.6 c
Dolomitic limestone	6.0	38.5 b	246.1 b	399.1 c	196.3 b
Gypsum	2.0	19.1 e	69.4 c	133.7 d	57.8 d
Combination	–	28.9 c	28.9 d	18.0 e	23.9 e
Water check	–	66.8 a	289.4 a	866.5 a	243.9 a

[1]Mean separation within columns by Duncan's multiple range test, 5% level; values followed by the same letter are not statistically different.

Control of Basal Shoot Regrowth on Crapemyrtle with NAA

William J. Foster and Gary J. Keever

TREE-FORM CRAPEMYRTLES are popular landscape plants in the Southeast. Colorful blooms during the summer months, attractive bark, and rapid growth create demand for this plant. Many of the more recent cultivar releases display exfoliating bark revealing a two-toned inner bark, creating year-round interest.

During production, crapemyrtles require extensive pruning to remove one-quarter to one-third of the basal sprouts to expose the desirable bark characteristics and encourage upright growth. Removal of regrowth from these pruned areas requires a considerable amount of hand-labor, so tests were initiated to evaluate a potential chemical regrowth inhibitor.

NAA (naphthaleneacetic acid), currently not labeled for crapemyrtles, was evaluated to control basal sprout regrowth from crapemyrtles. On April 11, 1988, liners of *Lagerstroemia indica* x *fauriei* Natchez and *L. indica* Country Red were potted into 7-gallon containers. The growth medium was 3:1 (v/v) milled pine bark:peat moss amended with 6 pounds dolomitic limestone, 2 pounds gypsum, 1.5 pounds Micromax and 14 pounds Osmocote 17-7-12 (per cubic yard basis). Plants were grown under full sun and watered daily.

On July 22, 1988, all existing basal shoots about 18 inches above the soil line were pruned. Two application methods and five rates of NAA, table 18, were evaluated along with a pruned control. NAA was applied either as a directed trunk spray using a hand-held, pump-up sprayer equipped with a fan nozzle at low pressure or applied in a lanolin paste directly to the pruning cut.

About 5 months after treatments were applied, data were collected on plant height, sprout number and sprout dry weight. Basal sprout number for both cultivars was reduced by the two NAA application methods compared to the pruned control, table 18. NAA applied as a directed trunk spray was more effective in reducing total basal sprout number than NAA in lanolin paste. Plant height of Country Red, but not Natchez, was suppressed by NAA spray applications compared to the pruned control. NAA applied in lanolin paste did not suppress plant height for either cultivar.

Increasing NAA spray rate linearly decreased Country Red plant height, table 18. Increasing NAA rate significantly reduced the number and dry weight of basal shoots for both cultivars, regardless of the method of application.

See color plates 8-9, page 14.

TABLE 18. APPLICATION METHOD AND RATE OF NAA TO CONTROL BASAL SHOOT REGROWTH OF CRAPEMYRTLE

Treatment	Natchez			Country Red		
	Height	Sprouts	Sprout dry weight	Height	Sprouts	Sprout dry weight
	Cm	*No.*	*Grams*	*Cm*	*No.*	*Grams*
Method						
Spray	165.9 a[1]	0.4 c	6.6 b	142.9 b	1.9 c	31.6 c
Lanolin paste	167.0 a	2.8 b	40.0 a	157.5 a	6.6 b	102.8 b
Pruned control	179.9 a	6.5 a	41.3 a	167.6 a	19.8 a	142.8 a
Spray rate (%)						
0.00	179.9	6.5	41.3	167.6	19.8	142.8
0.25	174.5	1.0	10.9	145.4	4.5	43.7
0.50	172.3	.3	3.7	163.2	2.4	26.4
0.75	169.9	.1	.8	129.8	.7	14.4
1.00	147.1	.0	.0	133.2	.0	.0
Significance[2]	ns	C*	Q*	L**	C**	Q*
Paste rate (%)						
0.00	179.9	6.5	41.3	167.6	19.8	142.8
0.25	172.6	2.9	41.7	158.2	6.6	104.2
0.50	156.8	3.1	31.8	159.7	7.5	120.8
0.75	177.0	3.6	67.8	156.4	6.4	96.5
1.00	161.5	1.8	11.5	155.7	5.7	89.7
Significance[2]	ns	C**	C*	ns	C**	Q*

[1]Means followed by the same letter are not statistically different at the 1 percent level.

[2]Linear (L), quadratic (Q) or cubic (C) regression significant at 5 percent (*), or 1 percent (**) level, or not significant (ns).

Acer rubrum Cultivars for the South

Donna C. Fare, Charles H. Gilliam, Harry G. Ponder, and Wallace A. Griffey

LIMITED DATA have led to the use of some trees that are poorly suited to many sites, resulting in high maintenance and removal costs. As a result of these problems, research was initiated to provide information about the growth characteristics and adaptability of selected shade and ornamental trees. One group of trees in the study includes cultivars and seedlings of *Acer rubrum*, red maple. Cultivars were selected primarily for variation in canopy forms and outstanding fall leaf color.

Initial plantings were made in December 1980 at the Piedmont Substation in Camp Hill, with 3- to 4-foot bareroot whips planted in a Cecil gravelly sandy loam soil. Trees were planted 25 feet within rows and 30 feet between rows. Cultivars evaluated were: Armstrong, a fastigiate form; Karpick, Bowhall, Scarlet Sentinel, and Tilford, oval to upright forms; Schleslingeri, a rounded form; Gerling, a rounded to broadly pyramidal form; and Red Sunset and Autumn Flame, rounded to upright forms. Supplemental irrigation was not applied.

No preventive pesticide applications were made. In 1985, all maples were sprayed with endosulfan for control of twig borer. A complete fertilizer was applied yearly in early spring at 1 pound of nitrogen per 1 inch caliper. Soil tests were made annually and in 1986, 2 tons per acre of agricultural lime was applied. Weed control consisted of two applications per year of Roundup or Gramoxone for postemergence weed control, and a spring application of Surflan at 4 pounds per acre for preemergence weed control. Herbicides were applied by directing a spray at the base of each tree in an area 4-5 feet in diameter. Selective pruning occurred predominately during the dormant season, except for regular removal of suckers at the base of the trees.

Evaluation criteria included annual growth rate, adaptability to the Southeast (i.e. site conditions, heat tolerance), and aesthetic characteristics. Growth rate was determined by recording height and caliper (measured 12 inches above the soil line) annually. Aesthetic characteristics rated were flower and leaf color, shade potential, and canopy form. In July 1987, a numerical ranking was used to rate leaf color, canopy form, shading potential, and aesthetics. Leaf color rating scale was 1 = yellow, 3 = light green, 5 = dark green; canopy form scale was 1 = poor, 3 = good, 5 = excellent; shading potential scale was 1 = none, 3 = filtered, 5 = dense; and aesthetics rating was 1 = poor, 3 = good, 5 = excellent. The nature of the tree evaluation is subjective; to overcome the subjectivity of this test three individuals rated the trees independently with respect to the above rating scales. Values shown are an average value from the independent ratings.

Canopy form continues to develop on the red maple trees. After 7 years, distinct forms have developed, but trees have not reached maturity. Armstrong had the highest canopy rating of 3.9, but did not differ statistically from Autumn Flame, Bowhall, and Red Sunset. The informal branching habit of the broader canopied red maples is not as appealing in less mature trees, resulting in a lower rating throughout the test for the broader canopied trees. Seedlings from south Alabama and Tennessee received a good rating of 3.1, but inconsistency was obvious with these trees.

Differences existed among cultivars for shade potential. Cultivars with the greatest shade potential were the oval or rounded canopy forms (i.e. Red Sunset). Cultivars with the poorest shade potential were the upright forms (example Armstrong). Upright forms of red maple are more suitable to street plantings where shade requirements are less than for a traditional shade tree.

