SECTION 5
PATHOLOGY AND NEMATOLOGY

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Reaction of Dogwood Selections to Powdery Mildew in Alabama

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Alabama

Nature of Work:: Powdery mildew, which is caused by the fungus Oidium sp., is emerging as a common and sometimes damaging disease of flowering dogwood (Cornus florida) on both landscape and forested sites in Alabama and North Carolina (1). Flowering dogwoods found in heavy shade to full sun have been equally disfigured by this disease. Recently, several selections of the kousa (C. kousa) and hybrid dogwoods (C. kousa x florida) were shown to be highly resistant to powdery mildew. In Alabama, native flowering dogwoods differ considerably in their susceptibility to this disease; trees with heavily colonized foliage are often found adjacent those free of disease symptoms. The reaction of cultivars of the flowering dogwood to powdery mildew is unknown. The objective of this study was to determine the resistance from selections the flowering, kousa, and C. kousa x florida hybrid dogwood, along with a selection of C. nuttallii x florida and giant dogwood (C. controversa) to powdery mildew.

Bare-root dogwoods were planted in March 3, 1993 into a Marvyn loamy sand on 20 ft. centers spaced 25 ft. apart in Auburn, AL. Planting holes were dug to a depth of 24 inches with a 24- inch tractor-mounted auger. The experimental design was a randomized complete block with 6 two-plant replications. A trickle irrigation system with two emitters per tree was installed shortly after tree establishment. The dogwoods were grown in full sun and irrigated as needed. Each tree was topdressed with 0.2 lb. of 13-13-13 fertilizer on May 26 and June 24, 1994. Weeds were controlled with directed applications of Roundup herbicide and mechanically with a weed trimmer. Alleys between rows of trees were periodically mown. A visual rating of powdery mildew severity was made on August 4, 1994 and May 24, 1995 using a scale of 0 to 4 with 0 = no disease, 1 = 1% to 25%, 2 = 26% to 50%, 3 = 51% to 75% and 4 = 76% to 100% of leaves damaged or colonized by the powdery mildew fungus.

Results and Discussion: With few exceptions, cultivars of the flowering dogwood proved to be susceptible to powdery mildew (Table 1). Both years, discoloration of the foliage, leaf distortion, and some leaf shed were observed on symptomatic cultivars of flowering dogwood. Of the 26 flowering dogwoods cultivars screened, 19 with disease ratings of 2.0 or more one or both years were considered highly susceptible to powdery mildew. 'First Lady', 'Rubra Pink', 'Pink Beauty', 'Red Beauty', 'Pink Flame', and 'Purple Glory' consistently had the highest disease ratings. In both years, light to moderate powdery mildew infestations were observed on the flowering dogwood cultivars 'Fragrant Cloud', 'Springtime', 'Cherokee Chief', 'Cherokee Daybreak', 'Weaver's White', and 'Barton White'. The only flowering dogwood cultivar free of symptoms of powdery mildew in 1994 and 1995 was 'Cherokee Brave'.

Generally, the kousa and hybrid dogwood selections were more resistant to powdery mildew than those of the flowering dogwood (Table 1). Powdery mildew infestations on the foliage of these dogwoods were largely limited to a few, scattered colonies of the causal fungus. In both years, C. nuttallii x florida cv 'Eddie's White Wonder' had significantly higher disease ratings than all of the C. kousa x florida selections except 'Ruth Ellen' in 1993. The C. kousa x florida hybrids 'Constellation', 'Galaxy', 'Stardust', and 'Stellar Pink', all cultivars of the kousa dogwood, and the single selection of giant dogwood were highly resistant to powdery mildew.

In summary, flowering dogwoods are much more likely to suffer disfiguring damage than kousa or C. kousa x florida hybrid dogwoods. Of the 26 cultivars of the flowering dogwood screened, only 'Cherokee Brave' proved to be resistant to powdery mildew. Nearly all the C. kousa x florida hybrid and kousa dogwoods along with the single selection of the giant dogwood evaluated in this study have good disease resistance. Differences in the reaction of several C. kousa x florida hybrid dogwood selections between this and a previous study (1) were noted. Ranney et al (1) observed heavy fungal colonization of the leaf surfaces of C. kousa x florida hybrids 'Stardust', 'Constellation', and 'Ruth Ellen' while in this study only light infestations were noted on these same cultivars. Generally, the level of disease resistance shown by cultivars of the kousa dogwood common to both studies was similar (1).

