RESEARCH REPORT SERIES NO. 3 MAY 1985

RESEARCH REPORT 1985

ORNAMENTALS

ALABAMA AGRICULTURAL EXPERIMENT STATION AUBURN UNIVERSITY
GALE A. BUCHANAN, DIRECTOR AUBURN UNIVERSITY, ALABAMA

FOREWORD

Two years ago the Alabama Agricultural Experiment Station began a new publication series, the Research Report Series, with Volume No. 1 summarizing current research dealing with all phases of ornamental horticulture research by Auburn University. Response from members of the nursery industry indicated that such a summary of available research information would be of value to those involved in producing ornamentals commercially. Furthermore, those responding said they would like to see periodic updates. This publication is our response to that stated interest.

We are pleased to offer this current report, and trust that the information reported will be useful and contribute to the success of individual nursery operations and to the overall ornamentals industry in Alabama.

The team that prepared this publication included faculty and staff of three departments and two outlying units of the Alabama Agricultural Experiment Station (AAES), state staff of the Alabama Cooperative Extension Service (ACES), and former graduate students in horticulture. The contributors are:

Roger D. Anderson, Former Graduate Student in Horticulture

Hoyt E. Burgess, Associate Superintendent, Piedmont Substation, AAES, Camp Hill

Gary S. Cobb, Superintendent, Ornamental Horticulture Substation, AAES, Mobile

Douglas A. Cox, Assistant Professor of Horticulture, AAES

D. Joseph Eakes, Former Graduate Student in Horticulture

Clyde E. Evans, Professor of Agronomy and Soils, AAES

Donna C. Fare, Research Associate of Horticulture, AAES

Charles H. Gilliam, Associate Professor of Horticulture, AAES

Wallace A. Griffey, Superintendent, Piedmont Substation, AAES, Camp Hill

Austin K. Hagan, Plant Pathologist and Nematologist, ACES

Gary J. Keever, Assistant Professor of Horticulture, AAES

Leland W. Lee, Former Graduate Student in Horticulture

Willis C. Martin, Jr., Research Associate of Horticulture, AAES

Lorie E. Merrill, Former Graduate Student in Horticulture

Dean R. Mills, Horticulture Research Specialist, Ornamental Horticulture Substation, AAES, Mobile

Jacqueline M. Mullen, Extension Program Associate-Plant Pathologist, ACES

Harry G. Ponder, Associate Professor of Horticulture, AAES

Kenneth C. Sanderson, Professor of Horticulture, AAES

Ronald L. Shumack, Head, Extension Horticulture, ACES

James C. Stephenson, Assistant Superintendent, Ornamental Horticulture Substation, AAES, Mobile

Linda G. Waterhouse, Former Graduate Student in Horticulture

John C. Williams, Professor of Research Data Analysis, AAES

Gale A. Buchanan
Dean and Director
Alabama Agricultural Experiment Station
Auburn University

CONTENTS

COVER PHOTO. Members of the nursery industry view Alabama Agricultural Experiment Station research during a field day at the Ornamental Horticulture Substation, Mobile.

FIRST PRINTING 5M, MAY 1985

GREENHOUSE CROPS

Fertilizer-Use Efficiency of Several Nitrogen Fertilizers Applied to Potted Geranium

Douglas A. Cox

Nitrogen applied to potted plants is absorbed by the plant, retained by the growing medium, or lost by leaching or as a gas. Quantity of N absorbed by the plant and retained by the growing medium is a measure of fertilizer-use efficiency. Poor efficiency results in waste of fertilizer material. In this study the efficiency of several types of N fertilizer was determined using potted seed geranium, *Pelargonium* x *hortorum* Jackpot.

Fourteen-day-old seedlings were potted in 4-inch standard plastic pots of sphagnum peat moss, pine bark screened to pass a 0.25-inch mesh, and perlite (1:1:2 by volume), amended with 8 pounds single superphosphate, 5 pounds dolomitic limestone, 4 pounds Esmigran, and 2 tablespoons Sequestrene 330 iron chelate per cubic yard. Plants were grown 90 days and received 43, 100-milliliter applications of 200 p.p.m. N solution of ammonium sulfate, ammonium nitrate, calcium nitrate, or urea; 200 p.p.m. K was supplied in each treatment by potassium sulfate. In another treatment, Osmocote 14-14-14 supplied N, P, and K in split application, 3.6 grams per pot incorporated at planting and 2.5 grams per pot topdressed 53 days later. With Osmocote, no superphosphate was incorporated and plants received 43, 100-milliliter applications of water only. The total amount of fertilizer N applied in all treatments equalled 860 milligrams per pot. Analysis of the medium prior to planting showed that pots filled to planting depth contained an average of 264 milligrams of N. Therefore, 1,124 milligrams of N (fertilizer N + medium N) were potentially available to each plant during the experiment.

Leachate samples were analyzed for N at 10-day intervals during the experiment to determine N loss by leaching. At termination, shoot and root dry weights were determined and N analyses were made on plant (shoot and root) and medium samples. Data in table 1 are the percentages of N from fertilizer treatments and medium found in leachate, plant, and medium and N which could not be accounted for by analysis. Unaccounted-for N is assumed to be N lost from the medium as ammonia or other nitrogenous gases.

Ammonium nitrate and calcium nitrate fertilizer treatments resulted in the greatest shoot growth and ammonium sulfate the least, with urea and Osmocote intermediate, table 1. Root growth was reduced by ammonium sulfate compared with the other treatments; differences among the remaining treatments were small. All treatments except ammonium sulfate produced commercially acceptable plants; ammonium sulfate plants flowered 7-10 days later and youngest leaves developed chlorosis. Greatest plant absorption of N occurred with ammonium nitrate, followed by urea and Osmocote, and then by calcium nitrate and ammonium sulfate. Nitrogen lost by leaching was greatest with ammonium sulfate, due to low demand for N and water caused by poor growth, and calcium nitrate, due to the ready leachability of nitrate N. Significantly less N was lost by leaching with ammonium nitrate, urea, and Osmocote. Percentage of N retained in the medium was highest with Osmocote, indicating that some N remained in the fertilizer granules at the end of the experiment. Quantity of unaccounted-for N was greatest with urea and ammonium sulfate; both fertilizers are subject to loss by conversion to ammonia gas. Nearly all N supplied by ammonium nitrate, calcium nitrate, and Osmocote could be accounted for, indicating little N was lost as a gas with these fertilizers.

In summary, N-use efficiency was greatest with ammonium nitrate and Osmocote, with 65 and 64 percent, respectively, of N supplied being absorbed by the plant and retained by the medium. Appreciable amounts of N were lost by leaching in all treatments. With urea, N loss by leaching was significantly less than the other treatments, but this was offset by greater loss of gaseous N. In practical terms, about 5 to 9 ounces out of every pound of N potentially available were lost by leaching. Leaching must occur to prevent accumulation of harmful soluble salts. Results show that N loss by leaching can be reduced by choice of N fertilizer. Other ways of reducing leaching loss include (1) when using water soluble N fertilizers and irrigation, relating N rate to stage of growth and avoiding excessive irrigation early in the crop and (2) with slow-release fertilizers, splitting applications rather than making a single application at planting. Practical methods of controlling gaseous N loss have not been developed.

TABLE 1. GROWTH AND NITROGEN-USE EFFICIENCY OF 4-INCH JACKPOT SEED GERANIUM AS INFLUENCED BY TYPE OF NITROGEN FERTILIZER

Nitrogen fertilizer	Dry weight		N supplied[1]			
	Shoot	Root	Plant[2]	Leachate	Medium	Unaccounted for
	Grams	*Grams*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Ammonium sulfate	7.9c[3]	2.1c	27d	43a	19b	11b
Ammonium nitrate	14.9a	3.5a	47a	32b	18b	3c
Calcium nitrate	14.4a	3.3ab	33c	46a	18b	3c
Urea	13.2b	3.3ab	37b	21b	19b	23a
Osmocote	13.3b	3.0b	38b	30b	26a	6c

[1]Sum of medium N at planting and fertilizer N applied (1,124 mg = 100 percent).
[2]Shoot and root samples combined.
[3]Mean separation within columns by Duncan's multiple range test, 5 percent level; values followed by the same letter are not statistically different.

Comparison of Various Controlled-Release Fertilizers on the Growth of Ficus benjamina

Linda G. Waterhouse, Kenneth C. Sanderson, and John C. Williams

Nutrition has a major influence on growth rate, quality, and longevity of tropical foliage plants. Foliage plant production research indicates that in most situations, no single source or level of fertilization yields the best growth. The most common fertilizers used are water soluble forms; however, slow-release fertilizers are also used. Slow-release fertilizer facilitates larger single applications of fertilizer and reduces luxury consumption of nutrients, fertilizer application frequency, labor, leaching loss, and soil fixation of nutrients. The purpose of this study was to examine the effects of several slow-release fertilizers on the growth and development of *Ficus benjamina*.

Rooted cuttings of *Ficus benjamina* were potted in 6-inch standard pots on April 1. Beginning April 16, the plants were fertilized with Peters 20-20-20 at the rate of 3.4 pounds of N per 100 square feet per year (50 p.p.m. N-P-K applied at rates of 8 ounces every 2 weeks) until the experimental fertilizers were applied August 20.

The slow-release fertilizers used included Scott Pro-Grow 25-10-10, Mag Amp 7-40-6, and Osmocote 14-14-14. Experimental treatments are listed in table 2. The slow-release fertilizers were spread uniformly over the medium surface of the pots. Liquid fertilizer was applied at the rate of 3.4 pounds of N per 100 square feet per year.

TABLE 2. HEIGHT, DRY WEIGHT, VISUAL RATINGS, AND HUNTER COLOR DIFFERENCE VALUES OF *FICUS BENJAMINA* RECEIVING VARIOUS FERTILIZER TREATMENTS

Fertilizer source and formulation	Rate of N/100 sq. ft.	Plant height	Dry weight	Visual rating[1]	Green color[2]
	Lb.	*In.*	*Grams*		
Mag Amp 7-40-6	1.8	18.1	18.5	1.0	-4.1
	2.4	19.8	22.0	1.3	-5.7
Osmocote 14-14-14	1.8	22.3	24.7	2.3	.0
	2.4	22.2	26.1	2.2	3.9
Scott Pro-Grow 25-10-10	1.8	20.6	29.6	2.3	2.9
	2.4	22.0	32.9	2.8	11.9
Peters Liquid 20-20-20	3.4	22.2	28.3	3.3	13.0
Check		16.9	13.8	1.0	-6.2
LSD, 5 percent level		3.6	6.1	.6	8.1

[1]Rating scale: 4 = a dark green color, full spreading habit, and nonspindly growth; 3 = medium to light green color and some spindliness; 2 = light green color and a tall spindly habit; 1 = yellowish green to yellow color, short plants, thin growth, and nonacceptable plants.
[2]Green color determined with a Hunter Color Difference Meter. The greater the value the more intense the green color.

The medium was a 1:1:1 mixture (by volume) of sand, sphagnum peat moss, and pine bark. Added amendments consisted of 0.6 pound dolomite, 0.1 pound Perk (a micronutrient additive), and 2.5 ounces Aquagro (a nonionic wetting agent) per cubic yard. The sand and the peat moss were steam pasteurized before mixing, but the pine bark was not.

Experiments were conducted at Auburn University, Alabama, in a glass greenhouse cooled throughout the summer by evaporative pads. The plants were maintained under natural daylight at approximately 2,000 foot-candles. A randomized complete block design was utilized with six pots per treatment and one plant per pot. Height data were collected at the end of 4 months, with the plant height being measured from the pot rim to the terminal meristem. Two recently mature leaves were taken from each plant for the measurement of green color with a Hunter lab color difference meter.

At the end of the experiment, a visual rating of plant appearance was made using a rating scale ranging from 1 to 4, with 1 indicating a stunted and chlorotic plant and 4 a healthy, dark green plant. After the visual rating, dry weight data were taken.

The highest rates of each of the test fertilizers produced the most desirable plants. Most slow-release fertilizer treatments produced plants comparable in growth to plants receiving liquid fertilizer every 2 weeks. The shortest plants were produced by the check (no fertilizer) treatment, table 2. Other treatments were not significantly different. Unfertilized plants produced the least dry weight, table 2; however, plants receiving Mag Amp at 1.8 pounds of N per 100 square feet per year did not differ from unfertilized plants in dry weight. Scott Pro-Grow applied at 2.4 pounds of N per 100 square feet per year produced plants with the darkest green leaves, whereas Mag Amp-fertilized plants had the poorest leaf color. Plants receiving Mag Amp or no fertilizer received similar visual ratings. Scott Pro-Grow fertilizer at 1.8 and 2.4 pounds of N per 100 square feet resulted in plants similar in appearance to plants fertilized with Peters liquid fertilizer. Dry weight of plants receiving Scott Pro-Grow 25-10-10 at the rate of 2.4 pounds of N per 100 square feet was greater than that of plants receiving Mag Amp and Osmocote at the rate of 1.8 pounds of N per 100 square feet per year. With the exception of Mag Amp, plants receiving 2.4 pounds of N per 100 square feet per year produced similar dry weights.

Results of this study reveal that Osmocote and Scott Pro-Grow controlled-release fertilizers applied at the rate of 2.4 pounds of N per 100 square feet per year were comparable for growth of *Ficus benjamina*. Mag Amp, even at 2.4 pounds of N per 100 square feet per year, produced poor results in this study. Applications of surface broadcast, controlled-release fertilizers produced plant growth equal to that obtained with every-2-week applications of water-soluble liquid fertilizer.

Evaluation of Group IV Snapdragon Cultivars in Central Alabama

Kenneth C. Sanderson and Willis C. Martin, Jr.

Year-round production of snapdragon has been achieved in most major producing areas in the United States. Most of the information on cultivars and scheduling is for production in greenhouses in the Northern United States or cloth houses in Florida. Cultivar information and schedules are lacking for Southern culture. High temperature, high light intensity, and long photoperiods during Southern summers offer a special challenge for snapdragon production. Cultivars have been bred to do best under high temperature, high light intensity, and long days. This research was conducted to evaluate these cultivars (Group IV) under central Alabama conditions.

Seedlings of the various Group IV cultivars were sown under mist propagation on May 15 prior to transplanting on July 1 into a steam-pasteurized 1:1:1 (by volume) soil, peat, perlite medium or peat-lite medium (Jiffy Mix). Winchester, a cultivar usually flowered in the late spring or fall, was also included in this test. Plants were spaced 16 square inches per plant and grown single stem. Seedlings were treated at transplanting with Terrachlor™ at the rate of 8 ounces per 100 gallons to prevent disease. All crops received Borax at the rate of 0.5 ounce per 100 square feet to prevent boron deficiency. Fertilization generally consisted of 213 p.p.m. N-P-K every 2 weeks. Plants were grown in a glasshouse with a minimum night temperature of 62°F. The glasshouses were air cooled with a fan and pad system with a thermostat set at 72°F during experimentation. Plants were grown in light shade (approximately 10 percent). Monthly mean temperature, solar radiation, and daylength for Auburn, Alabama, latitude 32°34' N., longitude 85°31' W., are shown in table 3.

TABLE 3. MONTHLY MEAN TEMPERATURE, SOLAR RADIATION, AND DAYLENGTH, AUBURN, ALABAMA, LATITUDE 32°34' N., LONGITUDE 85°31' W.[1]

Month	Temperature[2] Average daily maximum	Temperature[2] Average daily minimum	Solar radiation[3]	Daylength, sunrise to sunset[4]
	°F	°F	Langleys	Hr:min.
May	84.3	58.5	15911	13:52
June	89.8	65.6	15607	14:13
July	90.9	68.3	14262	14:02
August	90.0	67.7	13650	13:21

[1]Taken from Auburn University Micro Meterological data.
[2]Means for 1941-70.
[3]Mean for 1982.
[4]Mean calculated from monthly range. Sunrise and sunset are considered to occur when the upper edge of the disk of the sun appears to be exactly on the horizon, with normal atmospheric conditions, at zero elevation above the earth's surface in a level region.

Growth data were taken on 20 plants at harvest, i.e. when one-third to one-half of the florets were open. Plants were harvested by cutting stems at the soil line. Data included date of harvest, plant height and weight, spike length, and stem strength, table 4. Stem strength was determined by stripping five plants of all leaves, cutting 20 inches of stem from directly below the last floret, weighing the stripped stem sections, and calculating an index of grams per centimeter. Top grade snapdragons (averaging a 3.2 quality grade out of a possible 4.0) have grams per centimeter ratios ranging from 0.17 to 0.22.

Oklahoma produced the tallest plants of any cultivar tested. Previous tests have shown that 37.8 inches is average for Group IV snapdragon plant height[1]. Winchester, a cultivar generally grown in the spring and fall, was the second tallest cultivar, followed by Miami. Most of the other cultivars were below average in height; Tampa, Houston, and Florida plants were more than a foot shorter than Oklahoma plants.

[1]Kenneth C. Sanderson and Willis C. Martin, Jr. 1978. Evaluation and Scheduling of Snapdragon Cultivars. Ala. Agr. Exp. Sta. Bull. 468.

TABLE 4. EVALUATION OF THE PLANT HEIGHT AND WEIGHT, FLOWER SPIKE LENGTH, STEM STRENGTH, AND FLOWERING TIME OF GROUP IV CULTIVARS OF SNAPDRAGON FLOWERED DURING AUGUST

Cultivar	Plant height	Plant weight	Spike length	Stem strength[1]	Days to flower
	In.	Oz.	In.	Grams/cm	No.
Oklahoma	44.7a[2]	1.5a	9.5a	0.012ab	53a
Winchester	39.4b	1.2bc	7.5b	.011bc	48c
Miami	37.4c	1.5a	7.6b	.0009cd	46d
Mobile	35.2d	1.0d	6.9cd	.011bc	45e
Alabama	35.2d	1.1cd	6.8cd	.014a	52b
Texas	34.3d	.9de	7.2bc	.009bcd	44f
Tampa	31.8e	.8e	6.6d	.007d	45e
Houston	31.7e	1.3ab	7.6b	.008cd	42g
Florida	31.6e	.9de	6.5d	.009bcd	44f

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

Oklahoma and Miami plants weighed more than the other cultivars and were the only cultivars to meet the average Group IV cultivar plant weight. Texas, Tampa, and Florida plants produced the least fresh plant weight.