An aesthetic value was assessed on cultivar uniformity with respect to canopy form and appearance. None of the cultivars received an excellent rating on aesthetics, but Armstrong and Red Sunset were rated the highest with a score of 3.5. Scarlet Sentinel had the lowest rating of 2.8 because of the inconsistency of the branching.

Because no one cultivar of red maple rated highest in all categories, an overall score was obtained by summing individual ratings for each cultivar (leaf color, canopy form, shading potential, and aesthetics) to decide which red maples were superior. Red Sunset had the highest score of 14.6, followed by Autumn Flame and Armstrong with 13.6 and 13.5, respectively. Scarlet Sentinel had the lowest total rating of 11.4 due to lighter summer leaf color and poor aesthetics. All other selections had scores between 12.7 and 13.3.

Bud union incompatibility occurred with most of the red maple cultivars, resulting in several trees dying during the first 3 years of the test. This delayed response of incompatibility to budding appears to be of genetic origin. Four and five trees of Bowhall and Scarlet Sentinel, respectively, died from incompatibility. Red Sunset was the only cultivar that had no trees to die from bud incompatibility. One tree each of Autumn Flame, Gerling, and Schlesingeri died, and two trees each of Armstrong and Tilford died.

Fall color was excellent on some cultivars each year. Autumn Flame, Bowhall, Gerling, and Tilford are four cultivars that have had excellent fall color each year, beginning with Autumn Flame and Tilford in mid- to late October, followed by Bowhall and Gerling in early November. Many of the other selections were inconsistent in leaf color development and duration. Red Sunset, for example, has not developed fall color every year. A few trees of Red Sunset have not developed fall color during any of the first 7 years of the test.

All of the cultivars evaluated are adaptable to Alabama. Fall color development has been consistent with Autumn Flame, Bowhall, Gerling, and Tilford, but inconsistent with other cultivars.

Currently, a long-term study is underway to evaluate red maple cultivars on their own roots. New selections of red maples have landscape potential for urban and residential sites. The variety of canopy shapes and leaf characteristics available with red maple cultivars can increase the selection of shade and ornamental trees used in Southeastern landscapes.

See color plates 10-12, page 15.

Effect of Hydrophilic Polymer Amendments on Growth of Container Grown Landscape Plants

Gary J. Keever, Gary S. Cobb, Jimmy Stephenson, and William J. Foster

WATER-ABSORBING POLYMERS (hydrogels) are a group of compounds capable of absorbing many times their weight in water. Research has shown hydrogels to reduce watering requirements of container grown plants, enhance plant growth, increase nutrient retention of media, lessen transplant shock to trees and shrubs, improve seed germination and seedling vigor, and increase the shelflife of pot crops. Conflicting results also have been reported in hydrogel tests. For example, addition of hydrogel did not affect or suppress plant growth, and nutrient content of growth medium leachate was minimally influenced. Tissue levels of macro- and microelements were less with hydrogel addition than in untreated media, root dips in hydrogels were not advantageous at transplanting, and seed germination and seedling vigor were not affected by gel-coating of seed. In spite of differing reports, numerous commercial hydrogels are being promoted for incorporation or dibbling into growth media as amendments that retain water available for plant uptake, increase aeration, and improve drainage.

Tests were conducted over 3 years to determine potential benefits of the hydrogel product, Mizuace, as a growth medium amendment in the container production of woody landscape plants. Specific objectives included evaluating selected rates, methods of application, and effects of hydrogel on fertilizer activity.

Three experiments were conducted beginning in April 1985 and ending in June 1987 in Mobile, Alabama, at the Ornamental Horticulture Substation. In each experiment, Mizuace, a starch-acrylate sodium hydrogel, was added to the growth medium of container grown woody landscape plants.

Experiment One

Uniform liners of *Rhododendron* x Sherwood Red (azalea), *Ligustrum japonicum* Aureo-marginatum (privet), *Buxus microphylla koreana* Wintergreen (boxwood), and *Ilex vomitoria* Stoke's Dwarf (yaupon holly) were potted April 15, 1985, in 1-gallon containers. A 100 percent milled pine bark growth medium was amended on a cubic yard basis with 6 pounds dolomitic limestone, 2 pounds gypsum, 1.5 pounds Micromax micronutrient fertilizer, 12 pounds Osmocote 17-7-12, and Mizuace (hydrogel). Hydrogel was incorporated into the growth medium on a cubic yard basis at 0.0, 1.5, 3.0, 4.5, and 6.0 pounds or dibbled beneath the liner at planting at 0.2 ounce per container. The dibbled rate was equivalent to 3.0 pounds per cubic yard. Plants were placed outdoors in full sun under overhead irrigation and maintained using accepted Alabama nursery practices.

Container growth medium temperatures were monitored during the study using three thermocouples per treatment placed at a 3-inch depth, 1.0 inch from the south wall of the pots. Temperatures were recorded on 9 clear days in July 1985. On July 24, 1985, foliar color ratings (scale: 1 = light green, 3 = medium green, 5 = dark green) were made and on July 24 and October 25, 1985, growth indices were calculated for each species. Shoots were removed for dry weight determination on November 1, 1985. Root development was rated (scale: 1 = no roots on surface, 2-5 = 25, 50, 75, and 100% of root ball covered, respectively) at the same time.

Growth medium temperature, growth index, foliar color rating, root density rating, and shoot dry weight were not affected by hydrogel rate. Growth medium temperature also was not affected by hydrogel application method.

Dibbled hydrogel absorbed many times its volume in water with the increase in volume frequently forcing the liner out of the growth medium, thus requiring repotting. After roots extended out of the liner root ball into the pine bark growth medium, displacement was no longer evident.

Dibbling of hydrogel resulted in lower growth indices and shoot dry weights of all species compared to incorporation and control treatments. Root development, as indicated by the root density rating, was lower for azalea, boxwood, and privet in the dibbled treatment than in the incorporated and control treatments; root development of yaupon holly was similar when hydrogel was dibbled or incorporated, but was less than that of the control. Foliar color was either poorer (azalea, yaupon holly) or similar (boxwood, privet) when hydrogel was dibbled compared to other treatments.

Experiments Two and Three

Uniform liners of *Ligustrum japonicum* Aureo-marginatum (privet) and *Rhododendron* x Sherwood Red (azalea) were potted April 2, 1986, in 2-gallon and 1-gallon containers, respectively. Amendments listed in Experiment 1 and hydrogel at 0.0, 1.5, 3.0, 4.5, and 6.0 pounds per cubic yard were incorporated into the growth medium prior to potting. Plants were placed outdoors in full sun under overhead impact sprinklers and were irrigated based on water needs of plants in growth medium amended with 3.0 pounds hydrogel.

Growth indices were taken on July 21, 1986. Samples of the most recently matured leaves of each species were collected on November 11, 1986, and N, P, K, Ca, and Mg were determined. After sampling of tissue, shoots of five single plant replicates were severed at the soil line, dried at 176°F for 72 hours, and weighed. Relative root density of sampled plants was rated and growth medium samples were collected at this time. Shoot dry weights were determined and root density ratings were made on the remaining five replicates of two plants on June 22, 1987.

Experiment 3 was identical to Experiment 2 except that plants of each treatment were grouped around an individual sprinkler that supplied 1 inch of water per hour and were irrigated as needed. Growth medium leachates were collected on July 22, 1986. Leachates were collected by pouring 8.4 ounces of distilled water on the azalea growth medium; soluble salts levels and pH of the leachate solutions then were determined.