Significance to Industry: Establishment of disease-resistant dogwoods is an attractive alternative to the extensive fungicide spray program. A number of adapted dogwoods with good resistance to powdery mildew have been identified. In both nursery, retail, and landscape settings, disease resistance is the most effective and least costly method of preventing outbreak of powdery mildew on dogwood.

Literature Cited

1. Ranney, T. G., L. F. Grand, and J. L. Knighten. 1994. Resistance of Cornus kousa taxa to dogwood anthracnose and powdery mildew. Proc. SNA Res. Conf. 39:212-216.

Table 1. Incidence of powdery mildew on selected dogwoods.

Cultivar	Species[1]	Disease Rating[2,3] Jul 94	May 95	Cultivar	Species[1]	Disease Rating[2,3] Jul 94	May 95
Dwarf White	CF	N.R.[4]	3.0	Springtime	CF	1.5	0.8
Junior Miss	CF	2.8	1.7	Cherokee Chief	CF	1.5	1.4
First Lady	CF	2.6	2.1	Eddie's White Wonder	CN	1.4	1.3
Welch's Bay Beauty	CF	2.6	1.8	Cherokee Daybreak	CF	1.4	0.9
Ozark Spring	CF	2.6	1.8	Weaver's White	CF	1.1	1.1
Rainbow	CF	2.6	1.6	Ruth Ellen	RH	1.1	0.1
Rubra Pink	CF	2.5	2.0	Barton White	CF	1.1	1.5
World's Fair	CF	2.4	1.6	Wonderberry	CF	1.0	2.2
Stokes Pink	CF	2.3	1.5	Aurora	RH	0.6	0.0
Cloud 9	CF	2.3	1.7	Milky Way	CK	0.5	0.3
Cherokee Princess	CF	2.3	1.5	Satomi	CK	0.3	0.0
Double White	CF	2.3	1.5	Constellation	RH	0.3	0.0
Pink Beauty	CF	2.3	2.6	Galaxy	RH	0.2	0.1
Sunset	CF	2.2	1.4	Stardust	RH	0.2	0.2
Red Beauty	CF	2.2	2.0	Stellar Pink	RH	0.2	0.0
Pink Flame	CF	2.2	2.5	Milky Way Select	CK	0.1	0.0
Purple Glory	CF	2.0	2.0	National	CK	0.0	0.0
Autumn Gold	CF	1.7	2.9	Cherokee Brave	CF	0.0	0.0
Fragrant Cloud	CF	1.7	1.8	Giant Dogwood	CC	0.0	0.0
LSD (P=0.05)		0.8	0.8			0.8	0.8

[1]CF=Cornus florida, CN=Cornus nuttallii x florida, CK=Cornus kousa, CC=Cornus controversa, RH=Rutgers hybrids (C. florida x kousa). [2]Mean separation within columns according to Fisher's protected least significance (LSD) test (P=0.05). [3]Disease was noted on a scale of 0 to 4 where 0 = no symptoms of disease, and 4 = 75% to 100% of the leaves damaged or colonized.
[4]N.R.=Not recorded.

Resistance of Indian Hawthorn to Entomosporium Leaf Spot

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Nature of Work: Entomosporium leaf spot, which is caused by the fungus Entomosporium mespili, is the most common and damaging diseases of indian hawthorn (Raphiolepis umbellata) in the nursery and landscape plantings across the South (1,3). Raabe and Hansen (2) noted that Raphiolepis spp. considerably differ in their resistance to this disease. The indian hawthorn cultivars 'Majestic Beauty', 'Snow White' and 'Pink Lady' as well as the hybrid R. x Delacourii have good disease resistance while the cultivars 'Jack Evans', 'Springtime', 'Fascination', and 'Enchantress' are likely to be heavily damaged by Entomosporium leaf spot (1). The release of new cultivars of indian hawthorn by several nurseries has renewed interest in using this attractive and useful woody shrub. The objective of this field study was to determine whether newly released indian hawthorn cultivars are resistant to Entomosporium leaf spot and compare their reaction to this disease with that of commercially available cultivars of indian hawthorn and Raphiolepis hybrids.