A flower spike length of 8.1 inches is average for a Group IV cultivar. Oklahoma was the only cultivar in the test to meet this average. Mobile, Alabama, Tampa, and Florida had flower spikes an inch or more shorter than average and almost 2 inches shorter than Oklahoma spikes.

None of the cultivars equalled the average stem strength reading of 0.015 gram per centimeter, however Alabama came close with a rating of 0.014. Oklahoma was statistically similar to Alabama in stem strength.

Oklahoma was the latest-flowering cultivar and Houston was the earliest-flowering cultivar. Considerable variation in flowering time existed among the cultivars.

The research indicates that Oklahoma is a superior Group IV or summer-flowering snapdragon. There is a need for new Group IV cultivars that will grow as well and flower at the same time as Oklahoma.

Chemical Reduction of Induced Petal Abscission in Geraniums

Roger D. Anderson, Kenneth C. Sanderson, and John C. Williams

Loss of flower parts (shattering or abscission) is a serious problem of seedling hybrid geraniums, *Pelargonium* x *hortorum*. Petal abscission in geraniums is usually due to genetics and environmental stress. Cultivars differ in petal insertion and "easy to shatter" geraniums are characterized by a region of structural weakness that is absent or less evident in "difficult to shatter" geraniums. Environmental stress may increase ethylene production which stimulates petal abscission. Inhibitors of ethylene synthesis, such as aminoethoxyvinylglycine (AVG), aminoxyacetic acid (AOA), and silver thiosulfate (STS), might be useful in preventing or at least reducing petal abscission in geraniums. The objective of this work was to investigate the use of these chemicals on petal abscission in geraniums.

Seedling *P.* x *hortorum* Jackpot flowers were harvested from outdoor-grown plants on July 14, 1981. Individual, newly opened florets were selected for uniformity and placed in 0.15-ounce vials filled with one of the following solutions: 0.5, 1.0, or 2.0 millimole (mM = 1/1000 of the molecular weight of the chemical) AVG; 0.1, 0.5, 1.0, or 1.5 mM AOA; and 0.05 percent, 0.1 percent, or 0.5 percent of full strength CT 2000 (a commercial STS formulation for pretreatment of carnations). Deionized water was used in each treatment formulation and also served as the control. Florets were kept in these treatment solutions in a room maintained at 72°F for 12 hours under 40 to 120 foot-candles irradiance. Then, using a Halby Champ mist blower, 2,000 p.p.m. 2-chloroethylphosphonic acid (ethephon) was misted over the top of all florets at a rate of 2.3 ounces per 100 square feet. The number of florets abscised was determined before and after ethephon application. A floret was considered abscised when one or more petals had fallen.

Flowers treated with STS, AOA, and AVG abscised less than the check flowers after ethephon treatment. Differences between treatment concentrations of AOA and AVG were not significant in this experiment. The STS product, CT 2000, was effective at 0.1 percent in reducing petal abcission. Results of the present research agree with recent work by other researchers which reported that STS and AVG were effective in reducing abscission in geraniums. The current research also indicates AOA is effective in reducing petal abscission. AVG has been found to be too expensive to manufacture and will not be available for use as a cut flower preservative. AOA is readily available and relatively inexpensive, however it may be too toxic to humans to be safely used as a floral preservative. STS is currently being used commercially on carnations.

Effect of Fungicides on Rooting of Poinsettia Cuttings

Kenneth C. Sanderson, Willis C. Martin, Jr., and Leland W. Lee

Poinsettia is prone to fungal infections during propagation. Fungicides are frequently added to root-inducing powder or used as drenches to protect poinsettia cuttings from diseases such as *Pythium*, *Rhizopus*, *Rhizoctonia*, and *Thielaviopsis*. Fungicides have been shown to stimulate or inhibit the rooting of cuttings. This study investigated the influence of several fungicides as basal dips and drenches on the rooting of poinsettia cuttings. Two experiments considered fungicides applied to the base of cuttings and one examined fungicide drenches during rooting.

Experiment 1. Cuttings from field-grown stock plants of Annette Hegg were propagated October 1, 1981, in coarse perlite and under mist (3 seconds out of every minute, 8:30 a.m. to 4:30 p.m.) at a minimum night temperature of 70°F and maximum light intensity of about 5,000 foot-candles. The basal end of a 5- to 7-inch cutting was dipped to a depth of 1 inch into a commercial rooting compound (Hormodin No. 3, 0.3 percent indolebutyric acid, IBA) and then into the fungicide treatment (undiluted commercial formulation of the fungicide). All fungicides shown in table 5, except Subdue, were applied in this manner prior to inserting the cutting into the perlite propagation medium. Untreated or check cuttings were treated with Hormodin No. 3 only. Four weeks after propagation (November 12), rooting was evaluated by the following rooting scores: 0 = dead, 1 = no roots or callus, 2 = callused, 3 = light rooting, 4 = medium rooting, and 5 = heavy rooting.

TABLE 5. EFFECT OF FUNGICIDES APPLIED TO THE BASE OF ANNETTE HEGG POINSETTIA CUTTINGS PRIOR TO PROPAGATION UNDER MIST

Fungicide	Experiment 1[1] rooting score[3]	Experiment 2[2]	
		Rooting score	Dry weight
			mg
None, check	3.8a[4]	4.5a	157a
Benlate 50 WP	2.9bc	4.2abc	129abc
Captan 50 WP	3.5ab	Not tested	
Fermate 50 WP	3.6ab	4.4ab	143ab
Lesan 35 WP	1.6d	3.4c	86cdef
Subdue 25 WP	Not tested	4.0a	114abcd
Terrachlor 75 WP	3.7ab	3.9a	100abcde
Truban 30 WP	2.2cd	3.9a	100abcde

[1]Cuttings were dipped into Hormodin No. 3 (3 percent indolebutyric acid) and then dipped into the commercial formulation of the fungicide.
[2]Cuttings were dipped into a 0.1 percent indolebutyric-talc rooting powder containing 5 percent of the commercial formulation of the fungicide by weight.
[3]Rooting scores were: 0 = dead, 1 = no roots or callus, 2 = callused, 3 = light rooting, 4 = medium rooting, and 5 = heavy rooting.
[4]Mean separation within columns by Duncan's multiple range test, 5 percent level; values followed by the same letter are not statistically different.

Three days after treatment, the shoot tip of cuttings receiving Lesan turned black. Cuttings treated with Terrachlor, Fermate, and Captan had rooting scores statistically similar to check cuttings. Benlate, Truban, and Lesan reduced rooting, table 5. Plants treated with Truban or Lesan also showed an increased mortality 4 weeks after propagation, with 16 percent and 24 percent, respectively, dead. Check plants showed 8 percent mortality.

Experiment 2. Fungicides were incorporated at the rate of 5 percent by weight into a 0.1 percent IBA and talc root-inducing compound in an experiment conducted in early September. All fungicides shown in table 5 except Captan were used. The basal 1-inch of Annette Hegg Brilliant cuttings was dipped into the fungicide-rooting powder treatment. A control, 0.1 percent IBA and talc, was included. Propagation and rooting scores procedures were similar to Experiment 1. Root dry weight was measured by severing the roots from the shoot and drying at 122°F for 24 hours prior to weighing. The control and all fungicide treatments, except for Lesan treatment, produced similar rooting scores and root dry weights, table 5. Rooting of Lesan-treated plants was significantly reduced.

Experiment 3. Cuttings of Annette Hegg Topstar and Annette Hegg Lady were treated with 0.1 percent IBA rooting compound prior to placement in 6-inch pots containing perlite. The cuttings were immediately drenched with 6 ounces of a fungicide drench treatment that contained one or two fungicides, table 6. A water drench was used as a control. Root dry weights were recorded 5 weeks after drench treatment.

TABLE 6. DRY WEIGHTS OF POINSETTIA ROOTS TREATED WITH FUNGICIDE DRENCHES PRIOR TO ROOTING

Fungicide	Rate per 100 gal.	Dry weight
	Oz.	mg
Control	—	129a[1]
Benlate 50 WP	8	106a
Captan 50 WP	8	89ab
Subdue 25 WP	1	89ab
Truban 30 WP + Captan 50 WP	4 + 4	88ab
Truban 30 WP + Benlate 50 WP	4 + 4	87ab
Subdue 25 WP + Benlate 50 WP	0.5 + 4	75ab
Truban 30 WP + Terrachlor 75 WP	4 + 4	67ab
Truban 30 WP	8	65ab
Lesan 35 WP + Benlate 50 WP	4 + 4	62ab
Subdue 25 WP + Captan 50 WP	0.5 + 4	60b
Lesan 35 WP + Terrachlor 75 WP	4 + 4	59b
Lesan 35 WP + Captan 50 WP	4 + 4	57b
Subdue 25 WP + Terrachlor 75 WP	0.5 + 4	55b
Lesan 35 WP	8	47b
Terrachlor 75 WP	8	37b

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

Single fungicide drenches of Benlate, Captan, Subdue, and Truban produced root dry weights similar to the control, table 6. Combination drenches of Truban + Captan, Truban + Benlate, Subdue + Benlate, Truban + Terrachlor, and Lesan + Benlate gave root dry weights similar to the control. Root dry weight was reduced where other fungicides or fungicide combinations were used as drenches.

The use of fungicides during propagation is an essential cultural practice in the production of crops such as poinsettia. Results of these tests show that caution must be used when selecting a fungicide since some fungicides may reduce rooting. In all test procedures, Lesan (Experiments 1, 2, and 3) reduced rooting, whereas Fermate (Experiments 1 and 2), Captan (Experiments 1 and 3), and Subdue (Experiments 2 and 3) did not affect root development. Benlate and Truban reduced rooting when used at high concentrations as a dip treatment (Experiment 1). Selecting a fungicide treatment for use during poinsettia propagation requires evaluation of the disease control desired and the fungicide effects on root development.

Tolerance of Four Potted Chrysanthemum Cultivars to Dursban

Kenneth C. Sanderson and Willis C. Martin, Jr.

Agromyzid leafminers are serious and persistent pests on chrysanthemum (*Chrysanthemum morifolium*). Crop quality depends on maintaining low leafminer populations, but most growers find it difficult to achieve satisfactory control of this pest with currently recommended insecticides. Dursban is effective against third stage larvae of *Liriomyza trifolii*, one of the three leafminer species that damage chrysanthemums. However, the safety (phytotoxicity) of Dursban on many chrysanthemum cultivars is not known. The purpose of this study was to examine the safety of Dursban applied as a spray and drench on four potted chrysanthemum cultivars.

Rooted cuttings of the chrysanthemum cultivars Bright Golden Yellow Princess Anne, Loyalty, Spirit, Sunlight, and Yellow Mandalay were planted four cuttings per pot into 6-inch azalea pots on January 29. Two media were used: Promix and 1:1:1 (by volume) soil, sphagnum peat moss, and perlite medium. The soil, sphagnum peat moss, and perlite medium was amended with 6 ounces of dolomitic limestone and 1 ounce of single superphosphate per cubic foot. Plants were pinched 2 weeks after potting. Dursban treatments were applied 4 weeks after planting. Sunlight plants were grown as "spray" types with the center flower bud being removed at disbudding. Lateral buds were removed on the other cultivars. Supplementary incandescent light was provided from 10 p.m. to 2 a.m. each night starting at transplanting and ending at pinching, except Bright Golden Yellow Princess Anne plants received 1 week less lighting. Fertilization consisted of weekly applications of Peters liquid 20-20-20 at the rate of 213 p.p.m. N-P-K. Experimental treatments consisted of Dursban 6E applied at three rates as a drench and one rate as a spray. Application rates were adapted from the manufacturer's recommendation for use of Dursban on turf. DuPont Spreader Sticker was added to the spray at the rate of 1.3 ounces per 100 gallons. Data on date of flowering, plant height, plant spread, and flower number were recorded when two-thirds of the flowers were open.

Visible symptoms of toxicity were observed only on Sunny Mandalay, which developed a temporary chlorosis and small leaves when sprayed with 10 ounces per 100 gallons Dursban sprays. Cultivars flowered in the following order: check (no treatment), 5 ounces per 100 gallons drench, 10 ounces per 100 gallons drench, 20 ounces per 100 gallons drench, and 10 ounces per 100 gallons spray. The effect of Dursban on the height of Loyalty and Spirit was inconsistent, table 7. Differences in plant spread were not significant; however, the 5 ounces per 100 gallons drench usually produced plants with the greatest spread. The number of flowers per plant on Sunny Mandalay plants was reduced by the high rate (20 ounces) Dursban drench treatment, table 7. Media did not interact with Dursban treatment to affect chrysanthemum growth or phytotoxicity (data not shown).

These results show that Dursban drenches can be used safely on certain chrysanthemum cultivars, and this has been confirmed in other tests. A granular formulation of Dursban (Lorsban 15G) has received labeling for broad spectrum soil insect control on agronomic crops and should be tested on chrysanthemums as an alternative method of application.

TABLE 7. THE EFFECT OF DURSBAN APPLICATION TREATMENTS ON THE HEIGHT OF LOYALTY AND SPIRIT AND FLOWER NUMBER OF YELLOW MANDALAY CHRYSANTHEMUMS

Dursban per 100 gallons	Height		Flowers per plant
	Loyalty	Spirit	Sunny Mandalay
	In.	In.	No.
None	12.0ab[1]	8.9b	5.9a
5 oz. drench	12.1ab	10.0a	5.9a
10 oz. drench	12.3a	9.8a	5.5a
20 oz. drench	11.2c	9.5a	4.5b
10 oz. spray	11.4bc	8.8b	5.6a

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

WOODY ORNAMENTALS

Response of Woody Plants to Timing of Supplemental Nitrogen Applications

Gary J. Keever and Gary S. Cobb

Optimum growth of woody plants and efficient use of nitrogen fertilizer depend on the correct timing of fertilizer applications. Many woody plants exhibit cyclic or episodic growth during the growing season, i.e. spring or spring and late summer flushes with little growth during early to midsummer. Previous research by the authors has shown that excellent quality woody plants can be grown when a slow-release fertilizer is used in combination with supplemental liquid N fertilization. This study was initiated to evaluate four supplemental N fertilization schedules (three liquid, one granular) and one incorporated slow-release fertilizer treatment.

Uniform liners of *Ilex crenata* Compacta, *Euonymus japonica* Microphylla, and *Rhododendron* x Hino-crimson were potted in March, 1983, in 1-gallon plastic containers. A milled pine bark medium was amended with 5 pounds dolomitic limestone + 2 pounds superphosphate (0-20-0) + 2 pounds gypsum + 1.5 pounds Micromax + 10 pounds Osmocote 17-7-12 per cubic yard except for one treatment which had a 15-pound rate of Osmocote with no supplemental N. Euonymus and holly were grown in full sun and azalea in 47 percent shade. Supplemental N treatments included six weekly liquid fertilizations in the spring, six weekly liquid fertilizations in the spring plus six in the fall, weekly liquid fertilizations throughout the growing season, and surface applications of granular 12-6-6 (1 teaspoon per pot) spring and fall. Liquid fertilization rate was 300 p.p.m. N from ammonium nitrate.

In fall 1983, plants of all species given supplemental N in spring only were lighter in color compared with other treatments. This suggests plant uptake from the 10 pounds per cubic yards of incorporated Osmocote alone was not sufficient to maintain optimum foliar color throughout the first growing season.

Top dry weight of holly was lowest when supplemental N was applied in spring only; dry weights did not differ among other treatments, table 8. Similar growth of all species when given supplemental N in spring through fall and spring plus fall suggests that supplemental liquid N is more efficiently utilized if applied when plants are actively growing. Growth index was less with spring only supplemental N compared with the granular and the 15-pound Osmocote treatments. With euonymus and azalea, dry weights or growth indices did not differ among treatments (data not shown). Holly is often considered a "heavy feeder," while euonymus and azalea are not. These results suggest supplemental N is needed with heavy feeders when Osmocote 17-7-12 is incorporated at the lower end of the generally accepted range of 10-15 pounds per cubic yard. While the 15-pound Osmocote rate resulted in growth of holly similar to the 10-pound rate plus spring/fall supplements, the use of supplements provides greater control of growth and soluble salts during hot summer weather when the release rate of Osmocote increases with the temperature.

TABLE 8. EFFECTS OF FERTILIZER SCHEDULING ON GROWTH OF *ILEX CRENATA* COMPACTA

Item	Liquid[1]			Granular, spring and fall	Osmocote 17-7-12, 15 lb./yd.[3]
	Spring	Spring and fall	Spring through fall		
Top dry weight (g) . . .	93.4b[2]	121.0a	121.6a	117.2a	119.4a
Growth index[3]	43.3b	47.2ab	47.6ab	49.7a	49.0a

[1]300 p.p.m. N from NH_4NO_3 to supplement Osmocote 17-7-12 (10 pounds per cubic yard).
[2]Mean separation within rows by Duncan's multiple range test, 5 percent level; values followed by the same letter are not statistically different.
[3]Growth index = (height + width + width) ÷ 3.

Comparison of Fertilizer Application Methods for a Single Component Growth Medium

Gary S. Cobb

Blending of media and application of granular fertilizers are two labor-intensive tasks that should be done accurately and consistently. Slow-release fertilizers have reduced the frequency and application costs of primary nutrients, but mixing of multicomponent media and preplant incorporation of primary, secondary, and/or micronutrients is common practice among nurserymen. Most growers blend two or more components (bark, peat, perlite, shavings, etc.) with several fertilizers (N-P-K, dolomitic limestone, micronutrients, gypsum, etc.) to produce their growth media.