Results of these two studies were similar. Rainfall from April 1 to September 30, 1986, was 34.9 inches. During this period, plants in Experiment 3 treated with the highest rate of hydrogel required the most frequent irrigation and largest water volume, followed by the control (3.3 inches less), plants receiving 1.5 pounds per cubic yard and 4.5 pounds per cubic yard hydrogel (8.0 inches less), and plants receiving 3.0 pounds per cubic yard hydrogel (10.0 inches less). Growth indices, shoot dry weight values, and root density ratings either decreased or did not change as the rate of incorporated hydrogel increased.

Foliar levels of Mg and N in both species and growth medium concentration of Mg for privet in Experiment 2 and foliar and growth medium Mg in privet in Experiment 3 increased with increasing rates of incorporated hydrogel. In contrast, leachate soluble salts decreased with increasing rates of hydrogel. Other foliar elements (N, P, K, Ca), growth medium elements (NO_3-N, P, K, Ca), pH and soluble salts, and leachate pH were not affected by hydrogel rate.

Consistent results obtained during the 3 years of these studies indicated that hydrogel is not advantageous for container production. Irrigation frequency was not decreased by hydrogel rate, and shoot and root growth ratings were either decreased or not affected by hydrogel. A possible explanation is that hydrogel absorption of water was reduced by soluble salts from the incorporated fertilizers or irrigation water. Hydrogel absorbency is reduced by saline irrigation water, the divalent cations being particularly detrimental; hydrogels also may be damaged by fertilizer or other metal ions, reducing pore space and resulting in insufficient air exchange in the root zone.

The use of water-absorbing hydrogels as growth medium amendments for container grown plants to reduce irrigation frequency and promote growth is questionable, based on studies conducted over 3 years. Irrigation frequency was not reduced and plant growth was either not affected or was suppressed by incorporated hydrogels. Dibbling of hydrogel resulted in reduced growth.

Interior Performance of Temperate Zone Landscape Plants

Gary J. Keever, Gary S. Cobb, and Jimmy Stephenson

SEVERAL TEMPERATE zone woody landscape plants have recently proven to adapt and perform well in indoor environments. In addition to offering a new and varied source of plant materials for indoor landscapes, temperate species are generally more tolerant than tropical or semi-tropical species to cooler interior conditions that may result from energy-conserving measures or placement near building entrances where drafts of cold air frequently enter.

Successful indoor performance of temperate landscape plants is dependent upon the plant's ability to acclimate to low light conditions and to maintain vigor without experiencing a natural dormancy environmentally enhanced by shortening daylength and decreasing temperatures. Acclimatization to low light can be facilitated by production under a specific shade level for a portion of, or the entire production cycle. Characteristically, long days and relatively constant temperatures of interior environments will delay or prevent dormancy of temperate woody plants; however, the response is species dependent. The objective of this study was to continue previous research to evaluate production light level effects on the interior performance of selected temperate zone woody landscape plants typically used in the exterior landscape. In addition, several non-woody species typically used as ground covers were evaluated.

Experiment One

Thirty uniform liners each of *Euonymus japonica* Aureomarginata (golden Japanese euonymus), *Hosta ventricosa* (plantain lily), *Liriope spicata* (spreading lilyturf), *Magnolia grandiflora* (Southern magnolia), *Mahonia aquifolium* King's Ransom (King's Ransom Oregon grapeholly), *Nandina domestica* (heavenly bamboo), *Ophiopogon japonicus* (mondo grass), and *Ternstroemia gymnanthera* (cleyera) were potted March 12, 1985, in 6-inch containers. A 100 percent milled pine bark growth medium was amended with 6 pounds per cubic yard dolomitic limestone, 2 pounds per cubic yard gypsum, and 1.5 pounds per cubic yard Micromax micronutrient fertilizer. Plants were topdressed monthly during production with 0.14 ounce 12-6-6 Nursery Special per container. Plants of each species were divided into three groups of 10 plants and grown under the following light conditions: (1) full sun; (2) 47 percent shade; and (3) 64 percent shade. On August 16, 1985, growth indices (height plus width plus width ÷ 3) were taken prior to transferring plants to an interior environment with 40 watt cool white fluorescent lamps, 12-hour photoperiod (6 a.m.-6 p.m.), 70°F temperature, and about 80 percent RH. Plants were evaluated weekly during a 15-week period for leaf drop. After 15 weeks, growth indices, leaf color (1 = light green; 3 = medium green; 5 = dark green), and plant quality (1 = poor, not saleable; 3 = good, saleable; 5 = excellent) were determined. Following data collection, plants were transferred to a polyethylene covered greenhouse (70°F minimum temperature) for 5 months and fertilized every 3 weeks with 100 ppm N from Peters 20-20-20 soluble fertilizer to determine if plants would resume or continue vegetative growth without exposure to low temperatures.

Experiment Two

Uniform liners of *Aucuba japonica* Variegata Nana (dwarf gold-dust plant), *Ligustrum japonicum* Variegatum (variegated waxleaf privet) and *Nandina domestica* Wood's Dwarf (Wood's Dwarf heavenly bamboo) were potted in 6-inch containers, and *Ajuga reptans* (bugleweed), *Buxus microphylla koreana* Wintergreen (Wintergreen Korean boxwood), *Euonymus fortunei* Variegata (wintercreeper euonymus), *Ficus pumila* (climbing fig), *Illicium parviflorum* (Japanese anisetree), and *Raphiolepis indica* Pink Lady (Pink Lady Indian hawthorn) were potted in 4- to 6-inch containers on April 16, 1986. Methods were the same as those in Experiment 1 except plants were transferred to an interior environment on September 3, 1986.

Post-production. All plants grown in full sun were smaller than shade-grown plants except *Mahonia* grown in 47 percent shade and *Ophiopogon* and *Ficus* grown in 47 percent and 64 percent shade, tables 19 and 20. Species grown in full sun were denser and more compact, with smaller, lighter green leaves than plants grown in shade. Marginal leaf necrosis was present on plants of *Hosta, Liriope, Mahonia, Nandina domestica* Wood's Dwarf, and *Aucuba* grown in full sun. With both *Euonymus* spp. and *Ligustrum* there was a reduction in the amount and intensity of variegation as production light levels decreased. Overall plant quality was generally poorer with plants grown in full sun due to a hard, stunted appearance. Only plants of *Ternstroemia* and *Magnolia* were of similar quality under all light regimes.

Plants of all species except *Buxus* continued to produce new growth during the 15-week interior period. Growth of full-sun grown plants in the interior environment was similar in color and leaf size to growth of shadegrown plants during production. Production size of *Nandina domestica* Wood's Dwarf and *Illicium* were smaller for plants grown in full sun, but after 15 weeks indoors plant size was similar among light treatments. Other species maintained the same relative size among treatments as when brought indoors. Foliar color ratings were higher for shade-grown plants of *Euonymus* spp., *Magnolia, Liriope,* and *Mahonia* compared to ratings for full-sun grown plants. Ratings were similar for other species, regardless of production light treatment. These ratings indicate