In March 1994, twenty cultivars of indian hawthorn were planted in a Benndale fine sandy loam at the Brewton Experiment Field in Escambia County (Zone 8a) on 5 ft. centers with 10 ft. between beds. The cultivars 'Rosalinda' and 'Snow White' were added to the study in March 1995. The experimental design was a randomized complete block with 6 three-plant replications. Soil fertility and pH were adjusted according to soil assay recommendations. Approximately one half cup of Osmocote 17-7-12 fertilizer was uniformly distributed around each plant twice each spring. A trickle irrigation system was installed at the time of establishment and the plants were irrigated as needed. Directed applications of Roundup herbicide at recommended rates were made to keep the beds free of weeds. All plants were mulched with aged pine bark. Disease incidence was visually assessed on March 8 and May 24, 1995 on a scale of 1 to 5 with 1 = no disease, 2 = 1 - 25%, 3 = 26 - 50%, 4 = 51 - 75%, and 5 = 75 - 100% of leaves diseased.

Results and Discussion: Disease development continued through the unusually wet and mild weather in the fall of 1994 and winter of 1995. By March 1995, heavy spotting of the leaves and premature leaf shed was seen on the most susceptible indian hawthorn cultivars 'Pinkie', Harbinger of Spring', 'Enchantress', 'Heather', 'White Enchantress', and 'Springtime' (Table 1). Moderate spotting of the leaves was noted on the cultivars 'Spring Rapture' and F6. Symptoms (Disease Ratings) were light to very light on all remaining cultivars except for the newly installed 'Rosalinda' and 'Snow White' which were free of leaf spot.

From March thorough May, the weather in the Brewton area was dry but warm. The leaf spot ratings for the susceptible cultivars remained a very high 3.2 to 3.9 (Table 1). The light to moderate spotting of the leaves on the cultivars 'Rosalinda', 'Clara', F3, F2, 'Janice', 'Eleanor Tabor', F1, and 'Majestic Beauty' was noted. Indian hawthorn cultivars with the lowest disease ratings were Dwarf Yedda, Olivia, Indian Princess, and R. x Delacourii.

The majority of indian hawthorn cultivars suffered moderate to heavy spotting of the leaves and light to severe leaf spot-related defoliation while several others were nearly free of symptoms of Entomosporium leaf spot. Cultivars with excellent disease resistance included 'Dwarf Yedda', 'Olivia', 'Indian Princess', R. x Delacourii and possibly 'Snow White'. An additional nine cultivars were moderately resistant to Entomosporium leaf spot. The resistance of 'Majestic Beauty', 'Snow White', and R. Delacourii to Entomosporium leaf spot noted in this study was similar to that previously reported by Corley (1). A number of cultivars including 'Pinkie', 'Harbinger of Spring', 'Enchantress', 'Heather', 'White Enchantress', 'Springtime', 'Spring Rapture' and F6 were unacceptably susceptible to this disease. The susceptibility of 'Springtime' and 'Enchantress' to Entomosporium leaf spot has been previously reported (1).

Significance to Industry: Intensive and costly fungicide spray programs are often required in nurseries and landscape to control Entomosporium leaf spot on susceptible selections of indian hawthorn. Effective, long-term control of this disease can be obtained by establishing one of the leaf-spot resistant selections of indian hawthorn identified in this study.

Literature Cited

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Table 1. Reaction of indian hawthorne to Entomosporium leaf spot.

Cultivar	Disease Rating[1] Mar 95[2]	May 95	Cultivar	Disease Rating[1] Mar 95[2]	May 95
Pinkie	4.4	3.5	Clara	1.9	2.3
Harbinger of Spring	4.2	3.6	Jack Evans	1.8	2.2
Enchantress	3.9	3.3	F1	1.8	2.0
Heather	3.9	3.5	Majestic Beauty	1.7	2.0
White Enchantress	3.8	3.6	Indian Princess	1.6	1.1
Springtime	3.5	3.9	F3	1.6	2.3
Spring Rapture	3.1	3.2	Eleanor Tabor	1.6	2.2
F6	2.7	3.5	Olivia	1.4	1.1
R. x Delacourii	2.3	1.4	Dwarf Yedda	1.2	1.0
Janice	2.1	1.9	Rosalinda[3]	1.0	2.5
F2	2.0	2.2	Snow White[3]	1.0	1.6
LSD (P=0.05)	0.6	0.5		0.6	0.5

[1]Disease was visually assessed on a scale of 1 to 5 where 1 = no disease, and 5 = 76% to 100% of the leaves are diseased. [2]Mean separation within columns according to Fisher's protected least significance (LSD) test (P=0.05). [3]Added to study in March 1995.