Several years of research and limited commercial trials have demonstrated that a milled pine bark (with the appropriate particle size distribution) is a suitable growth medium without additional medium components. Use of a single component growth medium eliminates the need for blending except to add the preplant incorporated fertilizers. If all fertilizers are applied by means other than incorporation, then the labor, equipment costs, and inconsistency associated with blended media would be eliminated. This study was initiated to compare fertilizer application methods for a pine bark growth medium.

Uniform liners of *Ilex crenata* Rotundifolia, *Ligustrum* x *vicaryi*, *Gardenia jasminoides* Radicans, and *Rhododendron* x Amy were potted in 3-quart (trade gallon) containers May 10, 1984, in a 100 percent milled pine bark growth medium. Fertilizers were applied to all treatments and species at a rate equivalent to 6 pounds dolomitic limestone, 2 pounds gypsum, 1.5 pounds Micromax, and 12 pounds Osmocote 17-7-12 per cubic yard. Three fertilizer application methods were compared: preplant incorporation, surface application (topdress), and dibble application (where the fertilizers are

TABLE 9. EFFECTS OF FERTILIZER APPLICATION METHOD ON GROWTH OF FOUR WOODY ORNAMENTALS IN A 100 PERCENT MILLED PINE BARK GROWING MEDIUM

Crop	Fertilization method[1]	Growth index[2]	Shoot dry weight	Root rating[3]
			Grams	
Ilex *crenata* Rotundifolia (Japanese holly)	Incorporated	32.4	17.6ab	3.7
	Surface appl.	30.4	20.6a	4.0
	Dibbled	30.1ns[4]	15.6b	3.7ns
Liqustrum x *vicaryi* (Golden privet)	Incorporated	51.6b	19.0b	4.3b
	Surface appl.	55.0b	23.0ab	4.7ab
	Dibbled	62.2a	26.1a	4.9a
Gardenia jasminoides Radicans (Dwarf gardenia)	Incorporated	54.7a	55.5	5.0
	Surface appl.	51.9b	55.0	5.0
	Dibbled	52.0b	54.6ns	5.0ns
Rhododendron x Amy (Amy azalea)	Incorporated	36.3a	24.7a	3.8a
	Surface appl.	37.4a	29.1a	3.9a
	Dibbled	33.7b	17.4b	2.7b

[1]Equivalent to 12 pounds Osmocote 17-7-12 (18 grams per pot) + 6 pounds dolomitic limestone (9 grams per pot) + 2 pounds gypsum (3 grams per pot) + 1.5 pounds Micromax (2.3 grams per pot) per cubic yard.
[2]Growth index = (height + width + width) ÷ 3, with measurements taken in centimeters.
[3]Root development was rated on a scale of 1 to 5 where 1 = few roots penetrating to the outside of the root ball and 5 = dense coverage of entire root ball.
[4]Mean separation within species and columns by Duncan's multiple range test, 5 percent level; values followed by the same letter are not statistically different. ns = no statistical difference among treatments.

placed directly under the liner). All crops were grown in full sun (except Amy azalea in 47 percent shade); irrigation was applied as needed by overhead impulse sprinklers.

After 5 months, growth index and root rating of holly were similar regardless of application method, but shoot dry weight of surface-fertilized plants was greater than with dibble-fertilized plants, table 9. With ligustrum, growth index was greatest with dibble fertilization. Shoot dry weight and root rating of ligustrum were greater with dibble fertilization than with preplant fertilizer incorporation. Shoot dry weight and root rating of gardenia were similar with all treatments, but growth index of plants fertilized by preplant incorporation was greater than with the other fertilization methods. With Amy azalea, preplant incorporation and surface application of fertilizers resulted in greater growth index, shoot dry weight, and root rating than dibble fertilization.

Although growth response varied somewhat among treatments and species, all crops were produced successfully regardless of fertilizer application method. In general, fast-growing species responded better than slower-growing species to dibble fertilization. This is consistent with previously reported data and probably reflects that the roots of slower-growing plants take longer to penetrate the lower portion of the container where dibble-applied fertilizers are in greatest concentration. Surface application compared favorably to preplant incorporation for all species. These results suggest that fertilization of a single component growth medium (pine bark) can be successfully accomplished with surface application, dibble application (except perhaps with slow-growing crops), or preplant incorporation of the entire fertilizer package. Surface or dibble fertilizer application of a single component medium would eliminate the need and costs of blending fertilizers and media components and ensure amendment uniformity among individual pots. Selection of the appropriate method should be based on costs and adaptability to existing production practices.

See color plates numbers 1-3.

Response of Four Woody Ornamentals to Superphosphate Incorporation and Osmocote Placement

Gary S. Cobb and Clyde E. Evans

In the production of container-grown woody ornamentals, superphosphate is frequently recommended for preplant incorporation into the media. The basis for this recommendation is questionable in view of recent studies showing that phosphorus from incorporated superphosphate leaches readily from pine bark media. Because of phosphate mobility in bark media, placement of a complete fertilizer may be important. This study was initiated to evaluate four woody ornamentals grown with and without preplant incorporation of regular superphosphate (0-20-0). A complete slow-release fertilizer was included and its placement investigated.

Uniform liners of *Cotoneaster rotundifolius, Ilex crenata* Helleri, *Rhododendron* x Hino-crimson, and *Rhododendron* x Delaware Valley White were potted April 15, 1982, into 1-gallon containers using a milled pine bark-sandy loam (7:1, by volume) medium amended with 8 pounds dolomitic limestone, 2 pounds gypsum, and 1.5 pounds Micromax per cubic yard. Fertilizer treatments included preplant incorporation of superphosphate (0 and 2 pounds per cubic yard) factorialized with Osmocote placement (incorporation and surface application, 10 pounds per cubic yard). Cotoneaster and holly were grown in full sun, while azaleas were grown in 47 percent shade. Plants were irrigated as needed by overhead impulse sprinklers.

All species responded similarly, thus only data for Hino-crimson azaleas are presented. After 6 months there was no difference in plant growth (growth index and shoot dry weight); root rating; leaf tissue nitrogen (N), phosphorus (P), and potassium (K); and growing medium N, P, K, and pH for Hino-crimson azaleas grown either with or without preplant incorporation of regular superphosphate (data not shown).

TABLE 10. EFFECT OF OSMOCOTE PLACEMENT ON GROWTH INDEX[1], SHOOT DRY WEIGHT, ROOT RATING, LEAF PRIMARY NUTRIENT LEVELS, AND MEDIUM pH WITH CONTAINER-GROWN HINO-CRIMSON AZALEAS

Item	Osmocote 17-7-12, (10 lb./yd.^{3})	
	Incorporation	Surface application
Growth index	46a[2]	43b
Shoot dry weight (grams)	53a	43b
Root rating[3]	3.1a	1.8b
Leaf tissue		
Pct. N	1.6b	2.0a
Pct. P	.15b	.17a
Pct. K	.61b	.88a
Medium pH	5.6a	5.2b

[1]Growth index = (height + width) ÷ 2, with measurements taken in centimeters.
[2]Mean separation within rows by Duncan's multiple range test, 5 percent level; values followed by the same letter are not statistically different.
[3]Root development was rated on a scale of 1 to 4 where 1 = few roots penetrating to the outside of the root ball and 4 = dense coverage of entire root ball.

Plants fertilized with a surface application of Osmocote initiated a growth flush and became dark green in color quicker than those grown with the fertilizer incorporated. Perhaps liner roots were in closer proximity to surface-applied fertilizer. However, at the end of the growing season, plant growth and root rating were greater when Osmocote was incorporated, table 10. These data and observations suggest fertilizer placement influences nutrient availability. Leaf tissue N, P, and K were higher in plants fertilized with a surface application, possibly reflecting a growth dilution in the larger plants produced with incorporated fertilizer. Medium pH was higher when Osmocote was incorporated.

This study showed no increase in leaf tissue P, shoot growth, or root development when superphosphate was incorporated into the growth medium. While adequate P was provided by fertilization with Osmocote 17-7-12 at 10 pounds per cubic yard, placement influenced plant growth and root development.

Effect of Trickle Irrigation, Nitrogen Rate, and Method of Nitrogen Application on Field-Grown Japanese Holly

D. Joseph Eakes, Charles H. Gilliam, Harry G. Ponder, and Clyde E. Evans

Increased production costs have caused nurserymen to seek more effective production practices. One way to produce higher quality plants in a shorter period is with irrigation. However, irrigation is generally not considered economical or practical for field-grown nursery stock because conventional irrigation practices create heavy demands on available water, and irrigation systems are costly to install and maintain. An alternative is trickle irrigation, which is a more cost-effective method of irrigating field-grown nursery stock.

Trickle irrigation is the daily maintenance of at least 25 percent of a plant's root system under adequate moisture conditions. Trickle uses 60 to 70 percent less water than overhead irrigation because water is applied directly to the root zone. Disease and weed problems are reduced since neither the foliage nor the area between rows and plants is wetted. Research has indicated that restricting water to a specific area directly around the plant produces a more desirable compact, fibrous root system. Other possible advantages of trickle irrigation for nursery producers are extended planting season and the injection of fertilizer, preemergent herbicides, and systemic pesticides reducing labor requirements.

The objectives of this study were to determine the effects of trickle irrigation, four nitrogen (N) rates, and three methods of N application on field-grown Compacta Japanese holly. Growth, foliar nutrient content, livability, and visual ratings were measured.

On April 30, 1982, uniform liners of Compacta Japanese holly were planted in a Marvyn loamy sand soil at Auburn University. Plants were spaced 3 feet within rows and rows were 3 feet apart. Liners were watered at planting, fertilized according to soil test recommendations except for N (120 pounds of N per acre was recommended), and thereafter maintained according to normal nursery practices.

Three methods of applying ammonium nitrate (NH_4NO_3) were evaluated at four N rates each: broadcast, broadcast with trickle irrigation, and injection into the irrigation system. The four N rates used were 30, 60, 120, and 240 pounds per acre split equally among four applications during each growing season. These rates were based on Auburn University's general recommendation of 120 pounds N per acre for field-grown nursery stock.

Trickle irrigation lines of ½-inch inside diameter black plastic pipe were run to two-third of the plants (192) in the study. A Rain Bird J10 pressure-compensating emitter (1 gallon per hour) was installed in the trickle irrigation line at the base of each plant. At the head of half of the irrigation lateral lines, fertilizer was injected by hydraulic displacement of fertilizer from a small plastic container. The fertilizer injection system consisted of a gate valve, two microtubes held in place by brass grommets, and a fertilizer solution container. The gate valve created a pressure differential in the line forcing water into the solution container through a long microtube running from the main line below the gate valve. As water was forced through the tank, fertilizer was displaced by continual dilution of the fertilizer solution in the tank.

Daily rainfall and net evaporation from a class A pan were recorded throughout the 2-year study. Water was applied when net evaporation reached ½ inch or greater at the rate of 50 percent replacement of net evaporation. The system was operated from May to October of each year.

Irrigated vs. Nonirrigated. Holly growth significantly increased with trickle irrigation. Twelve weeks after initiation of the study, irrigated hollies had produced more new growth than nonirrigated hollies. Differences increased throughout the duration of the study. Root and shoot dry weights for irrigated hollies were double those of nonirrigated hollies after each growing season, table 11. The largest root increase for

TABLE 11. EFFECTS OF TRICKLE IRRIGATION AND N RATES ON GROWTH OF COMPACTA JAPANESE HOLLY

Treatment	Growth index[1]		Root dry weight		Shoot dry weight		Livability	
	1982	1983	1982	1983	1982	1983	1982	1983
			Grams	*Grams*	*Grams*	*Grams*	*Pct.*	*Pct.*
Irrigation rate[2]								
0% net evaporation	10.6	26.7	8.4	62.4	14.4	128.6	76.0	55.2
50% net evaporation	15.1	34.0	19.2	126.8	32.2	202.0	100.0	86.6
N rate (lb./acre)								
30	12.7	29.9	13.4	85.2	24.1	155.4	91.6	77.1
60	12.6	32.0	14.8	106.4	22.3	176.7	93.8	72.9
120	13.4	31.9	13.5	96.5	25.6	161.9	83.3	66.7
240	13.9	31.7	13.6	90.5	21.3	167.2	83.3	66.7

[1]Growth index = (height + weight + width) ÷ 3. The initial growth index, taken at planting, was subtracted from subsequent measurements taken in late fall of 1982 and 1983.
[2]All differences significant at 1 percent level. There was no significant effect as a result of N rate or N rate x irrigation rate.

the irrigated hollies over the nonirrigated hollies was inside an 8-inch diameter root ball. Both primary and fibrous roots were increased by trickle irrigation in this 8-inch root ball. Fibrous roots were increased threefold for irrigated hollies over nonirrigated hollies. Trickle-irrigated plants should transplant more successfully due to enhanced root growth, especially of fibrous roots.

Holly survivability increased with trickle irrigation. Irrigated plants had 24 percent greater survivability the first year and 31 percent greater the second year than nonirrigated ones. Nonirrigated holly losses occurred mostly in the winter. A visual inspection in the fall of the first year revealed nonirrigated plants to have more chlorosis and dieback. This indicates that nonirrigated plants were under greater stress entering cold weather.

Method of N Application. Plants receiving surface-applied N had only slightly greater growth than those receiving injected N by the end of the 2-year study. No differences were found in visual rating, dry weights of roots and shoots, livability, and foliar nutrient content with method of N application. However, by injecting the fertilizer, less fertilizer was used because less area was fertilized, and less labor was required. Therefore, injection of N fertilizer is an effective method of fertilizing field-grown nursery stock.

N Rate. Plant N content increased as applied N rate increased regardless of method of application or irrigation rate.

However, N rate had little effect on growth, livability, or visual rating. Nitrogen applied at 60 pounds of N per acre produced as high a quality plant as higher N rates, indicating lower N rates are adequate for production of Japanese holly.

Many practical and economical ideas can be found in these results. Injection of fertilizer into a trickle irrigation system can produce high quality plants while using less water, fertilizer, and labor than conventional field nursery practices.

See color plate number 4.

Container Growth Medium Temperature as Influenced by Moisture Content

Gary J. Keever and Gary S. Cobb

Optimum growth medium temperature for root and shoot growth of many plants is between 68°F and 86°F. Outside this temperature range, plant growth is reduced with plant injury or death often occurring below 23°F or above 104°F. It is not uncommon for temperatures in unprotected containers during the summer and winter months to exceed these extremes. Water for irrigation, whether from ponds, wells, or municipal sources, is generally cooler than air and container medium temperatures during the summer months and warmer during the winter, so its use may lessen temperature extremes in containers. This study was initiated to determine the influence of water in a container medium on medium temperature when air temperature was varied.

Milled pine bark with a bulk density of 0.26 gram per cubic centimeter was divided into four samples using a Humboldt sample splitter. One sample was air-dried at 68°F for 1 week. A second sample was submerged in water under 21 inches mercury vacuum for 72 hours to insure medium saturation and then allowed to drain (sample at container capacity). The two remaining samples were brought to intermediate moisture levels by syringing them with water, mixing, and placing them in sealed containers for 7 days. Moisture content on a volume basis was 2.7 percent for the air-dried sample, 23.2 percent and 35.2 percent for the intermediate samples, and 55.3 percent for the sample maintained at container capacity.

Three 1-quart black plastic pots were filled with pine bark medium at each moisture level, and individually enclosed in plastic bags to prevent desiccation. A thermocouple was inserted through the plastic bag into the center of each pot to a 2-inch depth. Pots were randomized in a freezer, brought to 3.2°F (-16°C), then removed to a 68°F (20°C) environment. Temperature was monitored every 30 minutes until container medium reached ambient air temperature. Pots were again placed in the freezer and temperature monitored until the medium reached 10.4°F (-12°C).

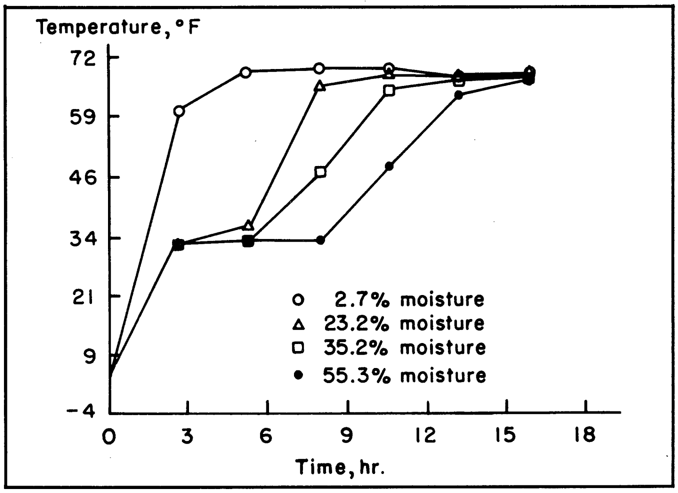


FIG. 1. Temperature versus time for pine bark medium of different moisture content when warmed to 68°F (20°C).

Container medium temperature increased rapidly to about 59°F (15°C) in the air-dried samples and to 32°F (0°C) at the three higher moisture levels, figure 1. As moisture content increased, container medium temperatures remained at the freezing point longer, reflecting the high heat of fusion (80 calories per gram) needed to change ice in the medium to water. Above 32°F (0°C), medium temperature rose slower in samples with higher moisture content. This may be explained by the high specific heat of water (1 calorie per gram), about 5 times as much heat to raise the temperature of a unit volume of water 1.8°F (1°C) as is necessary to raise the temperature of a unit of soil. Because the growth medium samples studied were composed of different ratios of organic components to water, heat capacities would be between those for water and oven-dried medium. Differences among treatments may have been greater if samples had been unsealed, due to a more pronounced evaporative cooling effect at the higher moisture levels. As temperature of all medium groups approached the maximum, the rate of change decreased because of the small temperature differential between medium and ambient air.