TABLE 19. RESPONSE OF 8 TEMPERATE ZONE LANDSCAPE PLANTS, GROWN UNDER 3 LIGHT LEVELS, TO AN INTERIOR ENVIRONMENT, 1985

Cultivar and production light level	Growth index[1]		Post-interior		
	Post-production	Post-interior	Color rating[2]	Leaf drop[3]	Quality rating[4]
Euonymus japonica Aureomarginata					
Full sun	20.5 b[5]	20.5 b	4.5 b	76.6 a	1.8 c
47% shade	26.0 a	26.1 a	5.0 a	14.2 b	3.8 b
64% shade	26.5 a	26.7 a	5.0 a	8.6 b	5.0 a
Hosta vertricosa					
Full sun	26.3 b	42.3 b	4.5 a	6.0 b	2.0 b
47% shade	43.3 a	47.1 a	4.5 a	9.2 a	3.8 a
64% shade	43.9 a	47.4 a	4.5 a	9.4 a	3.9 a
Liriope spicata					
Full sun	35.5 b	35.6 b	4.1 b	0.0 a	3.7 b
47% shade	40.8 a	41.1 a	5.0 a	0.0 a	4.8 a
64% shade	41.4 a	41.7 a	5.0 a	0.0 a	4.8 a
Magnolia grandiflora					
Full sun	37.4 b	44.6 b	4.2 b	5.6 a	4.6 a
47% shade	48.3 a	52.6 a	5.0 a	6.4 a	4.8 a
64% shade	51.8 a	53.5 a	5.0 a	2.6 b	4.8 a
Mahonia aquifolium King's Ransom					
Full sun	35.0 b	35.6 b	2.1 b	123.2 a	1.1 c
47% shade	38.5 ab	39.6 ab	4.5 a	63.0 b	3.2 b
64% shade	43.6 a	43.6 a	4.7 a	53.6 b	3.4 a
Nandina domestica					
Full sun	51.3 b	51.5 b	4.2 a	269.0 a	4.2 a
47% shade	61.3 a	62.5 a	4.4 a	230.5 a	4.6 a
64% shade	64.2 a	67.3 a	4.9 a	137.5 a	4.8 a
Ophiopogon japonicus					
Full sun	19.1 a	19.7 a	5.0 a	0 a	5.0 a
47% shade	19.4 a	19.8 a	5.0 a	0 a	5.0 a
64% shade	18.3 a	19.8 a	5.0 a	0 a	5.0 a
Ternstroemia gymnanthera					
Full sun	48.8 b	49.2 b	5.0 a	15.4 a	5.0 a
47% shade	53.9 a	54.8 a	5.0 a	13.2 a	5.0 a
64% shade	56.3 a	56.5 a	5.0 a	17.4 a	5.0 a

[1]Growth index: (height + width + width) ÷ 3.
[2]Color rating: 1 = light green; 3 = medium green; 5 = dark green. Recently matured leaves and green portions of variegated leaves rated.
[3]Leaf drop: total number of leaves dropped during interior period; leaflet drop for *Mahonia* and *Nandina*.
[4]Quality rating: 1 = poor, not saleable; 3 = good, saleable; 5 = excellent.
[5]Mean separation within columns and species by Duncan's multiple range test, 5% level.

an improvement in leaf color of full-sun grown plants during the interior period.

Euonymus spp., *Mahonia*, *Aucuba*, *Nandina domestica* Wood's Dwarf, *Ligustrum*, and *Ficus* grown under both shade levels and *Ajuga* and *Magnolia* grown under 64 percent shade dropped fewer leaves than plants grown under higher light conditions. Plants of *Hosta* grown in full-sun lost fewer leaves than plants grown in shade; leaf drop from other species did not vary among production light levels.

Plant quality, as determined by visually rating the plants following the 15-week interior period, considered numerous plant characteristics including habit of growth (density), leaf size and spacing, foliage color, leaf drop, and overall appearance. At the end of the interior period, the quality of *Ternstroemia, Liriope, Magnolia, Nandina domestica, Ophiopogon, Ficus*, and *Ligustrum* was good to excellent for plants grown under all production light levels, tables 19 and 20. Of these species, quality was higher for shade-grown plants of *Liriope, Ficus*, and *Ligustrum* than for sun-grown plants. Quality of *Euonymus japonica, Hosta, Mahonia, Aucuba, Nandina domestica* Wood's Dwarf, *Illicium*, and *Raphiolepis* was good to excellent for plants grown in shade, while quality of plants grown in full sun was unacceptable, due to excessive leaf drop, stunting, and foliar necrosis from the production period or both.

All plants of *Raphiolepis* grown in full sun, 10 percent grown in 47 percent shade, and 20 percent grown in 64 percent shade died in the interior environment, while 20 percent of *Illicium* grown in full sun died. Plants of *Ajuga* and *Euonymus fortunei* grown under 64 percent shade were of acceptable quality but plants grown in full sun or in 47 percent shade were of poor quality. With *Euonymus*, 70 percent of plants grown in full sun died during the 15 weeks indoors. Plants of *Buxus* grown under all production light levels were of unacceptable quality due to excessive leaf drop and death (100 percent of plants grown in full sun, 50 percent grown in 47 percent shade, and 10 percent grown in 64 percent shade) during the interior period.

Species that performed well in the interior environment continued to produce new growth indoors or in the greenhouse, indicating that dormancy was not a limiting factor during the 15-week interior period and 5 months in the greenhouse. Plants of several species, including *Buxus* and sun-grown *Raphiolepis*, exhibited extensive branch dieback and death of entire plants. These symptoms may have been dormancy- or disease-related or simply the results of the plants' inability to tolerate the low light levels of the interior environment. The fungus *Rhizoctonia* was isolated from dead plants of *Raphiolepis*. *Raphiolepis* plants grew and improved in appearance during the 5 months in the greenhouse.

Temperate-zone landscape plants, characteristically more cold tolerant than tropical or semitropical species, can be used successfully in the interior environment. Plants of *Euonymus* spp., *Hosta, Liriope, Magnolia, Mahonia, Nandina, Ophiopogon, Ternstroemia, Aucuba, Ligustrum, Ajuga, Ficus, Illicium*, and *Raphiolepis* performed well when placed indoors for 15 weeks. Quality was generally higher for shade-grown plants but not always, exemplified by *Magnolia, Nandina domestica, Ophiopogon*, and *Ternstroemia*. Some species, such as *Buxus*, do not appear to adapt to interior conditions, regardless of production light levels. It is suggested that before committing to a large scale planting with plants that performed well in this study, a trial of a few plants be conducted over 12 to 18 months indoors.

See color plates 13-14, page 15.

TABLE 20. RESPONSE OF NINE TEMPERATE ZONE LANDSCAPE PLANTS, GROWN UNDER 3 LIGHT LEVELS, TO AN INTERIOR ENVIRONMENT, 1986

Cultivar and production light level	Growth index[1]		Post-interior		
	Post-production	Post-interior	Color rating[2]	Leaf drop[3]	Quality rating[4]
Ajuga reptans					
Full sun	18.5 b[5]	19.6 b	3.0 a	118.1 a	1.6 b
47% shade	21.8 a	22.7 a	3.0 a	101.9 a	1.9 b
64% shade	22.6 a	23.6 a	3.0 a	47.3 b	3.0 a
Aucuba japonica Variegata Nana					
Full sun	16.2 b	17.9 b	5.0 a	14.5 a	1.6 b
47% shade	24.8 a	26.4 a	5.0 a	7.8 b	4.8 a
64% shade	24.3 a	26.1 a	5.0 a	7.7 b	4.8 a
Buxus microphylla koreana Wintergreen					
Full sun	13.3 c	0.0[6]	0.0	0.0	0.0
47% shade	16.4 b	16.1 b	3.4 a	76.2 a	2.6 a
64% shade	19.1 a	18.7 a	3.5 a	59.0 a	2.8 a
Euonymus fortunei Variegata					
Full sun	21.0 c	19.4 b	4.2 a	495.0 a	1.0 c
47% shade	25.0 a	25.8 a	4.2 a	308.8 b	2.8 b
64% shade	22.9 b	24.3 a	4.2 a	131.6 c	4.0 a
Ficus pumila					
Full sun	21.6 a	24.5 a	4.8 a	433.4 a	3.5 c
47% shade	22.4 a	25.1 a	4.8 a	306.0 b	4.1 b
64% shade	23.3 a	25.9 a	4.8 a	280.1 b	4.6 a
Illicium parviflorum					
Full sun	18.7 b	22.4 a	3.5 a	7.0 a	2.6 c
47% shade	21.7 a	23.2 a	3.5 a	5.4 a	3.7 b
64% shade	22.9 a	25.4 a	3.5 a	5.4 a	4.1 a
Nandina domestica Wood's Dwarf					
Full sun	35.7 b	38.6 a	4.8 a	152.3 a	1.9 c
47% shade	40.0 a	42.7 a	4.8 a	26.3 b	4.2 b
64% shade	39.6 a	42.6 a	4.8 a	22.6 b	4.6 a
Ligustrum japonicum Variegatum					
Full sun	20.5 b	21.3 b	4.8 a	7.3 a	3.6 b
47% shade	25.5 a	27.1 a	4.8 a	2.6 b	4.7 a
64% shade	27.3 a	28.7 a	4.8 a	3.4 b	4.8 a
Raphiolepis indica					
Full sun	17.9 b	–	–	–	–
47% shade	22.4 a	22.8 a	4.5 a	26.1 a	3.6 a
64% shade	24.4 a	24.5 a	4.7 a	20.3 a	3.9 a