Resistance of Crapemyrtle to Powdery Mildew

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Nature of Study: Powdery mildew, which is caused by the fungus *Erysiphe lagerstroemiae*, is the most common disease of crapemyrtle across the Southeastern U.S. (1). Typically, powdery mildew has little affect on tree vigor but diseased crapemyrtle are unattractive. Disease resistant cultivars offer a simple, effective, and environmentally sound method of controlling powdery mildew on crapemyrtle in production nurseries and the landscape. Recently, a number of *Lagerstroemia indica x fauriei* cultivars with resistance to powdery mildew have been released by the National Arboretum (2). The ornamental characteristics, adaptability, and pest resistance of 45 crapemyrtle (*L. indica* and *L. indicia x fauriei*) cultivars are being assessed in a field planting in Central Alabama. This report summarizes the reaction of these crapemyrtle cultivars to powdery mildew.

Bare-root crapemyrtle were planted on March 3, 1993 in a Marvyn loamy sand on 20 ft. centers in rows spaced 25 ft. apart in Auburn, AL. Planting holes were dug to a depth of 24 in. with a 24-inch tractor-mounted auger. The experimental design was a randomized complete block with 6 two-plant replications for each cultivar. A trickle irrigation system with two emitters per plant was installed at the time of tree establishment. The plants were maintained in full sun and irrigated as needed. On May 26 and June 24, 1994, 0.2 lb. of 13-13-13 fertilizer was uniformly distributed around the base of each plant. A visual rating of powdery mildew incidence was made on August 2, 1994 and May 24, 1995 on a scale of 0 to 4 where 0 = no disease, 1 = 1 to 25%, 2 = 26 to 50%, 3 = 51 to 75%, and 4 = 76 to 100% of the leaves damaged or colonized by *E. lagerstroemia*.

Results and Discussion: To date, the foliage of the cultivars 'Tonto', 'Osage', 'Fantasy', 'Muskogee', 'Acoma', 'Choctaw' and 'Apalachee' have consistently remained free of powdery mildew (Table 1). Light powdery mildew infestations (0.1-0.6) were observed one or both years on an additional 15 crapemyrtle cultivars. In many cases, only one to a handful of scattered colonies were seen on the leaves of the above cultivars. Disease ratings on these and the mildew-free cultivars did not significantly differ. Sharp increases in the incidence of powdery mildew were observed on 11 cultivars, most notably on 'Raspberry Sundae', from 1994 to 1995. Both years, the heaviest powdery mildew infestations were seen on 'Gray's Red', 'Orbin's Adkins', 'Carolina Beauty', PI 6789220, 'Byer's Wonderful White', and 'Potomac' crapemyrtles.

Over a two-year period, the cultivars 'Tonto', 'Osage', 'Fantasy', 'Muskogee', 'Acoma', 'Choctaw' and 'Apalachee' proved to be immune to powdery mildew. Cultivars with excellent disease resistance included Tuskegee, Lipan, Sarah's Favorite 'Comanche', 'Miami', 'Tuscarora', 'Sioux', 'Near East', 'Hopi', 'Basham's Party Pink', 'Wichita', 'Regal Red', 'Glendora White', 'Yuma', and 'Pecos'. The foliage and blooms on these cultivars were as attractive as those crapemyrtles immune to this disease. The excellent disease resistance of the cultivars of *Lagerstroemia indica x fauriei*, many of which are listed above, was confirmed in this study (2). The foliage of the heavily mildewed cultivars was unattractive and routine fungicide applications would be required to maintain tree appearance equal to that of the disease resistant cultivars (1,3).

Significance to Industry: Powdery mildew can greatly distract from the beauty of crapemyrtle. A sizable number of crapemyrtle selections with good to excellent resistance to powdery mildew have been identified. Wider use of such disease resistant selections would largely eliminate this disfiguring disease as a factor in the production and maintenance of crapemyrtle in southeastern landscapes.

Literature Cited

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3. Hagan, A. K. and J. M. Mullen. 1993. Controlling powdery mildew on ornamentals. Al. Coop. Ext. Ser. cir. ANR-407, 4 pp.

Table 1. Incidence of powdery mildew on selected crapemyrtle in Alabama.