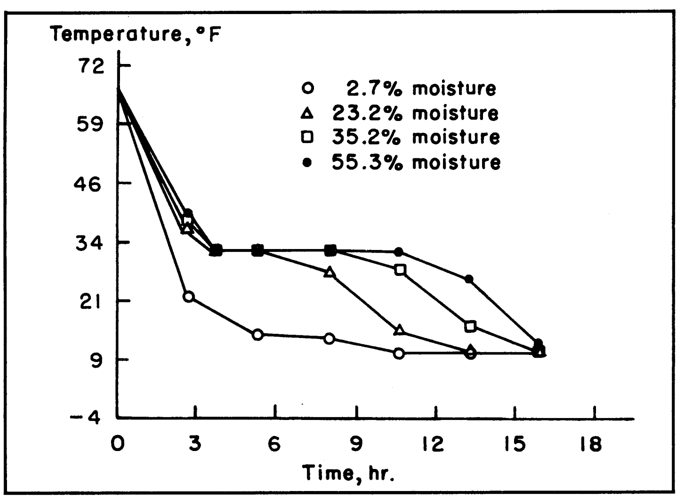


FIG. 2. Temperature versus time for pine bark medium of different moisture content when cooled to 10°F (-12°C).

Similar trends were observed in medium temperature when the four groups were cooled from 68°F (20°C) to 10.4°F (-12°C), figure 2. Air-dried samples dropped rapidly to 21.1°F (-6°C) due to the low moisture content of the medium, and more slowly to 10.4°F (-12°C) due to a small difference in medium and air temperatures. Samples with higher moisture content decreased more slowly to 32°F (0°C), again due to the high specific heat of water. With increasing moisture content, container growth medium remained at the freezing point longer. Due to water's high heat of crystallization (80 calories per gram) that was released when water solidified into ice, the temperature within the container did not fall below the freezing point as long as any unfrozen liquid remained, neither did it rise above the freezing point as long as the medium contained ice.

Knowledge of water's response to changes in ambient temperature is essential in utilizing it to effectively moderate growth medium temperature during container production. Due to water's unique properties, maintaining a high container water content during short periods of temperature extremes reduces growth medium temperature fluctuations and lessens temperature extremes, thus reducing the potential for root injury.

Irrigation Scheduling Effects on Container Temperatures and Plant Growth

Gary J. Keever and Gary S. Cobb

High temperatures within container growth media during the summer months have been shown to reduce root and shoot growth. Cultural practices which reduce high medium temperatures include use of reflective containers, non-reflective bed mulches, overhead shade, and reduced pot spacing. Another cultural practice which may reduce high medium temperatures in containers is irrigation scheduling. The objective of this study was to evaluate the effects of irrigation scheduling and syringing on growth medium temperature and plant growth.

Uniform Hershey's Red azalea liners were potted into 1-gallon containers of amended pine bark. Plants were grown in full sun and irrigated daily as outlined in table 12. All treatments received the equivalent of 0.5 inch of water per acre per day; syringing distributed an additional 0.2 inch of water per acre per day.

Maximum daily growth medium temperatures exceeded maximum air temperature with all irrigation schedules; however, there were differences among treatments, figure 3. Maximum growth medium temperature was lowest (95°F) when daily irrigation was split with 30-minute applications at 10 a.m. and 3 p.m. Maximum growth medium temperatures averaged 96°F with the 1 p.m. irrigation, 102°F with 8 p.m. irrigation, and 103°F with 9 p.m. irrigation + syringing. Growth medium temperatures were depressed for 1 to 3 hours when plants were irrigated during the day. Day irrigations (10 a.m., 1 p.m., and 3 p.m.) depressed maximum canopy temperatures an average of 8°F; the effective depression was for 2 to 3 hours, figure 4. Syringing reduced the max-

TABLE 12. EFFECTS OF IRRIGATION SCHEDULE ON GROWTH INDEX, TOP DRY WEIGHT, RELATIVE ROOT RATING, AND FOLIAR NUTRIENT LEVELS OF *RHODODENDRON* HERSHEY'S RED

Daily irrigation schedule	Growth index[1]	Dry weight	Relative root rating[2]	Leaf tissue N	Leaf tissue P	Leaf tissue K
		Grams		*Pct.*	*Pct.*	*Pct.*
8 p.m., 1 hr.	27.8d[3]	42.5bc	3.2b	1.8	.18	.59
1 p.m., 1 hr.	32.6b	46.7ab	3.8a	1.8	.17	.63
10 a.m. + 3 p.m., 30 min. each	34.2a	48.6a	3.4b	1.5	.20	.50
9 p.m. + 2½ min. hourly syringing, 9 a.m.-5 p.m.	31.1c	41.1c	3.2b	1.4	.17	.46

[1]Growth index = (height + width + width) ÷ 3, with measurements taken in centimeters.
[2]Relative root rating: 1 = poor, 4 = coverage of entire root ball surface.
[3]Mean separation within columns by Duncan's multiple range test, 5 percent level; values followed by the same letter are not statistically different.

imum canopy temperature by 2 to 3°F compared with 8 p.m. irrigation, while air temperature closely paralleled the 8 p.m. treatment.

Shoot growth as indicated by top dry weight and growth index was greatest with split irrigations (10 a.m./3 p.m.), followed by 1 p.m. irrigations, table 12. Top growth was similar with plants irrigated at 8 p.m. and 9 p.m. + hourly syringing. Relative root rating was highest with 1 p.m. irrigation and similar among other irrigation schedules. Foliar N was less with split 10 a.m./3 p.m. and hourly syringing treatments, which may indicate a growth dilution effect with split applications or greater foliar nutrient leaching with both treatments.

Reduced maximum growth medium and canopy temperatures, reduced duration of high temperature, and increased top and root growth support the utilization of day irrigation. Hourly syringing offered no benefit except a slight cooling of the canopy.

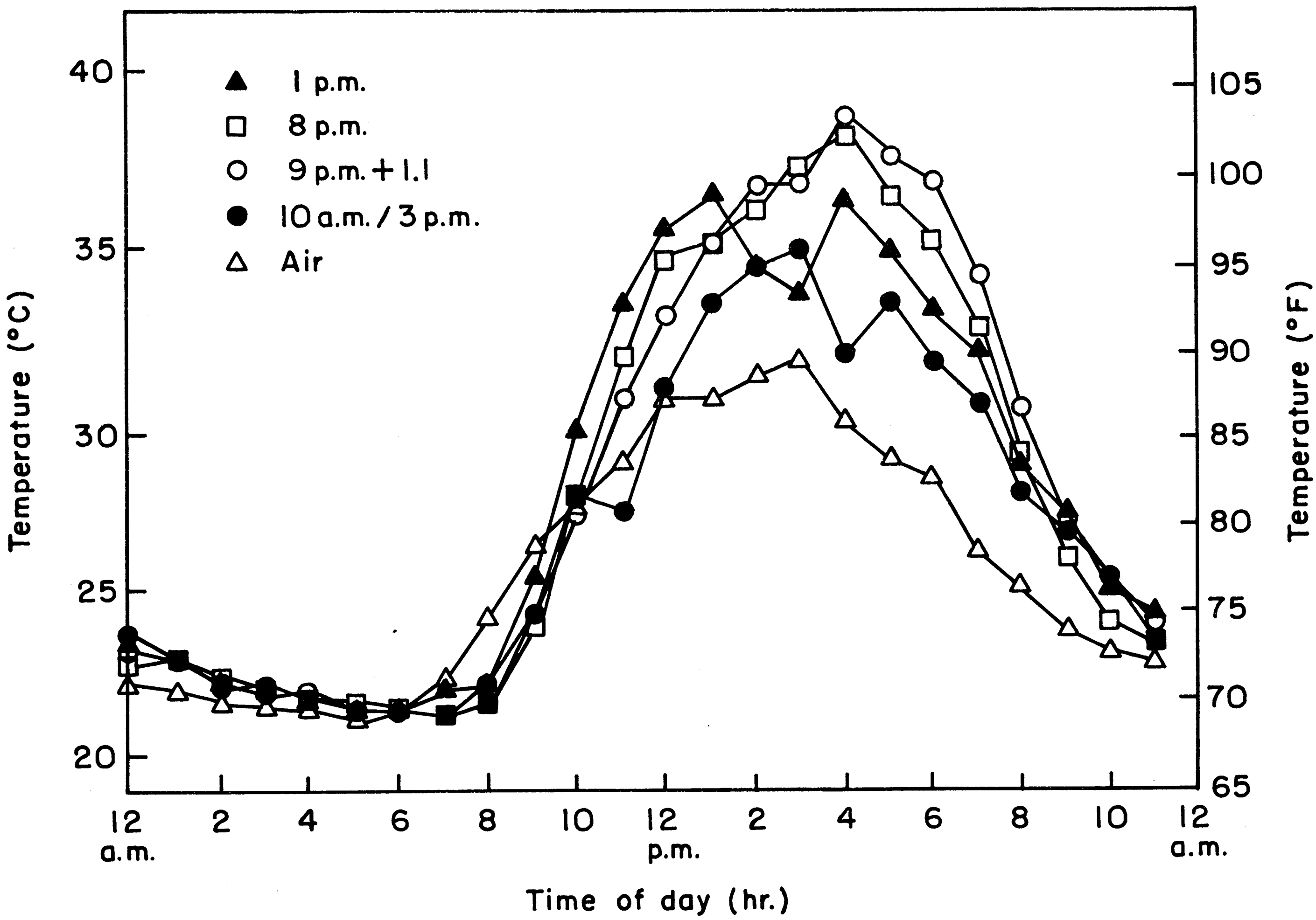
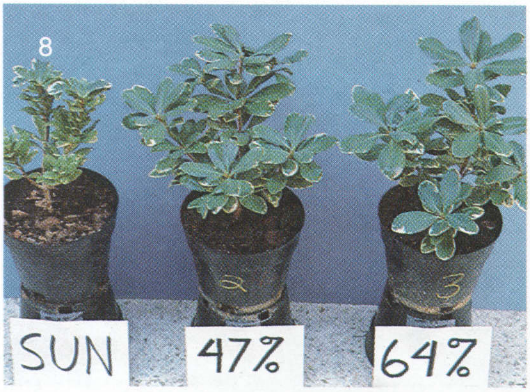
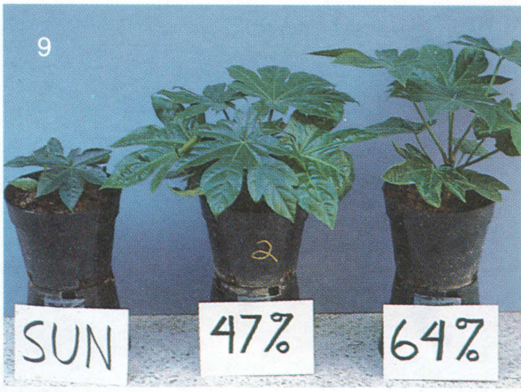


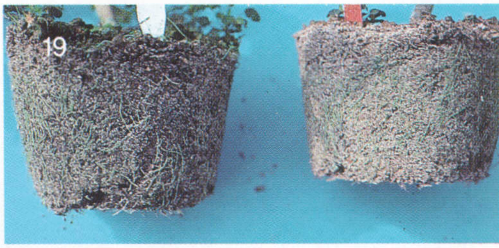
FIG. 3. Growth medium temperature patterns within a black pot on a white mulch, as influenced by irrigation schedule. Values are the means of 5 clear days in August 1984.

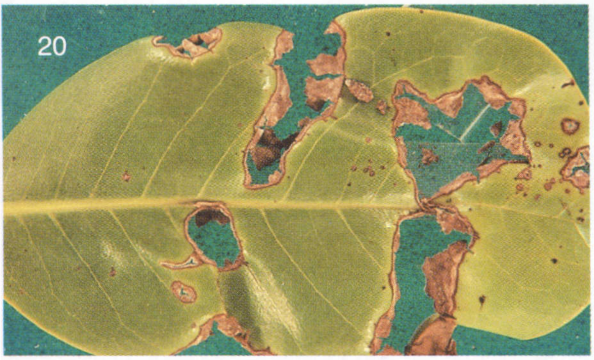
(1) Plants with fertilizer incorporated (left), surface applied (middle), and dibbled (right). (2) Dibbling. (3) Dibbled fertilizer. (4) Irrigated Japanese holly. (5) Effects of severe shoot pruning (left) in comparison with no shoot pruning (right). (6) Hershey's Red azalea grown in 3-inch deep x (l. to r.) 8-inch, 6-inch, and 4-inch wide pots. (7) Microphylla euonymus grown in 12-inch deep x (l. to r.) 8-inch, 6-inch, and 4-inch wide pots. (8) Variegated pittosporum and (9) fatsia following 3 months in an interior environment under three production light levels. *Cornus florida* cultivars: (10) Bay Beauty, (11) First Lady, and (12) Catawba. (13) Regal Red crapemyrtle.

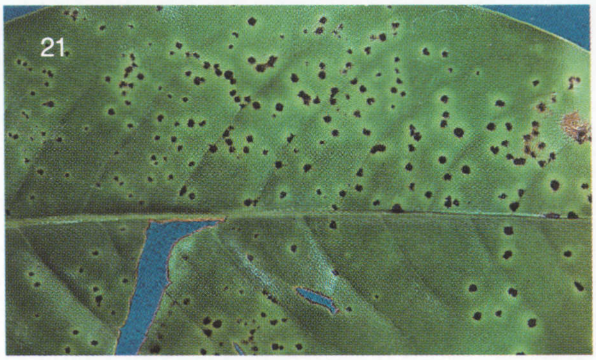




(14) Symptoms of Entomosporium leaf spot on photinia. (15) Symptoms of anthracnose on euonymus. (16) Control of black spot on roses with weekly applications of Daconil 2787 compared with (17) unsprayed plants. Symptoms of Thielaviopsis on (18) Nellie R. Stevens holly and (19) Japanese holly. (20) Pseudomonas leaf spot and (21) bacterial leaf spot on southern magnolia. (22) Heavy residue accumulation of Vendex on V-14 Glory poinsettia. (23) Diazinon Ag 500 phytotoxicity on foliage of V-14 Glory poinsettia. (24) Ornalin phytotoxicity on foliage of V-14 Glory poinsettia. (25) Daconil 2787 Flowable phytotoxicity on bracts and residue on foliage of V-14 Glory poinsettia.







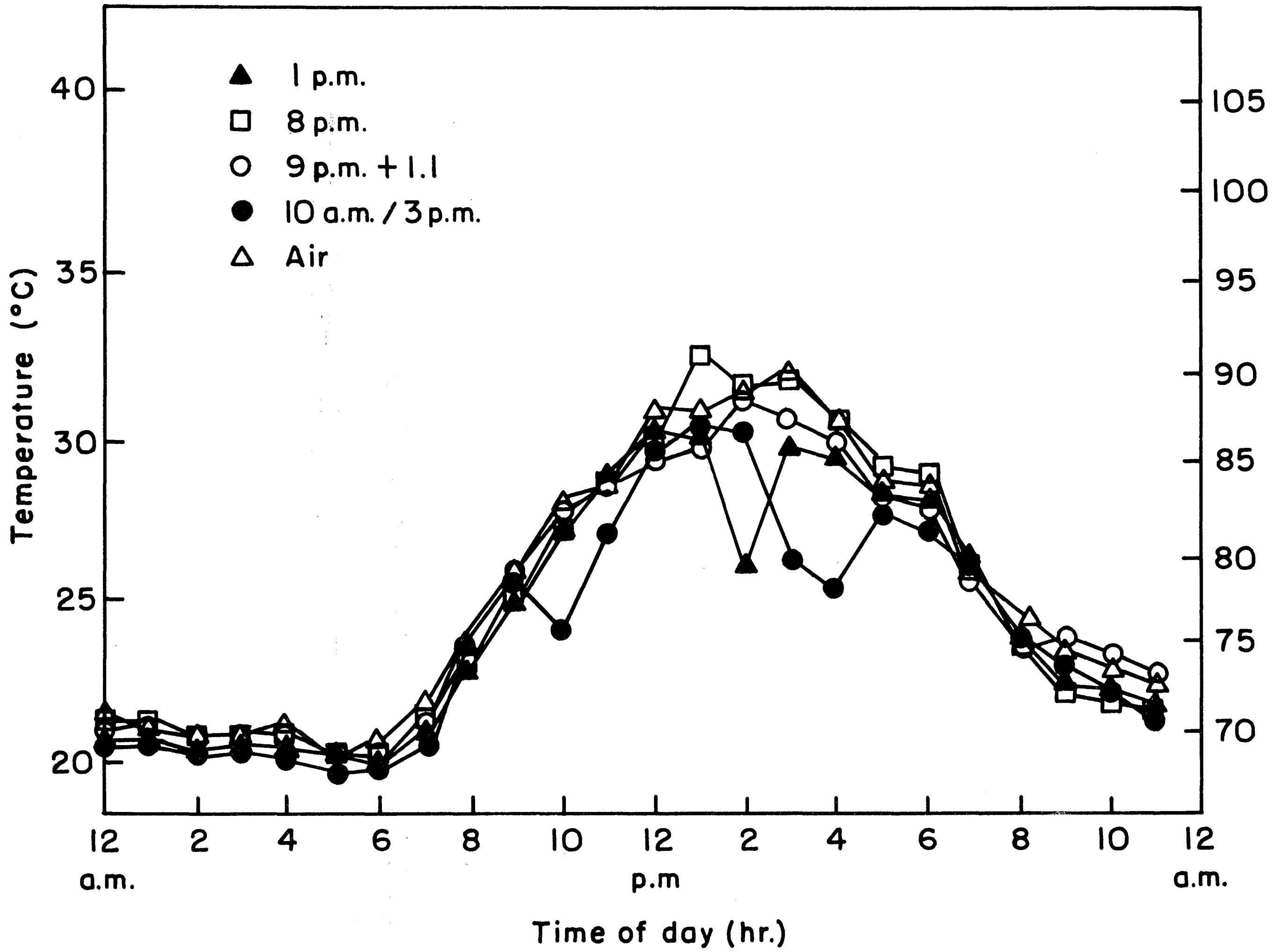


FIG. 4. Canopy temperature patterns within a black pot on a white mulch, as influenced by irrigation schedule. Values are the means of 5 clear days in August 1984.