[1]Growth index: (height + width + width) ÷ 3.
[2]Color rating: 1 = light green; 3 = medium green; 5 = dark green. Recently matured leaves and green portions of variegated leaves rated.
[3]Leaf drop: total number of leaves dropped during interior period; leaflet drop for *Nandina*.
[4]Quality rating: 1 = poor, not saleable; 3 = good, saleable; 5 = excellent.
[5]Mean separation within columns and species by Duncan's multiple range test, 5% level.
[6]All plants died during the interior period.

Persistence of Growth Inhibition of First Lady and Honeycomb Marigold to Drench and Foliar Applied Paclobutrazol

Gary J. Keever and Douglas A. Cox

CHEMICAL GROWTH retardants, including ancymidol, chlormequat, and daminozide, commonly are applied to bedding plants to produce more compact plants and extend marketability. Paclobutrazol, a gibberellin biosynthesis inhibitor currently labeled as Bonzi for use on container-grown poinsettia, has been effective in retarding growth of numerous flowering potted crops, foliage plants, and annual bedding plants.

An important consideration in the utilization of growth retarding chemicals on annual bedding plants is not only the magnitude but also the duration of internode suppression.

When compared to other growth retardants, paclobutrazol is active and persistent. In preliminary tests, spray and drench rates of paclobutrazol were effective in retarding internode elongation of *Tagetes erecta* (African marigold) and *T. patula* (French marigold). The objective of this study was to determine the duration of growth suppression of plants treated during production and subsequently transplanted into the landscape.

Seeds of First Lady African marigold and Honeycomb French marigold were sown in 5-inch pots containing Pro-Mix BX on February 4, 1987. Seedlings were thinned to one per pot and received a liquid feed of 200 ppm N and K from NH_4NO_3 and KNO_3 at each irrigation. Plants were grown in a polyethylene-covered greenhouse maintained at about 75°F day and 64°F night temperature. Paclobutrazol drenches of 0, 0.5, 1.0, 2.0, and 4.0 mg[1] active ingredient (a.i.) per pot were applied in 1.7-ounce volumes on March 4. Paclobutrazol sprays of 0.5, 1.0, 2.0, and 4.0 mg a.i. (250, 500, 1,000, 2,000 ppm, respectively) per plant were applied until runoff to achieve thorough coverage of the stems and leaves with the growing medium covered to protect it from drip. (Bonzi contains 120 mg a.i. per fluid ounce). Tween 20 (0.1 percent by volume) was used as a surfactant for all spray treatments. Spray and drench rates were chosen based on the results of unpublished results by the authors. Plants were transplanted 42 days after treatment (April 15) into a sandy loam soil amended with 2 inches of ground pine bark tilled into the upper 6 inches. Plant height was measured when treatments were applied, 2 weeks later (March 18), when transplanted, and 138 days after treatments were applied (July 20).

Growth of both cultivars was effectively suppressed by paclobutrazol within 2 weeks of application, tables 21 and 22. Height was quadratically retarded with increasing rates of both sprays and drenches. Height was extremely consistent within a treatment. At the rates tested, spray and drench applications resulted in a comparable magnitude of suppression. A similar response to rate was observed 43 days after treatments were applied, except that drench-treated plants of both cultivars were shorter than spray-treated plants. Leaf color of both cultivars was darker at higher spray and drench rates of paclobutrazol compared to lower rates and the control. Mild leaf cupping was present on First Lady marigolds treated with the three highest drench rates and the two highest spray rates. Paclobutrazol delayed inflorescence development of First Lady marigold (one-two open blooms per plant at transplanting) when compared to the control (three open blooms per plant). Inflorescence development of Honeycomb marigold was not affected by paclobutrazol, but inflorescence size was reduced by the three highest drench rates when compared to plants sprayed or the control (data not shown). Visual observations made at transplanting indicated that highest quality of First Lady marigold, based on plant size and form relative to pot size and foliage color, was obtained when plants were sprayed at the rates tested or drenched at the two lowest rates. With Honeycomb marigold, the highest quality resulted when plants were drenched at the lowest rate and sprayed at the two lowest rates.

After being transplanted into the garden environment, spray-treated Honeycomb and First Lady marigold plants grew more than untreated plants, such that 138 days after treatments were applied, heights were similar. Drench-treated plants of both cultivars continued to exhibit the paclobutrazol growth-retarding effect after being transplanted (quadratic response) and were shorter (First Lady) or similar (Honeycomb) in height to spray-treated plants.

Paclobutrazol applied as a single drench or spray application was effective in suppressing Honeycomb and First Lady growth. Plants sprayed with paclobutrazol resumed growth after being transplanted into the landscape and eventually obtained heights similar to those of untreated plants. Drench-applied paclobutrazol was more persistent than foliar-applied retardants, controlling height throughout the useful life of the plant. The persistence of drench-applied paclobutrazol may be undesirable.

TABLE 21. EFFECT OF DRENCH AND SPRAY APPLICATION OF PACLOBUTRAZOL ON HEIGHT OF FIRST LADY MARIGOLD

Treatment	Height			
	March 4[1]	March 18	April 16[2]	July 20
	In.	*In.*	*In.*	*In.*
Method				
Control	2.1 a[3]	5.4 a	10.3 a	10.6 a
Drench	2.0 a	3.7 b	7.3 c	9.3 b
Spray	1.9 a	3.6 b	7.6 b	10.5 a
Drench rate (mg a.i./pot)				
0.0	2.1	5.4	10.3	10.6
0.5	2.1	4.2	8.5	9.3
1.0	2.1	3.9	8.0	8.9
2.0	2.0	3.7	7.0	9.4
4.0	2.0	3.0	5.6	9.7
Significance[4]	ns	Q**	Q**	Q**
Spray rate (ppm)				
0	2.1	5.4	10.3	10.6
250	2.0	4.1	8.5	10.1
500	1.8	3.6	7.9	10.7
1,000	1.9	3.5	6.8	10.6
2,000	1.9	3.3	7.3	10.6
Significance[4]	ns	Q**	Q**	ns

[1]Date treatments applied.
[2]Date of transplanting; height to top of tallest flower head.
[3]Mean separation in columns for method by Duncan's multiple range test, 5% level.
[4]Treatment effects were not significant (ns) or significant at the 5% (*) or 1% (**) level and were linear (L) or quadratic (Q).