Cultivar	Disease Rating[1] Aug 94	May 95	Cultivar	Disease Rating[1] Aug 94	May 95
Gray's Red	2.3[2]	1.9	Basham's Party Pink	0.2[2]	0.0
Orbin's Adkin	1.8	2.3	Cherokee	0.1	1.5
Carolina Beauty	1.7	2.6	Hopi	0.1	0.1
PI 6789220 White	1.7	0.3	Near East	0.1	0.3
Byers Wonderful White	1.6	2.5	Catawba	0.1	0.9
Potomac	1.5	1.9	Choctaw	0.0	0.0
Zuni	0.9	1.3	Sioux	0.0	0.2
Country Red	0.9	1.7	Apalachee	0.0	0.0
Hardy Lavender	0.6	1.2	Tuscarora	0.0	0.5
Pecos	0.6	0.3	Acoma	0.0	0.0
Seminole	0.6	0.8	Muskogee	0.0	0.0
Raspberry Sundae	0.5	2.8	Miami	0.0	0.3
Yuma	0.5	0.2	Peppermint Lace	0.0	1.5
William Toovey	0.4	1.7	Comanche	0.0	0.5
Majestic Beauty	0.4	1.5	Fantasy	0.0	0.0
Caddo	0.3	0.0	Osage	0.0	0.0
Natchez	0.3	0.0	Biloxi	0.0	0.9
Velma's Royal Delight	0.3	0.7	Sarah's Favorite	0.0	0.1
Glendora White	0.3	0.4	Lipan	0.0	0.5
Powhatan	0.3	1.5	PI 6789713	0.0	1.2
Regal Red	0.3	0.2	Tuskegee	0.0	0.5
Wichita	0.3	0.3	Tonto	0.0	0.0
Centennial Spirit	0.2	1.2			
LSD (P-=0.05)	0.7	0.6		0.7	0.6

[1]Disease severity was assessed on a 0 to 4 scale where 0 = no disease, and 4 = 75-100% of the foliage damaged or colonized. [2]Mean separation within columns according to Fisher's protected least significance (LSD) test (P=0.05).

Fungicide Management of Phytophthora Blight of Madagascar Periwinkle

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Nature of Work: The popularity of Madagascar periwinkle (*Catharanthus roseus* = *Vinca rosea*) has increased in Florida in recent years. Reasons for this popularity include shade tolerance, improved color selection, and the perennial nature of this bedding plant in Florida's hardiness zones. A result of this popularity has been the increase in incidence and severity of Phytophthora blight caused by *Phytophthora nicotianae* Breda de Haan in the nursery and landscape. This disease has become epidemic throughout Florida since the mid 1980's(1). Standard recommended fungicides for Phytophthora blight have included Aliette WDG, Kocide 101 and Subdue 2E (2,3). This study evaluated the standard fungicides compared to the synergistic combination treatments of Aliette WDG (fosetyl aluminum) plus Fore WP (mancozeb) in both preventative and curative trials (G.W. Simone, unpublished data).

Plugs of *Catharanthus roseus* "Little Series: Bright Eye" were grown in Metro-Mix 300 for 10 days prior to experiment initiation in 5 in., plastic azalea pots in a glass greenhouse. Growth conditions included: 3,000 ft. candles of light, day/night temperatures of 75-85°F/68-75°F, overhead irrigation and weekly fertilization with Peters 20-10-20. Thrips and whiteflies were managed with a weekly insecticide rotation that included Enstar 2, Knox-out, Orthene, Pentac, and Talstar.

All fungicide treatments were applied by compressed air tank sprayer at 25 psi. Foliar sprays were applied to leaf run-off while the drench treatment (Subdue 2E) was delivered to the media at a rate of 3.4 fl.oz/pot (100ml/pot). Treatments were arranged in a randomized complete block design with 10 replicate plants per treatment. Treatments were delivered on a biweekly basis.

A periwinkle isolate of *Phytophthora nicotianae* was grown on V-8 juice agar for 5-6 days. These cultures were sectioned into nine pieces and floated in petri plates in a sterile, 1:1 mixture of deionized water and pond water. Cultures were washed twice with this mixture for two days and then chilled at 47°F for one hr. Zoospore release occurred within hours of chilling. Each plant was misted with 5ml of spore suspension (~100,000 spores) and bagged for 36 hr. Treatments were applied either 48 hr before (preventative test) or after the inoculation (curative test).