Effects of Pruning on Root and Shoot Growth of Ornamentals

Charles H. Gilliam and Gary S. Cobb

In commercial nurseries, an accepted practice is to produce rooted cuttings (liners) during the spring and summer, and then to pot them into larger containers the following year. Stepping-up into larger containers begins during spring and continues throughout the summer. Most of the stepping-up into larger containers occurs in late spring and summer due to the time requirements associated with shipping orders during early spring. Liners held in small pots become leggy and at potting are normally pruned severely to develop a compact plant. While the obvious effects of severe shoot pruning (numerous new shoots producing a compact plant) are known, information on the effects of severe shoot pruning on root growth are limited.

Uniform liners of *Ilex crenata* Compacta in 2-inch pots were transplanted to PVC containers 6 inches in diameter x 12 inches deep with a window cut from one side 4 inches across and 8 inches tall. The window was covered with clear acetate which lined the containers so that roots could be observed periodically.

On September 28, 1983, when the plants were potted, three treatments were initiated: no pruning, severe pruning (50 percent of growth removed), and tip pruning (1-2 inches of terminal shoots removed). One and 2 months later, root and shoot numbers were counted. At the second sample date, dry weight was taken on new shoots and total shoots, and fresh root weight was measured. Weekly data were taken on cumulative root and shoot length by marking three roots and three shoots per plant and measuring the length.

Shoot pruning at potting reduced root growth 1 and 2 months after potting. Nonpruned plants had 93 and 40 percent greater root numbers 1 month after potting than severely pruned and tip pruned plants, table 13. Two months after potting, tip pruning did not reduce the number of roots or fresh root weight. However, removal of terminal tips did reduce cumulative root growth throughout the study, table 14. Nonpruned plants had 60 and 88 percent greater cumulative root length than tipped and severely pruned plants, 6 weeks after

TABLE 13. EFFECTS OF PRUNING ON GROWTH OF JAPANESE HOLLY 1 AND 2 MONTHS AFTER PRUNING[1]

Treatment	October 28, 1983		November 28, 1983		Dry weight		Fresh weight new roots
	Roots	New shoots	Roots	New shoots	New shoot	Total shoot	
	No.	*No.*	*No.*	*No.*	*Grams*	*Grams*	*Grams*
Nonpruned	14.3a	17.6c	23.5a	25.0b	3.2a	11.6a	8.1a
Severely pruned	1.0b	41.2a	8.8b	41.2a	4.0a	8.7b	3.8b
Tip pruned	8.6ab	28.6b	21.1a	32.2b	3.6a	11.3a	5.8ab
Control vs. pruned[2]	*	**	*	**	ns	*	**
Severely pruned vs. tip pruned[2]	*	**	**	*	ns	**	*

[1]Plants were pruned at potting on September 28, 1983.
[2]Nonsignificant (ns) or significant at 5 percent (*) or 1 percent (**) level.

TABLE 14. EFFECTS OF PRUNING ON SHOOT AND ROOT GROWTH OF JAPANESE HOLLY[1]

Treatment	Cumulative root length			Cumulative shoot length		
	11-10-83	11-17-83	11-24-83	11-10-83	11-17-83	11-24-83
	In.	*In.*	*In.*	*In.*	*In.*	*In.*
Nonpruned	8.0a	11.1a	15.2a	13.6a	17.7a	23.7a
Severely pruned	.9c	1.9c	6.2b	5.6b	5.8b	5.9c
Tip pruned	3.1b	4.9b	8.0b	12.5a	14.9a	17.6b
Control vs. pruning[2]	**	**	**	**	**	**
Severely pruned vs. tip pruned[2]	*	*	ns	**	**	**

[1]Plants were pruned at potting on September 28, 1983.
[2]Nonsignificant (ns) or significant at 5 percent (*) or 1 percent (**) level.

potting. Initially, tip pruned plants had greater root length than severely pruned plants; however, by November 24 root length was similar between severely pruned and tip pruned plants. Nonpruned plants had greater root length than pruned plants, 2 months after potting. Shoot pruning also affected shoot growth. Shoot numbers were increased by severe shoot pruning, table 13. Tip pruning resulted in increased shoot numbers compared to nonpruned plants. Cumulative shoot length was also affected by pruning in that nonpruned and tip pruned plants generally had greater shoot length than severely pruned plants, table 14. However, when dry weight of new shoot growth was measured 2 months after potting, growth was similar among treatments, table 13.

These data show that shoot pruning increases shoot numbers and results in suppressed cumulative shoot length, producing the desired effect of a compact plant. However, when plants are pruned at potting during the summer months, root growth is suppressed during the first 2 months. Furthermore, severely pruned plants tend to have a growth flush during which new shoots emerge simultaneously, as evidenced by 41.2 new shoots 1 month after pruning and no additional new shoots 2 months after pruning, table 13. Consequently, suppressed root growth coupled with a vigorous growth flush during a time of the year when environmental conditions are conducive to water stress may adversely affect plant development. These data suggest that shoot pruning be omitted at potting in commercial production or at planting by homeowners. This delay will allow roots to become established before pruning which will initiate a vigorous growth flush. The data also indicate that a light tip pruning would have less impact on root establishment than severe pruning.

See color plate number 5.

Effects of Container Dimension and Volume on Growth of Three Woody Ornamentals

Gary J. Keever and Gary S. Cobb

Distribution of roots in the soil is determined by both genetic and environmental factors; however, due to restrictive container walls, limited growth medium, and high water-holding capacity of the media, root growth in containers differs from the field. Studies of seedling trees have shown a significant influence of container volume and shape on plant growth, with larger containers and those with a relatively low diameter/depth ratio generally producing larger seedlings. Numerous woody ornamental species are grown in nursery containers with a typical diameter/depth ratio of approximately 1:1. Matching the container dimensions to the natural shape of the root distribution may contribute to stimulating both canopy and root growth. This study was initiated to investigate the influence of container width, depth, and volume on root and shoot growth of three woody ornamentals having different root growth characteristics. Plants included *Rhododendron* x Hershey's Red (fibrous and shallow root system), *Ilex cornuta* Burfordii Nana (coarse with both lateral and deep roots), and *Euonymus japonica* Microphylla (medium fine and extensive root system).

Uniform liners of each species were potted May 31, 1983, in an amended peat-perlite (1:1, volume basis) growth medium. Containers were made from white PVC pipe in all combinations of three diameters, 4, 6, and 8 inches and three depths, 3, 6, and 12 inches. Plants were placed on raised,

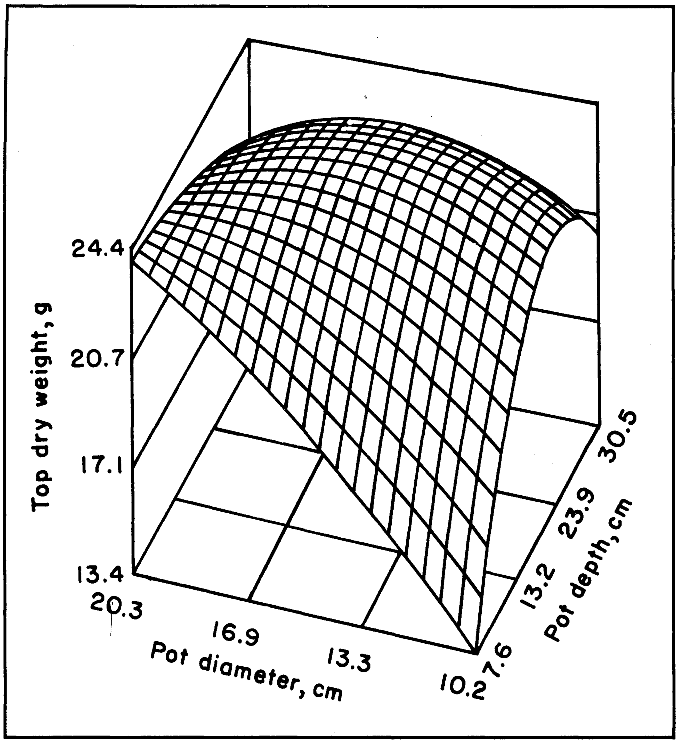


FIG. 5. Top dry weight for Burford holly grown in pots of three diameters and three depths (diameter x depth sign).

wire benches in a double polyethylene greenhouse and elevated to an equal pot height. Root and shoot growth were determined in January 1984.

Top dry weight of Burford holly increased as both pot diameter and depth were increased, figure 5. The greatest response to pot diameter occurred at the shallower depths and to pot depth at the smaller diameters. In the wider or deeper pots, increasing pot depth or diameter, respectively, had minimal influence on top dry weight. Relative root density of holly increased as pot depth increased except for a tapering off of root density in the wider and deeper pots. Roots reached the bottoms of pots of all depths. Root density was highest in the lower half of containers, reflecting the relatively deep rooting habit of Burford holly.

Top dry weight of euonymus increased linearly in response to both increased pot diameter and pot depth, figure 6, with a greater response from increased diameter. Relative root density of euonymus was greatest in the narrow, shallow pots and decreased as pot depth and diameter increased.

Top dry weight of azalea increased linearly in response to increased pot diameter while pot depth had no effect on dry weight, figure 7. Relative root density of azalea, like euonymus, was greatest in the narrow, shallow pot and decreased as pot depth increased. This root growth pattern contrasts with that observed with Burford holly and reflects the shal-

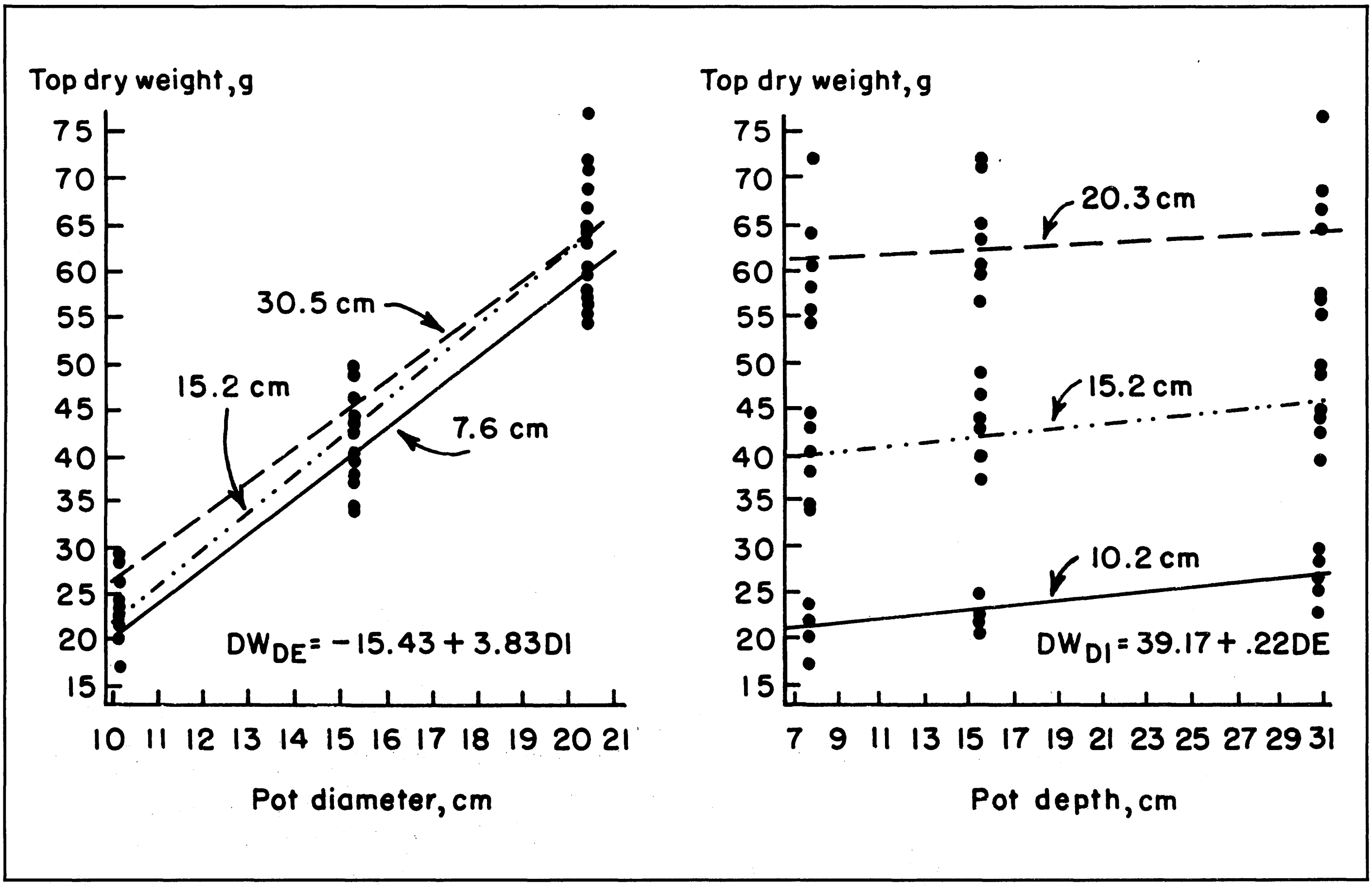


FIG. 6. Top dry weight for euonymus grown in pots of three depths as influenced by pot diameter and grown in pots of three diameters as influenced by pot depth. Equations are for the common regression.

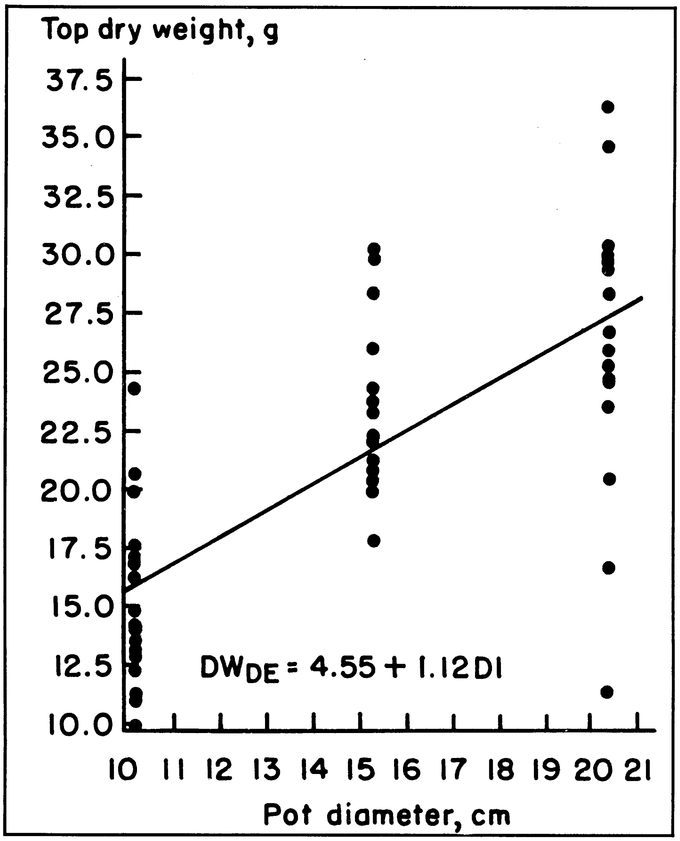


FIG. 7. Top dry weight for azalea grown in pots of three depths as influenced by pot diameter.

low, natural root distribution of azalea. Root density also decreased as pot diameter increased although the response was less rapid than to pot depth. Roots of azalea did not reach bottoms of all pots. Although additional volume of growth medium in wider and deeper pots must be considered a major contributor to plant response, these results suggest it is beneficial to grow shallow-rooted species in shallow, broad containers and deep-rooted species in pots deeper than standard nursery pots.

See color plates numbers 6 and 7.

Woody Plants for Interior Environments

Gary J. Keever and Gary S. Cobb

Most plants used in interior environments are tropical or semi-tropical in nature, adapting well to conditions of relatively low light, warm temperatures, and low humidity. Many temperate zone woody plants prefer or will tolerate low light conditions in the exterior landscape and may provide an additional source of plant material for the interior environment if properly acclimatized. The purpose of this study was to evaluate for interior use selected temperate woody ornamentals, grown under three production light levels.

Thirty uniform 3-inch liners each of *Fatsia japonica* (fatsia), *Gardenia jasminoides* Radicans (dwarf gardenia), *Pittosporum tobira* Variegata (variegated pittosporum), *Podocarpus macrophyllus* Maki (Japanese yew), *Ternstroemia gymnanthera* (cleyera), and *Trachelospermum asiaticum* (Asiatic jasmine) were potted July 22, 1983, in amended milled pine bark-sandy loam (10:1, volume basis) in 6-inch pots. Plants were divided into three groups of 10 single-plant replicates of each species and grown outdoors under the following light intensities: (1) full sun; (2) 47 percent shade; and (3) 64 percent shade. On October 23, plants were transferred to an interior environment (11.2 uEsec^{-1}m^{-2}, 70°F ± 2°, 80 percent relative humidity) and, over the following 3 months, were evaluated periodically for sustained quality and growth.

Plant size (growth index = height + width + width ÷ 3) and leaf size (leaf index = length + width ÷ 2) of fatsia, gardenia, and pittosporum were greater for plants grown in shade compared with those grown in full sun at the end of both the production cycle and the interior evaluation period, table 15. There was no difference in plant or leaf size of Japanese yew or Asiatic jasmine, regardless of production light intensity. With cleyera produced in 64 percent shade, plant size was larger at the end of the interior period compared with those produced in full sun. Leaf drop, an important criterion for interior plant selection, was least with shade-grown pittosporum, gardenia, and Asiatic jasmine produced in 64 percent shade. With other species, leaf drop did not vary with production light levels. At the end of the interior period, plant quality was greatest for shade-grown fatsia, gardenia, pittosporum, and Asiatic jasmine. Cleyera grown in 64 percent shade were superior to those produced in 47 percent shade or full sun. However, with Japanese yew, production light levels did not affect plant quality. Foliar color was best for shade-grown gardenia, pittosporum, and Asiatic jasmine, but was similar for other species at all production light intensities.