TABLE 22. EFFECT OF DRENCH AND SPRAY APPLICATION OF PACLOBUTRAZOL ON HEIGHT OF HONEYCOMB MARIGOLD

Treatment	Height			
	March 4[1]	March 18	April 16[2]	July 20
	In.	*In.*	*In.*	*In.*
Method				
Control	1.7 a[3]	3.9 a	8.2 a	11.0 a
Drench	1.7 a	3.0 b	5.0 c	10.0 b
Spray	1.8 a	3.1 b	5.9 b	10.5 a
Drench rate (mg a.i./pot)				
0.0	1.7	3.9	8.2	11.0
0.5	1.8	3.3	6.0	11.9
1.0	1.7	2.8	4.9	9.4
2.0	1.7	2.8	4.6	9.6
4.0	1.7	2.8	4.7	9.0
Significance[4]	ns	Q**	Q**	Q**
Spray rate (ppm)				
0	1.7	3.9	8.2	11.0
250	1.7	3.3	6.7	11.0
500	1.7	3.1	6.2	10.0
1,000	1.7	3.0	5.4	9.9
2,000	1.9	3.0	5.4	10.9
Significance[4]	ns	Q**	Q**	ns

[1]Date treatments applied.
[2]Date of transplanting; height to top of tallest flower head.
[3]Mean separation in columns for method by Duncan's multiple range teest, 5% level.
[4]Treatment effects were not significant (ns) or significant at the 5% (*) or 1% (**) level and were quadratic (Q).

[1]28,350 milligrams (mg) equal 1 ounce.

Florist Azaleas Respond to New Growth Retardant

Gary J. Keever and William J. Foster

GROWTH RETARDANTS (GR) are an accepted component of florist azalea production. In addition to suppressing internode elongation, GR promote flower bud initiation, hasten flower development, and may inhibit the growth of vegetative shoots that develop below flowers (bypass shoots). Daminozide and chlormequat chloride are the principal GR applied to florist azaleas. Delayed flowering and smaller flower size are undesirable side effects of daminozide, while delayed flowering and smaller plant size are undesirable effects of chlormequat chloride.

Paclobutrazol, currently labeled as Bonzi for use on poinsettia, is an effective retardant on chrysanthemums, many species of tropical foliage plants, and annual bedding plants. This study was conducted to determine the effectiveness of paclobutrazol in controlling bypass shoots of florist azaleas relative to daminozide and to evaluate the chemical's effect on flowering.

Uniform 4-inch liners of Prize and Alaska azaleas were potted in March 1987, into 6-inch containers of three peat: two softwood shavings growth medium amended with 6 pounds SREF 19-2-10, 6 pounds dolomitic limestone, and 0.75-pound Micromax per cubic yard. Plants were placed in a double polyethylene greenhouse and maintained according to standard commercial practices. The following treatments were applied on September 15 in a volume of 2 quarts per 100 square feet: single paclobutrazol sprays of 0, 50, 100, 150, 200, 250, and 300 ppm and a daminozide spray of 3,000 ppm repeated 1 week later. Sprays were applied using a hand-held sprayer to uniformly wet foliage and stems. Treatments were applied at approximately 8 a.m. on clear days. Greenhouse temperature was 68°F with 82 percent relative humidity at time of applications.

Plants were placed in a cooler on November 23, and cooled in the dark at 38°F for 6 weeks. Plants were removed from the cooler on January 4, 1988, and forced into bloom in a heated glass greenhouse (68°F minimum temperature).

Number and length of bypass shoots on both cultivars decreased as paclobutrazol rate increased. At or above the 150 ppm rate, essentially no bypass shoots developed on either cultivar. Daminozide was ineffective in controlling bypass shoot number, with daminozide-treated plants forming more bypass shoots than the control plants and plants treated with all rates of paclobutrazol. Daminozide did suppress bypass shoot elongation of Alaska, but not of Prize.

Increasing rates of paclobutrazol from 0 to 300 ppm resulted in an increase in days-to-flowering, from 50.3 days to 55.5 days for Alaska plants and from 42.9 days to 48.5 days for Prize plants. Daminozide-treated plants of both cultivars required longer to reach full bloom than untreated plants and plants treated with all rates of paclobutrazol. Flower number of Alaska increased from 195 for the control to 225 for plants treated with 100 ppm paclobutrazol but decreased to 201 for plants receiving a 300 ppm paclobutrazol spray. Flower number of Prize increased from 138 for the control to 157 for plants treated with 200 ppm paclobutrazol but dropped to 139 at the highest rate of paclobutrazol. Flower number of daminozide-treated Alaska plants was similar to untreated plants and to plants sprayed with 250 and 300 ppm paclobutrazol, but less than that of plants receiving 50, 100, 150, and 200 ppm sprays. Flower number of daminozide-treated Prize plants was less than that of plants treated with 150 and 200 ppm paclobutrazol; flower number of control plants and plants receiving other rates of paclobutrazol was similar to flower number of daminozide-treated plants.

The flower diameter of Alaska decreased from 2.6 inches for the nontreated control to 2.4 inches for plants receiving the highest rate of paclobutrazol; flower diameter of Prize was not affected by paclobutrazol rate. Daminozide reduced flower size of Alaska and Prize to less than that of the control and paclobutrazol-treated plants.

Paclobutrazol rates of 100 and 150 ppm applied 5 1/2 weeks before cooling effectively controlled bypass shoot development and increased flower number of Alaska azalea compared to nontreated control plants, while minimally influencing days-to-flower and flower diameter. Rates of 150 and 200 ppm were most effective in controlling bypass shoots and increasing flower number of Prize, while not reducing flower diameter. Daminozide was less effective than paclobutrazol in controlling bypass shoot development and enhancing flower number. Daminozide also delayed flowering and reduced flower size relative to paclobutrazol and the nontreated control. Paclobutrazol has the potential of becoming the standard growth retardant for florist azaleas due to superior bypass shoot control and enhanced flowering compared to daminozide.

See color plate number 15, page 15.

Winter Protection of Container-Grown Landscape Plants in South Alabama

Gary J. Keever and Gary S. Cobb

PRODUCTION OF woody landscape plants in containers accounts for the majority of nursery crops grown in south Alabama. Historically, if minimal precautions are taken, overwintering of nursery crops has not been a limiting production factor, as it often is with container-grown plants in northern climates. However, the occurrence of severe freezes in the South in recent years has forced growers to reevaluate winter protection strategies. The objective of this study was to compare the efficacy of four rapidly deployable, short-term winter protection practices in minimizing winter injury of several container-grown species produced in south Alabama.

In late March, uniform liners of Japanese holly, dwarf Burford holly, Duc de Rohan azalea, pittosporum, and euonymus were potted in 3-quart black, polyethylene containers using milled pine bark growth medium amended with dolomitic limestone, gypsum, and slow-release fertilizers. Plants were placed outdoors on a white clam shell ground cover in full sun under overhead sprinkler irrigation and maintained according to conventional nursery practices.

In early December, the following winter protection treatments began and continued until the end of January: (1) plants temporarily covered with 6 mil (0.006-inch) white plastic film during freezing temperatures; (2) plants irrigated for 10 minutes on and 50 minutes off until irrigation heads froze, beginning when canopy temperature dropped to 33°F; (3)

plants irrigated continuously during freezing temperatures and subsequent thaw; and (4) plants unprotected. Treatment 2 resulted in the formation of a 1- to 2-inch layer of ice over plants and containers.

Medium and canopy temperatures were monitored during the study with thermocouples placed at a 4-inch depth, 1 inch from the south wall of the pots and in the center of the plant canopy, 4 inches above the medium.

On January 30, following the coldest temperatures of winter, plants were moved into a 60°F heated glass greenhouse. On February 19, foliage and stems were rated for desiccation and cold injury. Bark splitting occurred only on stems of azaleas and was rated at this time.