Experiments were evaluated on a biweekly interval after inoculation (10 wk preventative and 7 wk curative test). Plants were rated for root quality (1-5 scale; 1=no disease, 5=>75-100% necrotic roots), percent necrotic foliage, percent phytotoxicity, treatment residue (1-5 scale; 1=no residue, 5=total canopy with residue), and dry plant mass. All data are not presented here.

Results and Discussion: Preventative efficacy of treatment fungicide is presented in Table 1. At the 4 wk rating after inoculation, the upwardly mobile drench fungicide Subdue 2E offered no measure of disease management compared to the inoculated water control. Both the 5.0 lb rate of Aliette and the low combination rate of Aliette + Fore provided moderate disease suppression with foliar disease ratings of 12-20%. Superior treatments at this rating period were the 2.5 lb rate of Aliette, both rates of Exp. 019454B (Rhone-Poulenc Inc.) and the high rate of Aliette + Fore. By week 10, both the Subdue 2E and the inoculated water control plants were dead. The uninoculated control had sustained a 50% loss in canopy due to fungus spread in the greenhouse. The 2.5 lb rate of Aliette and the low rate of Exp. 019454B resulted in 20% canopy infection. The best treatments were the rates of Aliette + Fore, Aliette (5.0 lb. rate), and the high rate of Exp. 019454B that limited disease to <3% of the canopy.

Root quality ratings followed a similar trend to foliar disease ratings. Subdue was the worst treatment at both 4 wk and 10 wks and did not differ from the inoculated unsprayed control. Moderate root necrosis was observed from the 2.5 lb rate of Aliette, low rate of Exp. 019454B, and the uninoculated control (irrigation splash of the pathogen). Highest root quality was obtained by both Aliette + Fore rates and the high rates of both Aliette and Exp. 109454B. Total dry biomass did not differ among the rates of Aliette + Fore, the rates of Exp. 019454B and Aliette (5.0 lb rate). Phytotoxicity resulted from the fifth spray of Aliette (5.0 lb rate) application only. This rate reduced flower petal size, causing a lack of petal overlap. Affected flower petal tips were elongated.

Curative fungicide treatment results are presented in Table 2. Two weeks after inoculation of this experiment, neither the Subdue 2E nor the Kocide treatments could be distinguished from the unsprayed water control. The high rate of Aliette + Fore sustained the lowest foliar disease rating although this treatment did not differ significantly from either the low combination rate nor either rate of Aliette alone. The final rating period, the water sprayed control, the Subdue and the Kocide treatments were dead. The high rate of Aliette + Fore suppressed disease to <3%, equivalent to the non-inoculated control. This combination rate had the highest dry biomass of any treatment. The remaining treatments had canopy infections ranging from 11-35% with comparably lower dry weights. Both rates of Aliette + Fore had higher residue ratings caused by the dark, bluish-green pigment in the Fore formulation.

Significance to Industry: Both rate combinations of Aliette WDG + Fore WP represent useful management tools for preventative and curative Phytophthora blight situations. The high rate combination was superior to the low rate combination in the curative test but was equivalent in the preventative test. Both combination treatments were superior over the Subdue 2E or Kocide 101 standards. Although the 5.0 lb rate of Aliette was comparable to the Aliette + Fore mixture in the preventative control study, neither rate of the Aliette + Fore produced the flower injury demonstrated by the high rate of Aliette alone. Additionally, the combination rates offer equal or better efficacy at lower cost compared to the Aliette 5.0 lb rate.

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Table 1. Preventative Fungicide Management of Phytophthora Blight of Periwinkle

Treatment/100 gal.	Percent Foliar Disease[1] 4 wks	10 wks	Root Quality[1,2] 10 wks	Dry Biomass (gm)[1]
1. Inoc. H2O Control	68.3 a*	99.3 a*	5.0 a*	2.77 d*
2. Aliette WDG 2.5 lb	9.6 c	21.1 c	3.0 b	16.55 bc
3. Aliette WDG5.0 lb 5.0 lb	20.6 b	2.2 d	2.0 cd	20.17 ab
4. Exp. 019454B 5.7 lb	5.3 c	1.9 d	1.8 cd	21.57 a
5. Exp. 019454B 2.85 lb	4.1 c	21.5 c	2.7 bc	18.47 abc
6. Aliette WDG + Fore WP 2.5 + 5.0 lb	4.0 c	1.6 d	1.7 d	20.47 a
7. Aliette WDG + Fore WP 1.25 + 2.5 lb	12.3 bc	2.4 d	2.0 cd	21.67 a
8. Subdue 2E 2 fl oz	54.6 a	98.0 a	5.0 a	4.21 d
9. Uninoc. H_2O Control	10.0 bc	56.1 b	3.6 b	15.50 c

* Means within a column followed by the same letter are not significantly different as determined by a Duncan-Waller Multiple Range test (P=.05).