Following the final data collection in January 1984, plants were maintained in the interior environment until June. Plants were fertilized every 8 weeks with 100 p.p.m. nitrogen from 20-20-20 soluble fertilizer. All plants initiated new growth during this 5-month period.

The increased use of interior landscapes has created a market with the need and potential for new crop selections. With the exception of fatsia, the other species evaluated in this study have received limited or no consideration as potential interior plants. All species evaluated, with the possible exception of Asiatic jasmine, responded well when placed in the interior environment. Shade production generally resulted in highest plant quality.

See color plates numbers 8 and 9.

TABLE 15. RESPONSE OF SIX WOODY ORNAMENTALS, GROWN AT THREE LIGHT LEVELS, TO AN INTERIOR ENVIRONMENT

Cultivar and production light level	Growth index[1]		Leaf index[2]	Leaf drop[3]	Quality rating[4]	Color rating[5]
	Post-production	Post-interior				
	cm	*cm*				
Fatsia						
Full sun	12.7b[6]	15.9c	12.4b	0.7	1.7b	3.8
47% shade	28.6a	32.1b	22.8a	.0	4.2a	3.2
64% shade	31.4a	36.6a	24.8a	.3ns	4.1a	3.2ns
Dwarf gardenia						
Full sun	22.3b	22.6b	3.1b	77.3a	1.5c	1.5b
47% shade	28.0a	28.5a	3.4ab	38.8b	4.1a	3.7a
64% shade	28.6a	28.6a	3.7a	43.8b	3.6b	3.9a
Variegated pittosporum						
Full sun	17.4b	17.0b	3.3b	9.5a	1.5b	1.5b
47% shade	22.2a	22.6a	4.6a	3.3b	3.5a	3.6a
64% shade	23.7a	24.6a	4.8a	2.7b	3.3a	3.8a
Japanese yew						
Full sun	25.9	26.1	5.8	11.3	3.5	5.0
47% shade	27.5	27.2	6.0	7.5	3.6	5.0
64% shade	30.0ns	28.3ns	6.0ns	11.8ns	3.3ns	5.0
Cleyera						
Full sun	16.0	15.7b	3.5	6.0	1.3b	2.7
47% shade	16.2	18.2ab	3.9	6.0	1.6b	3.8
64% shade	17.1ns	19.0a	3.8ns	7.5ns	2.4a	3.9ns
Asiatic jasmine						
Full sun	18.9	18.7	2.3b	54.8a	1.4b	1.7b
47% shade	18.9	19.5	2.6a	48.0a	2.9a	4.8a
64% shade	21.3ns	17.4ns	2.7a	33.0b	2.8a	4.7a

[1]Growth index: (height + width + width) ÷ 3.
[2]Leaf index: (leaf length + width) ÷ 2.
[3]Leaf drop: total number of leaves dropped October 1983 to January 1984.
[4]Quality rating: 1 = poor, not salable; 3 = good, salable; 5 = excellent quality.
[5]Color rating: 1 = light green; 3 = medium green; 5 = dark green.
[6]Mean separation within columns and species by Duncan's multiple range test, 5 percent level; values followed by the same letter are not statistically different. ns = no statistical difference among treatments.

Promising Trees for the Southeast

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

The need for a comprehensive evaluation of traditional and new introductions of shade and ornamental trees has long been recognized by horticulturists, nurserymen, and landscape designers. Although most introductions are evaluated by the producer or in arboretums, little effort has been made in the Southeast to develop a comparative evaluation in a single location. Increased emphasis on tree plantings in cities, residential districts, and along streets and highways has accelerated the selection and introduction of new species and cultivars for use in these landscape areas. Limited data have led to the selection of some trees that are poorly suited to many sites, resulting in high maintenance and removal costs.

A project to evaluate the characteristics and adaptability of species and cultivars of shade and ornamental trees is in its fourth year, and has about 225 species or cultivars of trees. Trees are being evaluated on their growth rate, fruiting and flowering characteristics, and adaptability to the Southeast.

Trees were first planted in December 1980, as 1-year-old plants at the Piedmont Substation, Camp Hill, Alabama. This report presents information on promising cultivars of two of the Southeast's most common species, flowering dogwood and crapemyrtle. Each year additional selections have been added to the test.

Cornus florida, a native dogwood of the Eastern United States, has been planted extensively as an understory tree in many landscapes. It is used as both a specimen tree and in groupings. Flowering dogwood has a four season landscape value. In spring it is the white flowers (bracts); during summer and fall the leaf and fruit color; and in winter the sympodial branching habit and bark. True flowers are greenish yellow and unimportant as a landscape feature. The showy parts of the inflorescence are the bracts, which are obovate or emarginate and appear from April to May.

Many cultivars of *C. florida* are available in the nursery trade that have white, pink, or red flowers. Only those included in the test planting are described. Barton White blooms when young, and has large white bracts. During the fourth growing season of our study, there was some sporadic blooming of Barton White, followed by profuse blooming during early April of the fifth year. Bay Beauty, a double white-flowering cultivar, has bloomed prolifically during the third, fourth, and fifth growing seasons, usually peaking during early April. Cloud Nine has bloomed only sporadically during mid-April in the fourth and fifth years. Cherokee

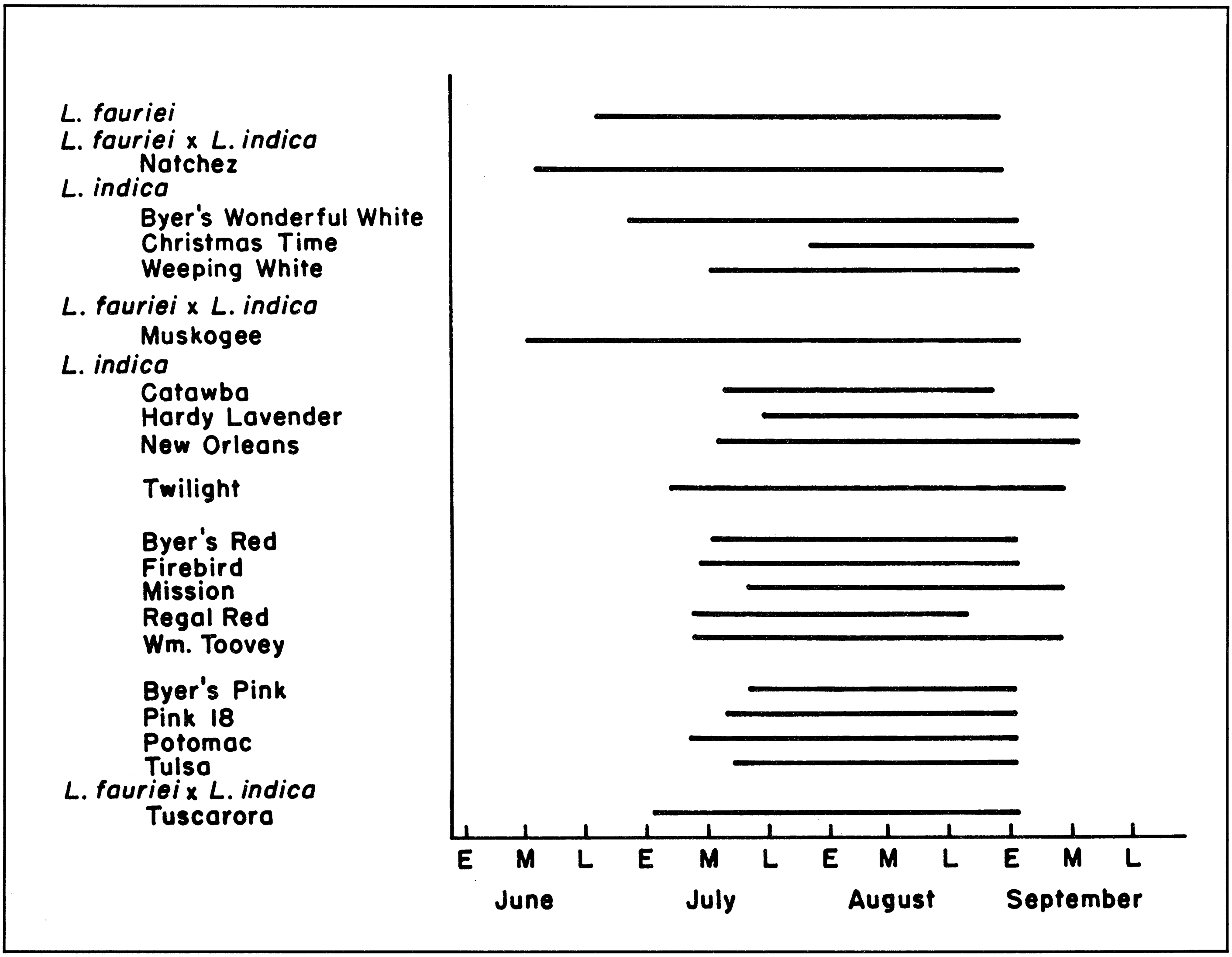


FIG. 8. Flowering duration of *Lagerstroemia* species and cultivars.

Princess, known to be a heavy bloomer with large white bracts, is in its fifth growing season and has not flowered. First Lady, a white-flowering dogwood with variegated leaves of yellow and green, has also not flowered during 5 years in the study. Springtime bloomed during early April of the fifth growing season, producing large white bracts up to 4 inches in diameter.

Cherokee Chief, Pink, Purple Glory, Reddy Red, Rubra, Sweetwater Red, and Welsh's Jr. Miss are the red-flowering dogwoods in the study. Welsh's Jr. Miss and Reddy Red had a few sporadic blooms during April of the fourth year. During the fifth growing season, all of the red-flowering cultivars bloomed, but only sporadically.

Bay Beauty, Springtime, and Welsh's Jr. Miss are the fastest growing dogwoods, averaging about 20 inches in height each year. Cloud Nine and First Lady are averaging only a 10-inch increase in height annually and all other cultivars are averaging 15 inches.

Another interesting native *Cornus* species is *C. stolonifera*, commonly known as American dogwood. This species has been trained into a single trunk tree in this study and has bloomed profusely from mid-May to mid-June the third, fourth, and fifth years. Other prominent features are blue fruit, early fall leaf color, and reddish brown twigs that are noticeable during winter months. American dogwood is averaging 20 inches a year in height growth.

C. kousa, Korean dogwood, is one of the few trees in bloom during June, usually 3 weeks after *C. florida*. Bracts are white, tapered at the end, and can last up to 6 weeks. Only a few sporadic blooms occurred during the fourth growing season, but blooms were prolific during the fifth year. With age, the bark is exfoliating, leaving mottled colors of grey, tan, and brown. The Korean dogwood is averaging 15 inches a year in height growth.

In summary, the white-flowering dogwoods have bloomed more prolifically than the red-flowering cultivars. The American dogwood and *C. florida* Bay Beauty have bloomed prolifically as young trees and have had the fastest growth among the dogwoods tested.

Lagerstroemia indica, crapemyrtle, has been commonly classed as a deciduous shrub, but may also be developed into a single or multi-trunk tree reaching up to 30 feet in height.

Crapemyrtles are used as accent trees in formal or informal gardens, and in street and highway plantings. *L. fauriei*, another cultivated crapemyrtle, has similar landscape potential.

Both species have year-round landscape attractions. In summer, flowers range from red to white to lavender in color. Until recently, most crapemyrtles were sold only by flower color—red, pink, white, or lavender. Within the last decade, named cultivars have resulted from breeding programs. Selections of white-flowering crapemyrtles in the test are *L. fauriei* x *L. indica* Natchez, *L. indica* Byers Wonderful White, Christmas Time, and Weeping White. *L. fauriei* has a long flowering period, from late June to early September, figure 8, and is scented with a light lemon fragrance. Natchez, the earliest to bloom of the white-flowering cultivars, has thick tapered panicles of flowers while Byer's Wonderful White has long panicles, up to 11 inches, with sparse flowers. Christmas Time is last to bloom, has short panicles, up to 4 inches, but has the purest white corolla of the white cultivars. Christmas Time also has distinctive light green foliage.

L. fauriei x *L. indica* Muskogee, and *L. indica* Catawba, Hardy Lavender, New Orleans, Powhatan, and Twilight have lavender flowers. Muskogee, the longest-flowering lavender crapemyrtle, has tapered rose panicles. Catawba, New Orleans, Powhatan, and Twilight are similar in color and duration. New Orleans has darker green foliage than the other lavender crapemyrtles. Hardy Lavender has a light lavender flower and blooms about 1 week longer than the other lavender crapemyrtles.

Byer's Red, Firebird, Mission, Regal Red, and Wm. Toovey are red-flowering crapemyrtles. Of the red crapemyrtles, Regal Red has the shortest flowering period. Mission, a late-flowering crapemyrtle, begins flowering in late July and continues through mid-September. It has flower panicles similar in size to Regal Red, but not as full. Firebird has an upright growth habit and the flowers hold their red color well throughout the summer.

Pink selections being evaluated are Byer's Pink, Pink 18, Potomac, Tulsa, and Tuscarora. Tuscarora, the longest-blooming pink crapemyrtle, has a full flower panicle when in bloom. Individual flowers in the panicle open about the same time which gives a heavy bloom effect. Byer's Pink, Pink 18, Potomac, and Tulsa have shorter flower panicles, 3-5 inches long, and have not bloomed prolifically in the study.

Average flower size of each selection was calculated each summer. Measurements from five flowers from each plant were used to determine the average size flower panicle, table 16. By 1984, all selections but Powhatan have had four growing seasons in the test (Powhatan has had only three). *L. fauriei* has had the largest overall flower panicle, but as the selections mature each year, the flower sizes are also increasing. This trend will probably taper off and flower size will become more consistent as the crapemyrtles reach mature size.

Bark characteristics are an added landscape feature of crapemyrtles in winter and spring. Trunks and branches have thin smooth bark which peels in long shreds to reveal a tan mottled bark. *L. fauriei*, Muskogee, and Natchez have demonstrated this trait after 3 years in the test plot.

L. fauriei, Muskogee, and Natchez had the greatest height and caliper growth rate, table 17. While there are significant differences in growth rate among the cultivars, the pink-flowering crapemyrtles are showing a trend to be less vigorous growers and less cold hardy than other cultivars. In April 1983, a late frost caused winter damage to many of the crapemyrtles. The leaves were beginning to unfurl when the frost occurred and the pink-flowering crapemyrtles, excluding Tuscarora, were damaged the most.

TABLE 16. AVERAGE FLOWER SIZE OF CRAPEMYRTLE SELECTIONS

Plant	Flower size[1]		
	1982	1983	1984
	cm	*cm*	*cm*
Byer's Red	185.9bcd[2]	212.7cd	258.0ij
Byer's Wonderful White	570.5a	572.6a	725.6b
Catawba	78.7d	199.8cd	276.2hij
Firebird	212.2bc	315.2bc	366.9efgh
Hardy Lavender	279.7b	344.7b	493.5cd
L. fauriei	285.3b	563.1a	1112.8a
Mission	259.4bc	276.0bcd	329.4fghij
Muskogee	142.42cd	241.2bcd	537.6c
Natchez	203.2bcd	303.8bc	400.0defg
Powhatan	—	168.7d	258.0ij
Regal Red	280.3b	270.1bcd	321.0ghij
Tuscarora	195.3bcd	206.0cd	337.6efghi
Wm. Toovey	239.4bc	300.9bc	430.9def

[1]Flower size determined by length x width of the flower panicle.
[2]Mean separation within columns by Duncan's multiple range test, 5 percent level; values followed by the same letter are not statistically different.

During the winter of 1983-84 the Southeast had an unusually cold winter with temperatures near zero for several days. Winter damage was assessed on the crapemyrtles the following spring.

Pink-flowering crapemyrtles were the least cold hardy, suffering branch dieback to the soil line or death. Tuscarora and Potomac were exceptions, having little or no damage. Byer's Wonderful White and L. fauriei had no winter damage, but other white-flowering selections had some stem dieback. Hardy Lavender and Powhatan escaped winter damage but other lavender-flowered crapemyrtles had some dieback. New Orleans had severe dieback to the soil level but produced new shoots during the growing season. Overall, the red-flowering crapemyrtles were the most cold hardy, with only Byer's Red suffering stem dieback.

Powdery mildew is the most serious disease of crapemyrtle, especially in the spring and fall months. Many of our cultivars are resistant or tolerant to the disease. Wm. Toovey is the only cultivar that has had a mildew problem on the foliage, while Firebird has had some powdery mildew on the flower panicles. This occurred in late summer and fall of 1982 and 1983.

In conclusion, the data suggest the more recently developed crapemyrtle cultivars, Muskogee, Natchez, Hardy Lavender and *L. fauriei*, are showing trends of more vigorous growth in respect to height and caliper, while *L. fauriei*, Muskogee, Natchez, Tuscarora, and Hardy Lavender have the greatest duration of flowering. Recent crapemyrtle selections, such as Natchez, Muskogee, *L. fauriei*, and Byer's Wonderful White, have the largest flower panicles.

See color plates numbers 10-13.