Minimum ambient air temperature was recorded during January 20 and January 21; low temperature was 3°F. During this period, canopy temperatures within the unprotected (Treatment 4) and thinly iced (Treatment 2) treatments closely followed air temperatures. Minimum growth medium temperatures were 23°F in unprotected containers and 25°F in pots of plants thinly iced (Treatment 2). Canopy temperatures under white plastic (Treatment 1) fluctuated widely (from 14°F to 55°F on January 21), particularly on cloudless days. Growth medium temperatures ranged from 30°F to 45°F during this 2-day period. When plants were continuously irrigated during freezing temperatures and thaw (Treatment 3), neither canopy nor growth medium temperatures dropped below 32°F.

No limb breakage resulted from either icing treatment or from coverage with plastic film. Root injury was least to plants of all species continuously irrigated and to plants covered with white plastic film, the two winter protection treatments in which the highest minimum temperatures were recorded in the growth medium. A thin ice cover provided some protection to the roots of azalea, Japanese holly, and dwarf Burford holly, while root injury to pittosporum and euonymus was similar to injury observed with unprotected plants.

Foliar and stem injury, as indicated by foliar ratings, was most severe to unprotected plants. A thin ice cover reduced the foliar and stem injury to azalea, euonymus, and pittosporum, while a covering of white plastic film or continuous irrigation protected leaves from desiccation and bark from splitting. Foliage of Japanese and dwarf Burford hollies was not injured.

Bark splitting occurred only on Duc de Rohan azalea and was most severe to plants covered with a thin layer of ice. Moderate bark splitting of the main trunk and secondary branches resulted from covering plants with white plastic film, while only slight splitting of the main stem occurred to unprotected plants. Continuous irrigation protected bark of most plants from splitting, although there was splitting of secondary branches on isolated plants.

Continuous irrigation during sub-freezing conditions effectively buffered canopy and growth medium temperatures and protected roots, stems, and foliage of several woody ornamental species when ambient air temperature dropped to 3°F. Protection was derived from the heat of water raising ambient air, foliage, and growth medium temperature, combined with the heat of fusion released during the formation of ice. A white plastic covering protected plant parts of all species except bark of azalea. A thin covering of ice provided little or no protection to euonymus and pittosporum, whereas bark splitting of azalea was more severe than to unprotected plants.

See color plates numbers 16-17, page 15.

Response of Selected Species of Woody Landscape Plants in South Alabama to Altered Photoperiod

Gary J. Keever and Gary S. Cobb

DAYLENGTH IS one of the most important factors influencing the duration of shoot growth and affecting the onset of dormancy in woody plants. Generally, the rate and duration of shoot growth is greater under long day conditions, while short day conditions decrease the rate of growth and hasten the onset of dormancy. By exposing plants to supplemental light, dormancy can be delayed and the growing season extended into the fall, possibly shortening the overall production cycle of woody landscape plants. However, winter injury may be increased if plants are exposed to winter conditions before they become fully dormant. This study was undertaken to determine how several species of temperate trees and shrubs grown as ornamental plants in southern Alabama respond to photoperiod.

Ten species of temperate ornamental trees and shrubs were evaluated for their growth responses to extended (EP) and night interrupted (NI) photoperiods in southern Alabama (zone 9a). Test species included *Abelia* x Edward Goucher (abelia); *Cercis canadensis* (redbud); *Ilex crenata* Compacta (compacta Japanese holly); *Ilex cornuta* Burfordii Nana (dwarf Burford holly); *Ilex vomitoria* Stoke's Dwarf (dwarf yaupon); *Lagerstroemia indica* x *fauriei* Basham's Party Pink (crapemyrtle); *Magnolia grandiflora* (southern magnolia); *Rhododendron austrinum* (Florida azalea); *Rhododendron* x Fashion (Fashion azalea); and *Ternstroemia gymnanthera* (cleyera).

On March 26, 1985, uniform liners of most species were potted in 1-gallon containers; Florida azaleas were potted in 2-gallon containers and Southern magnolia in 3-gallon containers. A 100 percent milled pine bark growth medium was amended with 6 pounds per cubic yard dolomitic limestone, 2 pounds per cubic yard of gypsum, 1.5 pounds per cubic yard of Micromax, and 12 pounds per cubic yard of Osmocote 17-7-12. Plants were placed outdoors in full sun and maintained following standard nursery practices until June 21, 1985, at which time photoperiodic treatments were begun. An extended photoperiod (EP) was provided from 3 a.m. until 2 hours after sunrise and from 2 hours before sunset until 9 p.m. using 100 watt incandescent bulbs 48 inches apart and 48 inches above the plant. A night interrupted photoperiod (NI) was provided between 10 p.m. and midnight (2200-2400 hr). Natural photoperiod (NP) ranged from 14 hours 8 minutes on June 21 to 10 hours 37 minutes on November 15, at which time natural photoperiods were resumed for all plants. In December 1985 and again in June 1986, following the spring growth flush, growth measurements were taken. These measurements included growth indices, heights, calipers, root ratings, and top dry weights in December and in June.

On December 10, 1985, all species receiving EP and NI were actively growing. Abelia was flowering, while recently emerged leaves of crapemyrtle and redbud had been burned during a cool spell in November. Growth indices of Florida and Fashion azaleas, yaupon, compacta holly, southern magnolia, crapemyrtle and redbud were greater for plants grown under EP and NI compared to NP, tables 23 and 24. Plants of Florida azalea and redbud also had significantly greater dry weights under EP and NI. Growth of other species, as indicated by growth indices and dry weight, was similar under the three photoperiodic treatments. Height of both redbud and crapemyrtle was greater with the EP and NI compared to the NP, while southern magnolia showed no photoperiodic effect. Caliper of crapemyrtle was greater with EP than with NI or NP, while caliper of redbud and southern magnolia did not differ among photoperiodic treatments.

Root density ratings of species whose top dry weight was unaffected by photoperiod (abelia, dwarf Burford holly, and cleyera) were higher under NP compared to EP and NI. In contrast, with species whose growth index was increased

TABLE 23. RESPONSE OF SEVEN SPECIES OF WOODY ORNAMENTAL SHRUBS TO THREE PHOTOPERIODS

Species/photoperiod	December, 1985			June, 1986		
	Growth index[1]	Top dry weight	Root rating[2]	Growth index[1]	Root rating[2]	Dead plants
	Cm[4]	*Grams*[5]		*Cm*		*No.*
Abelia						
Natural day length (NP)	70.3	74.4	4.2 a	122.4 a	4.9 a	0
Extended day length (18 hr./day = EP)	73.3	66.1	3.8 b	68.0 b	4.1 b	0
Night interrupted (2200-2400 hr. = NI)	76.5 ns[3]	63.8 ns	3.9 b	77.0 b	4.2 b	0
'Compacta' holly						
Natural day length	39.8 b	63.8	3.8	43.7	4.9	0
Extended day length	47.6 a	78.0	3.8	49.9	4.9	0
Night interrupted	46.3 a	69.3 ns	3.9 ns	48.2 ns	4.9 ns	0
Dwarf Burford holly						
Natural day length	30.9	29.5	3.5 a	42.1	4.2	0
Extended day length	33.8	31.2	3.2 b	43.2	4.1	0
Night interrupted	30.9 ns	22.8 ns	3.2 b	40.5 ns	4.2 ns	0
Yaupon						
Natural day length	31.4 c	27.4	2.7	35.2	4.9	0
Extended day length	37.0 a	31.4	2.6	38.1	4.9	0
Night interrupted	34.1 b	27.7 ns	2.6 ns	35.4 ns	4.8 ns	0
Florida azalea						
Natural day length	38.8 b	52.9 b	2.4	67.6	2.6	0
Extended day length	69.8 a	79.8 a	2.5	55.0	2.3	0
Night interrupted	75.3 a	95.8 a	2.7 ns	62.4 ns	2.6 ns	0
'Fashion' azalea						
Natural day length	42.1 b	67.5	4.6	55.8 a	5.0	0
Extended day length	54.2 a	84.4	4.2	49.6 b	4.8	0
Night interrupted	54.7 a	82.9 ns	4.4 ns	49.1 b	5.0 ns	0
Cleyera						
Natural day length	46.7	63.9	2.8 a	57.0	4.7 a	0
Extended day length	46.1	82.6	2.3 b	50.5	3.8 b	1
Night interrupted	50.3 ns	69.3 ns	2.3 b	47.4 ns	4.0 b	1

[1]Growth index: (height + width + width) ÷ 3.
[2]Root rating: 1 = no roots on rootball surface; 2 = 25% coverage; 3 = 50% coverage; 4 = 75% coverage; 5 = 100% coverage.
[3]Mean separation within columns and species by Duncan's multiple range test, 5% level; ns = not significant.
[4]One inch equals 2.54 cm.
[5]One gram equals 0.04-ounce.