[1] Treatment means area an average of 10 replicate plants.

[2] Root quality scale=1-5, 1= no disease, 2=1-25% root necrosis, 3=>25-50% root necrosis, 4=>50-75% root necrosis, 5=>75-100% root necrosis.

Table 2. Curative Fungicide Management of Phytophthora Blight of Periwinkle[1]

Treatment	Rate/100 gal	Percent Foliar Disease1 2 wk	7 wk	Dry Biomass1 (gm)
1. Inoc. H2O Control		58.6 ab*	98.6 a*	3.56 c*
2. Aliette WDG	2.5 lb	12.5 cd	11.5 bc	17.16 ab
3. Aliette WDG	5.0 lb	32.1 bc	35.3 b	11.89 a
4. Aliette WDG + Fore WP	2.5 lb + 5.0 lb	5.0 cd	2.4 c	18.66 a
5. Aliette WDG + Fore WP	1.25 lb +2.5 lb	24.8 bc	31.9 b	13.86 ab
6. Kocide 101 WP	1.0 lb	84.3 a	98.0 a	3.39 c
7. Subdue 2E	2 fl oz	56.3 ab	92.5 a	4.31 c
8. Uninoc. H2O Control		0.0 d	0.0 c	14.73 ab

* Treatment means followed by the same letter are not significantly different by a Duncan-Waller Multiple Range test (P=.05).

[1] Treatment means are an average of 10 replicate plants.

Evaluation of Selected Fungicides for Control of Photinia Leafspot

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Nature of Work: Photinia leafspot is a common and destructive disease of Photinia x fraseri (red top or red tip photinia) in both the nursery and the landscape. This fungal disease attacks the leaves and young stems, causing leaf spotting, defoliation and in severe cases, death of infected plants. This study was initiated to evaluate selected fungicides for control of this serious disease.

Healthy, non infected photinia liners were potted in trade gallon containers in mid July in a pine bark:peat moss medium (3:1 by volume) amended with 14 pounds of 17-7-12 Osmocote, 6 pounds of dolomitic limestone, 2 pounds gypsum, and 1.5 pounds of Micromax per cubic yard of media. Plants were heavily pruned to encourage new growth and were watered daily by overhead impact sprinkler irrigation. Severely infected photinia plants were placed within the block to serve as an inoculum source and to provide heavy disease pressure. The first treatment application was made July 26 and continued until the final application was made on November 17. Treatments were applied to run-off with a CO2-pressurized sprayer. Treatments included Banner (Ciba, Greensboro, NC) at 14 and 21 day intervals, 2 formulations of Daconil 2787 (ISK Biosciences, Mentor, OH) at 14 day intervals, Triforine (Valent U.S.A. Corp.) at 14 day intervals, and Neemguard Botanical Fungicide (W.R. Grace, Columbia MD) at 7 day intervals.

Results and Discussion: Disease incidence was evaluated monthly using a Horsfall Barrett rating scale and the final rating was taken 4 months after initial application (Table 1). Both formulations of Daconil, and Banner sprayed at 14 day intervals provided excellent control. Weekly applications of neem oil were not effective in controlling symptoms of the disease and when the final rating was taken, plants treated with Neemguard were stunted and severely defoliated.

Significance to Industry: Data indicate that both formulations of Daconil 2787 and Banner 1.1E provide adequate control of photinia leafspot disease when applied at 14 day intervals. Neemguard Botanical Fungicide applied at 7 day intervals was ineffective.

Note: This paper reports the results of research only. It does not imply registration of a pesticide nor is it intended as an endorsement of any named product. Before using any of the products mentioned in this research paper, be certain of their registration by appropriate state and/or federal authorities.