TABLE 17. HEIGHT AND CALIPER GROWTH FOR *LAGERSTROEMIA* SPECIES AND CULTIVARS

Plant	Height			Caliper	
	1981	1982	1983	1982	1983
	cm	*cm*	*cm*	*cm*	*cm*
L. fauriei	137.2a[1]	167.8a	222.1a	2.6a	4.0a
L. fauriei x *L. indica*					
Natchez	101.7b	157.8ab	201.6abc	2.2abc	3.5ab
L. indica					
Byer's Wonderful White	69.3cd	121.7cdef	132.8efg	1.6def	1.9defghi
Christmas Time	—	109.0defg	95.0ghi	1.3ef	1.4ghi
Weeping White	—	96.1efgh	92.9ghi	1.4ef	1.3hi
L. fauriei x *L. indica*					
Muskogee	89.4bc	144.4abc	212.8ab	2.3abc	3.8a
L. indica					
Catawba	—	72.0h	89.6ghi	1.2ef	1.8efghi
Hardy Lavender	62.4cd	125.1bcde	175.2bcde	2.3ab	3.6abc
New Orleans	61.1cd	94.0efgh	78.2i	1.6def	1.1i
Twilight	63.3cd	135.0abcd	155.0def	2.7abcd	3.1abc
Byer's Red	54.4d	92.2efgh	128.9fgh	1.7cde	2.3cdefg
Firebird	—	112.4cdefg	157.4cdef	1.6def	2.3cdefg
Mission	—	96.1efgh	163.0cdef	1.4ef	2.6bcdef
Regal Red	59.1cd	103.8defgh	158.6cdef	1.6def	2.6bcdef
Wm. Toovey	56.4d	116.2cdef	145.1def	1.7de	2.7bcde
Byer's Pink	54.3d	95.8efgh	83.9hi	1.2ef	1.1i
Pink 18	—	88.7fgh	78.6i	1.4ef	1.3hi
Potomac	—	91.2efgh	89.0ghi	1.4ef	1.1i
Tulsa	—	86.7fgh	86.0hi	1.0f	1.1i
L. fauriei x *L. indica*					
Tuscarora	—	79.6gh	123.0fghi	1.2ef	1.7efghi

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

DISEASE AND INSECT CONTROL

Control of Entomosporium Leaf Spot on Photinia Under Conditions of High Disease Pressure

Gary S. Cobb, Austin K. Hagan, Charles H. Gilliam, and Jacqueline M. Mullen

Leaf spot caused by *Entomosporium maculatum* is a persistent and destructive disease of *Photinia* and some other Roseaceae genera. Since splashing water and high humidity are conducive to disease development, this leaf spot is particularly damaging and difficult to control during periods of frequent rainfall and in nurseries equipped with overhead irrigation. Benlate and Daconil 2787 have been reported to be effective protectants against *E. maculatum*, but in commercial nurseries the results with these materials are often less than satisfactory, particularly when disease pressure is high. In fact, disease severity and the lack of effective control measures have resulted in some nurseries ceasing photinia production. The objectives of this work were to identify nonphytotoxic fungicides that would provide an acceptable level of preventative disease control under conditions of high disease pressure and to establish the appropriate rates and frequencies of application.

In spring 1983, several fungicides were screened for phytotoxicity and protectant efficacy in controlling Entomosporium leaf spot on *P.* x *fraseri* (Fraser photinia or red tip). The most effective material was further studied to determine appropriate application practices. A second fungicide comparison was made in fall 1983, with follow-up studies in spring 1984. All experiments were conducted using severely pruned photinias grown in an amended pine bark medium in 3-gallon pots. Treatments were initiated when new foliage began to expand. *E. maculatum* inoculum was provided by placing severely diseased photinias on the container rims of the test plants. With daily overhead irrigation, severe disease symptoms consistently developed on control plants within 4 weeks. Fungicides were sprayed on all leaf surfaces until runoff and plants were not irrigated for 24 hours after application. An adjuvant, Chevron Spray Sticker (8 ounces per 100 gallons of water), was included with all treatments unless otherwise noted. Disease levels on new foliage and phytotoxicity were assessed 4 weeks after treatment initiation.

In the initial screening test in spring 1983, Triforine 18.2%EC, Bayleton 25WP, Daconil 2787 75WP, Ornalin 50WP, Benlate 50WP, and Manzate 200 80WP were compared. Fungicide applications were made weekly.

Three separate experiments with Triforine were conducted simultaneously in summer 1983. In one experiment, Triforine at 0.5, 1.0, 1.5, and 2.0 pints per 100 gallons of water was applied weekly for 4 weeks. In a second experiment, Triforine at 2 pints per 100 gallons of water was applied at 7, 14, 21, and 28-day spray intervals. Effects of weekly application of Triforine (2 pints per 100 gallons of water) with and without the spray sticker was investigated in a third experiment. Overhead irrigation was applied 24 hours after treatment and at 24-hour intervals thereafter.

Weekly applications of Triforine, Bayleton, Tilt 3.6EC, Zyban 75WP, Rovral 50WP, and Kocide 77WP were evaluated in fall 1983. In spring 1984, Zyban was applied weekly at 0, 0.5, 1.0, and 1.5 pounds per 100 gallons of water and at 1.5 pounds per 100 gallons of water at 7, 14, and 21-day spray intervals. To investigate phytotoxicity, uninfected photinias were pruned and subjected to 4 weekly applications of Bayleton at 1 pound per 100 gallons of water. New shoot growth was compared with an untreated control.

TABLE 18. COMPARISON OF SIX FUNGICIDES AS PROTECTANTS AGAINST ENTOMOSPORIUM LEAF SPOT ON PHOTINIA, SPRING 1983

Fungicide	Rate per 100 gal. water	Percent leaves infected
Triforine 18.2%EC (triforine)	1.0 qt.	1a[1]
Bayleton 25WP (triadimefon)	1.0 lb.	5a
Daconil 2787 75WP (chlorothalonil)	1.5 lb.	18b
Ornalin 50WP (vinclozolin)	1.5 lb.	22b
Benlate 50WP (benomyl)	1.0 lb.	53c
Manzate 200 80WP (mancozeb)	1.5 lb.	61c
Check	—	95d

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

In spring 1983, all fungicides reduced incidence of Entomosporium leaf spot compared with the control; however, efficacy varied among materials, table 18. Greatest disease control was observed with weekly applications of either Triforine or Bayleton. No phytotoxicity was observed with Triforine, but leaves of Bayleton-treated plants were narrower and more bronze in color, and plant height was reduced compared with the check. Leaf spot was substantially reduced by Daconil 2787 and Ornalin, and no phytotoxicity was observed with either fungicide. While Benlate and Manzate 200 reduced leaf spot incidence, disease developed on more than 50 percent of the leaves. High disease pressure in the test was reflected by the 95 percent leaf spot incidence on control plants.

Good disease control was achieved with all rates of Triforine tested; maximum control was obtained with 2 pints per 100 gallons of water (data not shown). When Triforine at 2 pints per 100 gallons of water was applied at intervals exceeding 1 week, disease control declined dramatically (data not shown). At a 2-week interval, 55 percent of the new leaves were infected and disease severity increased significantly; disease severity increased linearly as application interval increased. Weekly applications of Triforine at 2 pints per 100 gallons of water resulted in 98 percent uninfected leaves with or without the spray sticker included.

In fall 1983, Triforine, Tilt, and Zyban provided excellent control of leaf spot, table 19; however, Tilt caused reddening, spotting, and some distortion of expanding foliage. Bayleton was less effective, but no phytotoxicity was observed, possibly due to cooler temperatures during the fall. Disease control with Rovral and Kocide 101 was only slightly better than the control. Disease control increased as the rate of Zyban increased; greatest control was obtained at 1.5 pounds per 100

TABLE 19. COMPARISON OF SIX FUNGICIDES AS PROTECTANTS AGAINST ENTOMOSPORIUM LEAF SPOT ON PHOTINIA, FALL 1983

Fungicide	Rate per 100 gal. water	Disease[1]	
		Incidence	Severity
Triforine 18.2%EC (triforine)	1.0 pt.	2a[2]	1.0a
Tilt 3.6EC (propiconazole)	.5 pt.	0a	1.0a
Zyban 50WP (thiophanate-methyl + zinc ion + maneb)	1.5 lb.	5a	1.2a
Bayleton 25WP (triadimefon)	1.0 lb.	19b	1.8b
Rovral 50WP (iprodione)	1.0 lb.	80c	3.3c
Kocide 101 77WP (copper hydroxide)	1.5 lb.	85c	3.5c
Check	—	100d	4.0d

[1]Average disease incidence determined by percent new leaves infected. Average disease severity: 1 = no symptoms, 3 = moderate infection, and 5 = defoliation.

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

gallons of water (data not shown). Weekly application of Zyban provided the greatest disease protection; however, control decreased linearly as spray interval increased (data not shown). In spring 1984, four weekly applications of Bayleton (1 pound per 100 gallons of water) reduced dry weight of new shoot growth 43 percent compared with the check.

Results using fungicides for control of Entomosporium leaf spot have often conflicted, possibly because of differences in disease pressures and cultural and environmental variations. Although time of year varied, the results reported here were obtained under similar experimental conditions of consistently heavy disease pressure. Weekly applications of Triforine at 1-2 pints per 100 gallons of water gave near-complete disease control, and subsequent trials in commercial nurseries have substantiated these results. Under conditions less favorable to disease development, fewer applications and/or lower rates of Triforine may be sufficient. Zyban at 1.5 pounds per 100 gallons of water applied weekly provided excellent disease protection without phytotoxicity. Daconil 2787 and Ornalin offer substantial disease protection and could prove effective under conditions less favorable for disease development or in fungicide rotations.

See color plate number 14.

Control of Anthracnose on Euonymus

Gary S. Cobb

Euonymus japonica cultivars are reported to be susceptible to several foliar diseases. A leaf spot caused by *Colletotrichum gloeosporioides* was identified on *E. japonica* Aureo-marginata (Golden euonymus) in Mobile County, Alabama, in summer 1983. Small circular lesions, 1-3 millimeters in diameter, were found on both leaf surfaces and on stems. Foliar lesions, which often exhibited a scab-like appearance, had raised, purplish-brown margins and sunken,

TABLE 20. COMPARISON OF 11 FUNGICIDES AS PROTECTANTS AGAINST COLLETOTRICHUM LEAF SPOT ON GOLDEN EUONYMUS

Fungicide	Rate per 100 gal. water	Percent leaves infected	Disease rating[1]
Zyban 75WP (thiophanate-methyl + mancozeb)	1.5 lb.	1a[2]	1.0a[2]
Daconil 2787 75WP (chlorothalonil)	1.0 lb.	2a	1.2a
Benlate 50WP (benomyl)	1.0 lb.	4a	1.2a
Manzate 200 80WP (mancozeb)	1.5 lb.	4a	1.5a
Kocide 101 77WP (copper hydroxide)	1.5 lb.	40b	3.0b
Tilt 3.6EC (propiconazol)	.5 pt.	46bc	3.2b
Rovral 50WP (iprodione)	1.0 lb.	57bc	3.7c
Ro 15-1297[3]	76 ml	61bcd	3.8c
Ornalin 50WP (vinclozolin)	1.0 lb.	65bcd	3.8c
Triforine 18.2% EC (triforine)	2.0 pt.	70cd	3.8c
Bayleton 25WP (triadimefon)	1.0 lb.	85d	4.0c
Control	—	57bc	4.0c

[1]Disease rating scale: 1 = clean; 2 = slight infection; 3 = moderate infection (marketing affected); 4 = heavy infection; 5 = severe infection with defoliation.
[2]Mean separation within columns by Duncan's multiple range test, 5 percent level; values followed by the same letter are not statistically different.
[3]MAAG Agrochemicals, Vero Beach, Florida 32960.

lighter brown centers. Leaf spots coalesced to form large, irregularly shaped lesions where acervuli (fruiting bodies) developed and were visible to the naked eye as small, pinpoint black dots. In most cases, stem lesions were entirely raised and darker in color than foliar lesions.

C. gloeosporioides was isolated on acidified potato-dextrose agar medium and confirmed as the causal organism by satisfying Koch's postulates. Golden euonymus (1-gallon) in an active flush of growth was treated September 12, 1983, with the fungicides outlined in table 20. Twenty-four hours later foliage and stems of plants were sprayed with a conidial suspension (5 x 10^4 conidia per milliliter) with a hand-pumped atomizer until plant surfaces glistened. Plants were placed in plastic bags for 48 hours. Plants were evaluated for percent new leaves infected and disease rating (1 = no infection, 5 = severe infection and defoliation) on September 26. *C. gloeosporioides* was isolated from all infected test plants.

Another cultivar, *E. japonica* Aureo-variegata (Gold Spot euonymus), was treated with fungicides and inoculated at the same time as the Golden euonymus; however, these plants had only a few actively growing shoots. Observations on disease incidence, symptoms, and leaf age effects on susceptibility were made.

Zyban, Daconil 2787, Benlate, and Manzate 200 provided excellent protection against Colletotrichum leaf spot on euonymus with no phytotoxicity on either cultivar, table 20. Other fungicides did not protect against disease development.

Immature expanding leaves on both cultivars were highly susceptible to infection; however, mature, fully expanded leaves were not susceptible, suggesting that fungicidal applications should coincide with growth flushes. Symptom expression differed slightly on Gold Spot, with foliar lesions generally darker and more scab-like (raised) than on Golden euonymus.

See color plate number 15.

Fungicides for Black Spot Control on Roses

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

Black spot, the most widespread and destructive disease of roses in Alabama, can be controlled with a season-long fungicide spray program. Among the many fungicides currently available for rose black spot control, Daconil 2787 generally provides the best results. However, the usefulness of this fungicide is often limited during hot summer months due to foliar burn. Triforine (sold as Funginex) is one of a group of new experimental fungicides known as sterol-inhibitors. Recently labelled for control of several diseases of roses, including black spot, Triforine has proven to be as effective as Daconil 2787 without the danger of foliar burn. Other sterol-inhibiting fungicides may prove equal or superior to Triforine and other fungicides for black spot control on roses. This research compared the effectiveness of several experimental sterol-inhibiting fungicides with fungicides currently recommended for control of rose black spot.

Triforine 18.2E, Zyban 75W, Daconil 2787 4.17F, Rubigan 12.5E, Maag RO 15-1297, Ortho XE779 25W, and RH-3866 2E were compared for black spot control on field-grown Queen Elizabeth roses. Each rose plant was fertilized at planting in September 1983 and then bimonthly beginning in 1984 with 8 ounces of 8-8-8 fertilizer. Plants were pruned periodically during the growing season to remove suckers and spent flowers. Water was applied as needed by overhead irrigation. To ensure heavy disease pressure in 1984, roses were not sprayed for black spot in the fall of 1983. Each fungicide was applied weekly to runoff with a hand pump, compressed air sprayer to a total of eight roses from March 22 to August 17, 1984. Disease severity was evaluated on May 29, June 21, and August 21 on a 1-5 scale: 1 = no disease, 5 = severe defoliation.

Weekly applications of the different fungicide treatments failed to prevent black spot development, table 21. However, all treatments significantly reduced disease severity through the growing season and several were quite effective against black spot.

TABLE 21. COMPARISON OF FUNGICIDES FOR BLACK SPOT CONTROL ON ROSES

Treatment and ratio per 100 gal. water	Disease severity[1]		
	May 29	June 21	August 21
Maag RO 15-1279 4E, 1.4 fl. oz.	1.1d[2]	1.4de	2.1d
Maag RO 15-1279 4E, 2.7 fl. oz.	1.1d	1.1de	1.4e
Zyban 75W, 14.8 oz.	2.0bc	1.6cd	1.8de
Rubigan 12.5E, 6.8 fl. oz.	2.1bc	2.0c	3.1b
Daconil 2787 4.17F, 32 fl. oz.	1.6bcd	1.0e	1.3e
Triforine 18.2, 12 fl. oz.	1.6bcd	1.1de	1.3e
Ortho XE779 25W, 1.8 oz.	2.3b	2.5b	3.4b
Ortho XE779 25W, 3.2 oz.	2.3b	2.6b	3.1b
Ortho XE779 25W, 6.4 oz.	2.1bc	2.0c	2.9bc
Ortho XE779 25W, 12.8 oz.	2.1bc	1.6cd	2.3cd
RH-3866 2E, 0.5 fl. oz.	1.6bcd	1.1de	2.4cd
RH-3866 2E, 1.0 fl. oz.	1.3d	1.0e	1.9de
RH-3866 2E, 2.0 fl. oz.	1.5cd	1.0e	1.3e
Untreated control	3.4a	3.9a	4.3a

[1]Disease rated on a 1-5 scale: 1 = no disease, 5 = severe defoliation.
[2]Mean separation within columns by Duncan's multiple range test, 5 percent level; values followed by the same letter are not statistically different.

As expected, Triforine and Daconil 2787 had good season-long activity against black spot. Zyban also provided a high level of control though it was slightly less effective than Daconil 2787 or Triforine.

Of the experimental fungicides screened, Maag RO 15-1297 and RH 3866 provided the best disease control. At all application rates, both fungicides proved as effective as Daconil 2787, Triforine, or Zyban in reducing black spot development through June 21. Under heavy mid-season disease pressure, efficacy of the lowest application rates of Maag RO 15-1297 and RH-3866 began to decrease. By August 21, these treatments no longer provided adequate disease control. Both fungicides continued to maintain good black spot control through August 21 at the higher application rates.

Rubigan and Ortho XE779 significantly reduced disease severity below levels on the nonsprayed controls, table 21; however, neither of these fungicides provided adequate disease control when compared to Daconil 2787 or Triforine. Performance of Ortho XE779 declined as its application rate was reduced from 12.8 to 3.2 ounces per 100 gallons of water.

All fungicides screened, with the exception of Daconil 2787 and Zyban, belong to a group of fungicides often called sterol-inhibitors. Some sterol-inhibiting fungicides not only inhibit the growth of fungi but also can act as plant growth regulators. Ortho XE779 was the only fungicide which had an adverse effect on plant growth. Roses sprayed with this fungicide had a distinctly compact growth habit, especially at higher application rates. In addition, fewer fast-growing suckers were noted on the Ortho XE779 treated roses. None of the other fungicides was phytotoxic to roses.