Species/photoperiod	December, 1985					June, 1986			
	Growth index[1]	Top dry weight	Height	Caliper[2]	Root rating[3]	Height	Caliper[2]	Root rating[3]	Dead plants
	Cm	*Grams*	*Cm*	*Cm*		*Cm*	*Cm*		*No.*
Redbud									
Natural daylength	47.9 b[4]	36.6 b	81.5 c	1.2	1.9	120.8	1.7	3.1 a	0
Extended daylength (18 hr./day)	83.1 a	91.3 a	165.3 a	1.4	2.1	107.2	1.7	2.7 b	1
Night interrupted (2200-2400)	69.8 a	86.5 a	111.1 b	1.4 ns	2.2 ns	126.1 ns	1.4 ns	3.3 a	0
Crapemyrtle									
Natural daylength	125.2 b	406.8 b	116.6 b	2.8 b	4.3	157.4	3.0	5.0 a	0
Extended daylength	184.6 a	700.9 a	177.1 a	3.2 a	4.8	157.0	2.9	4.0 b	4
Night interrupted	169.6 a	536.7 ab	167.6 a	2.6 b	4.8 ns	123.4 ns	2.7 ns	3.2 c	2
Southern magnolia									
Natural daylength	72.8 b	268.2	89.1	2.6	4.9	133.9	2.6	4.9 a	0
Extended daylength	91.3 a	370.1	102.6	2.7	4.6	134.6	2.7	4.4 b	0
Night interrupted	90.9 a	307.3 ns	100.1 ns	2.8 ns	4.7 ns	137.8 ns	2.8 ns	4.1 b	0

[1]Growth index: (height + width + width) ÷ 3.
[2]Caliper: taken 5 cm above container medium surface.
[3]Root rating: 1 = no roots on rootball surface; 2 = 25% coverage; 3 = 50% coverage; 4 = 75% coverage; 5 = 100% coverage.
[4]Mean separation within columns and species by Duncan's multiple range test, 5% level; ns = not significant.

with EP and NI (compacta holly, yaupon, Florida and Fashion azaleas, redbud, crapemyrtle, and southern magnolia), root ratings were unaffected by photoperiod.

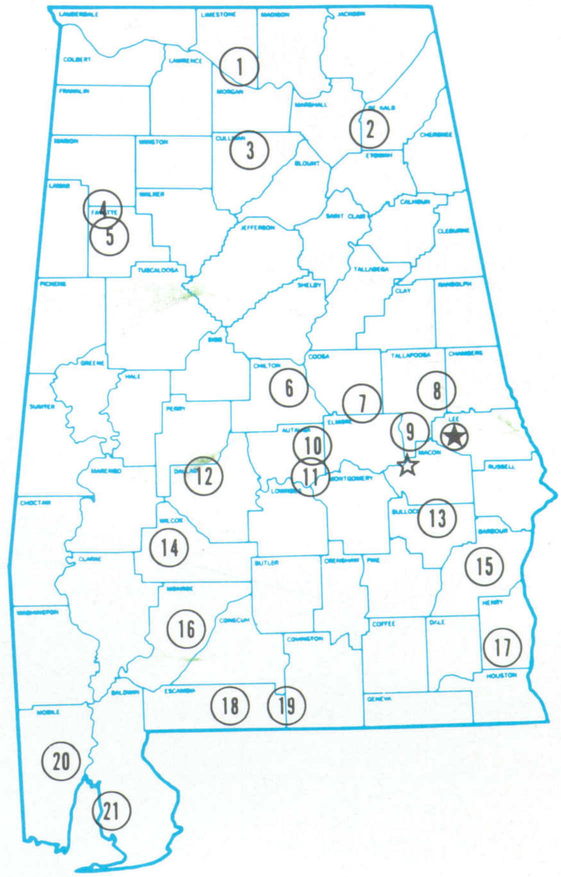
During the winter of 1985-86, subfreezing temperatures were experienced 24 times, beginning on December 3 and ending March 22. The total number of hours below freezing was 206 and the minimum temperature was 3°F. Plants of abelia, Florida and Fashion azaleas, cleyera, and redbud exposed to EP and NI during fall 1985 exhibited extensive twig dieback by June 5, 1986. Shoots of crapemyrtle were either killed to the ground with new growth emerging from the base or the entire plant killed (57 percent mortality under EP, 29 percent under NI). Fourteen percent of cleyera and redbud receiving EP and 14 percent of cleyera under NI were also killed. No injury occurred to plants of the remaining species.

Growth as determined by growth indices, height, caliper, and root rating in June was either greater under NP compared to EP and NI or similar except for caliper growth of crapemyrtle, tables 21 and 22.

Growth of several species of woody ornamentals in southern Alabama was enhanced during the fall by long day conditions. However, the benefits of long day conditions were not present following the spring flush of growth, either because of greater growth in early spring under natural photoperiod or winter injury under extended day or night interruption photoperiods. If photoperiodic manipulations are to be used to increase growth of photoperiodic sensitive woody ornamental crops in southern Alabama, sufficient winter protection must be provided to prevent cold injury to actively growing and non-dormant tissues.

Alabama's Agricultural Experiment Station System
AUBURN UNIVERSITY

With an agricultural research unit in every major soil area, Auburn University serves the needs of field crop, livestock, forestry, and horticultural producers in each region in Alabama. Every citizen of the State has a stake in this research program, since any advantage from new and more economical ways of producing and handling farm products directly benefits the consuming public.



Research Unit Identification

⍟ Main Agricultural Experiment Station, Auburn.
☆ E. V. Smith Research Center, Shorter.

1. Tennessee Valley Substation, Belle Mina.
2. Sand Mountain Substation, Crossville.
3. North Alabama Horticulture Substation, Cullman.
4. Upper Coastal Plain Substation, Winfield.
5. Forestry Unit, Fayette County.
6. Chilton Area Horticulture Substation, Clanton.
7. Forestry Unit, Coosa County.
8. Piedmont Substation, Camp Hill.
9. Plant Breeding Unit, Tallassee.
10. Forestry Unit, Autauga County.
11. Prattville Experiment Field, Prattville.
12. Black Belt Substation, Marion Junction.
13. The Turnipseed-Ikenberry Place, Union Springs.
14. Lower Coastal Plain Substation, Camden.
15. Forestry Unit, Barbour County.
16. Monroeville Experiment Field, Monroeville.
17. Wiregrass Substation, Headland.
18. Brewton Experiment Field, Brewton.
19. Solon Dixon Forestry Education Center, Covington and Escambia counties.
20. Ornamental Horticulture Substation, Spring Hill.
21. Gulf Coast Substation, Fairhope.