Of the four experimental sterol-inhibiting fungicides screened, RH-3866 and Maag RO 15-1297 looked most promising for black spot control on roses. At highest application rates, both of these fungicides almost completely prevented disease development over a 5-month period under heavy disease pressure. Performance of RH-3866 at 2.0 fluid ounces per 100 gallons of water and Maag RO 15-1297 at 2.7 fluid ounces per 100 gallons of water was equal to or surpassed that of the fungicide standards, Daconil 2787, Triforine, and Zyban. Lower application rates that were not highly effective in this test could provide good black spot control under light to moderate disease pressure. Rubigan and Ortho XE779 had some activity against rose black spot; however, neither of these fungicides proved as effective as Daconil 2787 or Triforine. In addition, strong growth regulator activity could greatly limit the use of Ortho XE779 on roses and possibly other woody ornamentals.

See color plates numbers 16 and 17.

Susceptibility of Ilex Cultivars to Black Root Rot

Lorie E. Merrill, Kenneth C. Sanderson, and John C. Williams

Black root rot caused by *Thielaviopsis basicola* Ferrasis is a soilborne disease and has been reported to occur on Japanese hollies, *Ilex crenata* Thumb, in Alabama, Florida, North Carolina, and Tennessee. Above-ground symptoms of the disease include stunted growth, leaf chlorosis, reduced foliage, and dieback. Roots become necrotic and turn black. Microscopic examination of Japanese holly roots colonized by *T. basicola* show conidia and chlamydospores in and on the root tissue. Plants slowly decline and die after 3 to 4 years.

To determine the relative susceptibility of seven *Ilex* cultivars to *T. basicola*, a controlled growth chamber experiment was initiated. Hollies tested were *I. aquifolium* x *I. cornuta* Nellie R. Stevens, *I.* x *aquipernyi* Brilliant, *I. cornuta* Burfordii x *I. pernyi* Lydia Morris, *I. cornuta* Burfordii Nana, *I. crenata* Helleri, *I. pernyi* Franch, and *I. vomitoria* Stokes Dwarf.

Liners, growing in 3- x 3-inch plastic containers, were obtained from a commercial nursery and repotted in 1-gallon plastic containers. The growth medium consisted of equal parts of sandy loam soil, Canadian sphagnum peat moss, and pine bark amended with 0.5 pound of ground dolomitic limestone and 0.18 pound of superphosphate per cubic yard. Plants were fertilized every 2 weeks with an aqueous solution of 20-20-20 soluble fertilizer (250 p.p.m. N-P-K). After repotting, the plants were grown in a glass greenhouse for 7 weeks prior to being moved to a growth chamber. In the growth chamber, plants were set on inverted, plastic pots to reduce chance of contamination from runoff. A light intensity of 2,500 foot-candles was provided by cool white fluorescent and incandescent lamps. Plants were grown on a 9-hour daylength at a minimum night temperature of 55°F and a day temperature of 65°F.

Two isolates of *T. basicola* obtained from *I. crenata* were grown on PDA medium for 3 days at 74°F. Mycelial disks were transferred to flasks containing a 10 percent V-8 juice broth medium and incubated in darkness at 74°F for 14 days. Inocula containing spores and mycelia were prepared from the broth cultures and applied at the rate of 3.3 ounces per pot. After 4 weeks, root balls were washed and rated on a scale of 1 to 5 (1 indicating a healthy root system and 5 indicating all roots dead). To establish the presence of *Thielaviopsis*, soil

TABLE 22. ROOT RATINGS OF SEVEN *ILEX* CULTIVARS 4 WEEKS AFTER INOCULATION WITH *THIELAVIOPSIS BASICOLA*

Ilex cultivars	Root rot rating[1]		
	Noninoculated	*I. crenata* isolate 1	*I. crenata* isolate 2
I. aquifolium x *I. cornuta* Nellie R. Stevens	1.0a[2]	1.0a	1.0a
I. x *aquipernyi* Brilliant	1.0a	1.6ab	2.0b
I. cornuta Burfordii x *I. pernyi* Lydia Morris	1.0a	1.0a	1.0a
I. cornuta Burfordii Nana	1.0a	1.0a	1.0a
I. crenata Helleri	1.0a	3.0c	3.4c
I. pernyi	1.0a	3.0c	2.6b
I. vomitoria Stokes Dwarf	1.0a	1.8b	2.2b

[1]Root rot rating system: 1 = all roots healthy, 2 = few roots involved, 3 = moderate root rot, 4 = most roots involved, 5 = all roots dead. Mean of 5 plants.
[2]Mean separation within columns by Duncan's multiple range test, 5 percent level; values followed by the same letter are not statistically different.

and root samples were taken and cultured on carrot disks in sterile Petri dishes. Samples were incubated for 7 to 8 days at room temperature (67°F) and then examined microscopically to determine the colonization and the percent recovery of *T. basicola*.

Of the seven *Ilex* cultivars inoculated, I. crenata Helleri and *I. pernyi* had the highest root rot ratings, table 22, but no apparent symptoms of black root rot were evident on leaves or stems of any test plants. No root damage was observed on *I. aquifolium* x *I. cornuta* Nellie R. Stevens, *I. cornuta* Burfordii x *pernyi* Lydia Morris, or *I. cornuta* Burfordii Nana. The two isolates of *T. basicola* showed no significant difference in pathogenicity (data not shown). Recovery of *T. basicola* on carrot disks was possible from all inoculated plants, even apparently healthy roots (data not shown). *T. basicola* was not recovered from noninoculated plants (data not shown). Results of this investigation revealed cultivar differences in susceptibility to black root rot. Further research is warranted to find additional substitutes for susceptible hollies.

See color plates numbers 18 and 19.

Control of Pseudomonas Leaf Spot on Magnolia grandiflora

Jacqueline M. Mullen and Gary S. Cobb

In the spring of 1981, a previously unreported leaf spot on southern magnolia was observed in a nursery in south Alabama. Later the same year, a similar disease was found at two other locations. Young, newly unfolded leaves were most severely affected, developing dark brown spots which expanded and coalesced until as much as two-thirds of the leaf area was covered with dark brown irregular lesions. Many lesions dried and deteriorated, leaving large holes in the leaf tissue. Expanding leaves developed black spots (0.1-0.4 inch in diameter) surrounded by thin yellow halos (less than 0.1 inch wide). Mature current-season foliage typically developed small black spots (less than 0.1 inch in diameter) surrounded by thin pale yellow halos (less than 0.1 inch wide). Bacteria isolated from these spots was subsequently identified as *Pseudomonas cichorii*, and pathogenicity tests confirmed *P. cichorii* as the causal agent of the southern magnolia leaf spot.

Tests were designed to evaluate various chemical and cultural treatments for prevention of disease spread. Severely infected southern magnolias were grown in a pine bark medium in 5-gallon containers in full sun. Normal nursery cultural practices were followed with the exception of pesticide applications and irrigation. Spray treatments were applied weekly to the foliage until runoff, using hand pump compressed air sprayers. Nu-film 17, an adjuvant, was included with each bactericide treatment.

Experiment 1. Three bactericides, each at two rates, were evaluated for disease control. Also, two rates of Exhalt 800, a sticker-extender, were evaluated to determine if a layer of inert material would provide protective disease control. Treatments and rates are given in table 23. Irrigation was applied daily with overhead impulse sprinklers. Disease incidence (percent leaves infected) and severity (foliar-disease rating) were recorded after 7 weeks of treatment.

TABLE 23. CHEMICAL CONTROL OF PSEUDOMONAS LEAF SPOT ON *MAGNOLIA GRANDIFLORA*, EXPERIMENT 1

Treatment and rate per 100 gallons water[1]	Percent leaves infected	Foliar disease rating[2]
Kocide 101 (copper hydroxide)		
1 lb.	66	1.9
2 lb.	61	1.8
Tri-basic Copper Sulfate (basic copper sulfate)		
2 lb.	56	1.7
4 lb.	47	1.6
Citcop 4E (copper resinate)		
2 pt.	74	2.1
4 pt.	84	2.5
Exhalt 800		
4 pt.	85	2.4
8 pt.	97	2.7
Check	97	2.7

[1]Nu-film 17, 1 pint per 100 gallons, was added to each bactericide treatment.
[2]Foliar disease rating: 1 = no lesions, 2 = less than 10 percent total leaf area damaged, and 3 = more than 10 percent total leaf area damaged.

Disease incidence (percent leaves infected) and disease severity (foliar disease rating) were suppressed by all treatments except Exhalt 800, table 23. According to statistical test results (analysis of variance with orthogonal comparisons), Kocide 101 and Tri-basic Copper Sulfate were most effective, with Tri-basic Copper Sulfate providing greatest control. Application rates were not significant with either material.

Experiment 2. Four chemicals were evaluated in an experiment where overhead irrigation was compared with ground-level irrigation for leaf spot disease control. The chemicals and rates tested per 100 gallons of water were Kocide 101, 2 pounds; Tri-basic Copper Sulfate, 2 pounds; Agri-Strep 17, 1 pound; and Bordeaux mixture, 8 pounds. Disease incidence and severity were evaluated after 15 weeks of treatment.

None of the chemicals evaluated (by analysis of variance) in Experiment 2 provided significant disease control. However, disease severity on hand-watered plants was lower than that on plants watered by overhead irrigation.

Results of the two experiments showed that Kocide 101 or Tri-basic Copper Sulfate will provide limited disease control under some environmental conditions. When humid, rainy conditions prevailed, as was the case during much of the duration of Experiment 2, neither of these chemicals provided effective disease control. Results of Experiment 2 also revealed that water droplets are an important element in disease spread. Plants watered with ground-level irrigation developed less disease than plants watered with overhead sprinklers.

Combining chemical and cultural control methods did not provide adequate disease control when conditions for disease development were favorable. As with some other bacterial diseases of ornamental crops, control of this disease in nurseries will require strict sanitation practices in addition to chemical and/or cultural control measures.

See color plates numbers 20 and 21.

Pesticide Phytotoxicity and Residue Accumulation on Poinsettia

Dean R. Mills, Ronald L. Shumack, and Gary S. Cobb

Pesticide phytotoxicity and residue accumulation can substantially reduce poinsettia quality. Eleven foliar pesticides (acaricides, insecticides, and fungicides) were evaluated for phytotoxicity and residue accumulation on leaves and bracts of three poinsettia cultivars (V-14 White, V-14 Glory, and V-10 Amy Red).

Poinsettias were potted August 3, 1983, and grown in 7 ½-inch pots in an amended pine bark-peat moss (3:1, volume basis) growth medium. Standard cultural and nutritional practices were followed. Beginning September 30, foliar applications of the treatments outlined in table 24 were made biweekly for 8 weeks.

Vendex, a contact acaricide, was phytotoxic to V-14 Glory bracts only (circular spotting). It was safely applied to the other two cultivars; however, residue accumulation was heavy. Pentac, an acaricide with residual activity, was slightly phytotoxic to the foliage of all cultivars and slightly more phytotoxic to the bracts (pinpoint and irregular spotting), but left no residue.

Meta-Systox R, a contact and systemic insecticide, was phytotoxic to leaves of both V-14 cultivars (irregularly shaped light brown lesions); similar, but less severe phytotoxicity was observed on V-14 Glory bracts. No phytotoxicity was observed on V-10 Amy Red and no residue accumulated on any cultivar. Orthene, a contact and systemic insecticide with limited residual activity, resulted in phytotoxicity on foliage of both V-14 cultivars (cupping, distortion, and marginal chlorosis). V-10 Amy Red was not damaged by Orthene and residue accumulation was light. A third insecticide, Diazinon AG 500, which has contact and stomach poison activity, was phytotoxic to leaves and bracts of both V-14 cultivars (irregular lesions, bleached out bracts). Slight leaf injury was observed on V-10 Amy Red. Spray residue was not visible on any cultivar.

TABLE 24. PESTICIDE PHYTOTOXICITY AND RESIDUE ACCUMULATION ON POINSETTIA

Pesticide	Rate per 100 gal.	V-14 White			V-14 Glory			V-10 Amy Red		
		Leaf injury	Bract injury	Residue	Leaf injury	Bract injury	Residue	Leaf injury	Bract injury	Residue
Vendex 50WP	0.5 lb.	OK[1]	OK	X[2]	OK	X	X	OK	OK	X
Pentac Aquaflo	.5 pt.	C[3]	X	OK	C	X	OK	C	C	OK
Meta-Systox R 2EC	2.0 pt.	X	OK	OK	X	C	OK	OK	OK	OK
Orthene 75SP	1.0 lb.	X	OK	OK	X	OK	OK	OK	OK	OK
Diazinon AG 500 EC	1.0 pt.	X	C	OK	X	X	OK	C	OK	OK
Ornalin 50WP	.75 lb.	C	X	X	X	X	X	C	C	X
Rovral 50WP	1.0 lb.	OK	OK	X	OK	OK	X	OK	OK	X
Daconil 2787 F	2.0 pt.	OK	X	X	OK	X	X	OK	X	X
Kocide 101 77WP	1.0 lb.	OK	OK	X	OK	OK	X	OK	OK	X
Benlate 50WP	1.0 lb.	OK	OK	X	OK	OK	X	OK	OK	X
Zyban 75WP	1.5 lb.	OK	OK	X	OK	OK	X	OK	OK	X

[1]OK = acceptable quality.
[2]X = unacceptable quality.
[3]C = apply with caution.

Unsightly residue accumulations were experienced with all fungicide treatments. Ornalin, a contact fungicide, was phytotoxic to foliage and bracts of all three poinsettia cultivars (irregular blotching). Daconil 2787 Flowable, a preventative fungicide with relatively long residual activity, was phytotoxic to the bracts of all cultivars (dark, irregular spots and light lesions). Rovral, a broad-spectrum fungicide, and Kocide 101, a copper hydroxide compound, resulted in no phytotoxicity, nor did the systemic fungicides Benlate and Zyban.

Clearly, pesticide phytotoxicity varies among poinsettia cultivars, with V-10 Amy Red being generally more tolerant than the two V-14 cultivars. Residue accumulation was substantial with fungicides; however, applications made early in the production cycle should not reduce plant quality. After bract formation, extreme caution should be exercised with any pesticide application. Good cultural practices, fungicidal drenches, exothermic formulations, and granular insecticide application will control most disease and insect problems, minimizing the need for foliar pesticide applications.

See color plates numbers 22-25.

Chemical Control of Fungus Gnats

James C. Stephenson

Fungus gnat, *Bradysia coprophila* (Linter), larvae live in the upper surface of poorly drained and frequently irrigated soil, feeding on soil fungi and organic matter. While larvae will occasionally feed on plant roots, the main concern in controlling the insect is to eliminate the impression of poor sanitation projected by large numbers of adults flying around plants. This study was conducted to evaluate several pesticides and application methods, table 25, for control of fungus gnats in container media.

Rhododendron x Hershey's Red azaleas were placed under 47 percent shadecloth in a glass greenhouse and watered frequently to promote infestation. After several weeks, infested plants were selected and treated. Treatments were replicated six times, randomized, and pots individually caged with paper cylinders covered with tulle to limit gnat movement. Control was determined by trapping adults with Olsen Yellow Sticky Traps, 1.4 x 1.6 inches. Data reflect control of larvae and eggs present at time of treatment application.

Diazinon AG 500 applied as a drench at two rates and as a spray effectively controlled fungus gnats within 1 week after application. Ro 13-5223, an insect growth regulator (IGR), applied as a drench provided no control during week 1; however, excellent fungus gnat control was obtained at both application rates at week 2. Slow response is characteristic of most IGR's. Some control was observed with Orthene at week 2. No significant difference between drench and foliar spray application of Diazinon or Orthene was observed. This may be attributed to a thorough foliar application with a significant amount of material contacting the soil surface. No phytotoxicity was observed with any treatment.

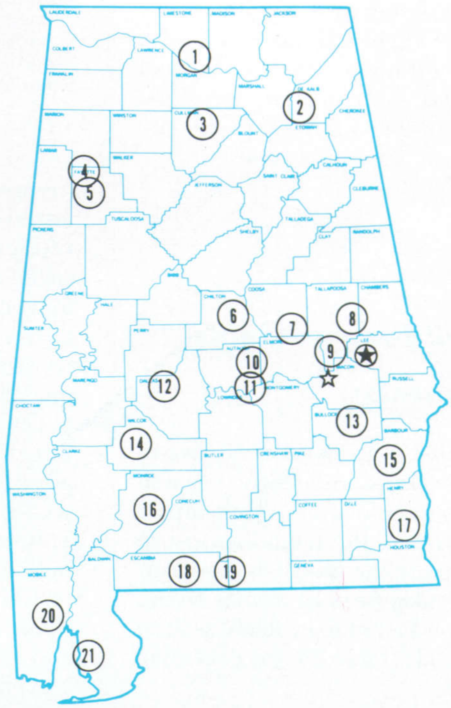
TABLE 25. CHEMICAL CONTROL OF FUNGUS GNATS

Insecticide[1]	Appl. method	Rate per 100 gal. water	Mean emerging adults	
			Week 1	Week 2
Ro 13-5223 25WP[3]	D	1.0 lb.	5.8c[4]	0.4a[4]
Ro 13-5223 25WP	D	.5 lb.	5.5bc	.2a
Diazinon AG 500 4EC	D	1.0 pt.	.8a	.3a
Diazinon AG 500 4EC	D	.5 pt.	.7a	.2a
Diazinon AG 500 4EC	S	1.0 pt.	1.2ab	1.8a
Orthene 75S	D	.7 lb.	7.3c	1.2a
Orthene 75S	S	.7 lb.	3.3abc	1.8a
Control	—	—	6.2c	5.2b

[1]Applied March 9, 1983; dry bulb 74°F, wet bulb 60°F.
[2]D = 250 milliliter drench; S = foliar spray application to run-off with hand-pumped, compressed air sprayer.
[3]MAAG Agrochemicals, Vero Beach, Florida 32960.
[4]Mean separation within columns by Duncan's multiple range test, 5 percent level; values followed by the same letter are not statistically different.

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.