Table 1 Effect of Selected Fungicides on Photinia Leafspot

Treatment	Spray Interval	Rate/ 100 gal	Disease Incidence1
Banner 1.1E	21 Day	6 fl oz	7.2
Banner 1.1E	14 Day	6 fl oz	3.5
Daconil 2787 4.17F	14 Day	32 fl oz	1.8
Daconil 2787 SDG	14 Day	1.4 lb	2.7
Neemguard	7 Day	0.5 gal	12
Neemguard	7 Day	1.0 gal	12
Neemguard	7 Day	1.5 gal	12
Triforine 1.6E	14 Day	18 fl oz	7.8
Non-Sprayed Control	—	——	11.7

1Disease incidence was measured using a Horsfall Barrett rating scale of 1-12 (1=no disease, 2=0-3 percent, 3=3-6 percent, 4=6-12 percent, 5=12-25 percent, 6=25-50 percent, 7=50-75 percent, 8=75-87 percent, 9=87-94 percent, 10=94-97 percent, 11=97-100 percent, 12=100 percent of leaves diseased).

Chemical Control of Powdery Mildew of Poinsettia

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Tennessee

Nature of Work: Powdery mildew of poinsettia, Euphorbia pulcherrima, was found in Tennessee greenhouses in 1992 and 1994. Powdery mildew of poinsettia usually appears mid to late season and can be difficult to control. The purpose of this experiment was to evaluate several chemical treatments to manage powdery mildew.

In January 1995, cultivars of Freedom and Angelica Marble were sprayed with one to the following treatments: Phyton 27(copper sulfate pentahydrate), Source Technology Biologicals, Inc.; Heritage 50WG (B-methoxyacrylate), Zeneca Ag Products; fluazinam 500F(fluazinam), ISK Biotech; or SunSpray Ultrafine Oil, Sun Company, Inc. Treatments were applied with a CO_2 backpack sprayer with a single hollow cone nozzle at 30psi. Treatments were applied to the point of runoff. Twenty four hours after spraying, poinsettias heavily infected with powdery mildew were placed among treated plants. Plants were maintained in the greenhouse at 75F daytime and 70F night temperatures.

Results and Discussion: All treatments had less powdery mildew than the untreated control (Table 1). The fluazinam and Sunspray treatments were superior to other treatments. Phyton 27, although used in the greenhouse industry at a rate of 15 fl oz/ 100 gal of water, did not perform well in this test. Heritage, also did not adequately protect plants from mildew, but may need to be applied at a higher use rate. None of the plants showed phytotoxicity from any of the treatments.

Significance to Industry: Although Sunspray Oil is normally used as an insecticide/ miticide, plants may also benefit from mildew control. Fluazinam has been used to manage diseases caused by fungi such as Rhizoctonia and Phytophthora, but appears to have good activity against the Oidium sp. that causes powdery mildew of poinsettia.

Table 1. Chemical control of powdery mildew of poinsettia.

Treatment	Rate/100gal	Colonies/plant	% Disease
Untreated	——	>500 A	44.4 A
Phyton 27	15 fl oz	362.6 B	7.0 B
Heritage 50WG	3.5 oz	186.6 B	2.5 C
Sunspray Oil	2 gal	39.1 B	0.9 D
fluazinam 500F	3.5 fl oz	12.7 B	0.4 D

Means within a column followed by the same letter are not statistically different as determined by Duncan's Multiple Range Test where P=0.05.

Blackspot Disease Management on Hybrid Tea Roses in Alabama

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Nature of Work: Blackspot (caused by *Diplocarpon rosae*) can cause serious defoliation of rose plants in the Southern landscape. Reports that baking soda (sodium bicarbonate) was effective in controlling this disease were made in more northly test sites (1). The purpose of our study was to evaluate alternatives to weekly applications of a fungicide and various ground covers on minimizing blackspot disease development on hybrid tea roses.

In 1992, hybrid tea roses were planted in exterior beds in full sun with drip irrigation. The study was arranged in a randomized complete block design with three replications. Treatments were factorial arrangements of a foliar spray and ground cover. Plots consisted of one each of three varieties (Cary Grant, Dolly Parton, and Princess Monaco). Ground covers were: oat straw, pine straw, pine bark, landscape mat, and bare soil. A 10-cm layer of each mulch was placed around the base of plants in March of each year. Foliar sprays were applied 1 May through September of 1992, 1993, and 1994 and consisted of 1) weekly applications of chlorothalonil (1.3 g a.i./L), 2) an application of chlorothalonil only after 0.63 cm or more rain, 3) weekly applications of a sodium bicarbonate and horticultural oil solution (5.3 g/L $NaHCO_3$ [baking soda] and 1% SunSpray Ultra-Fine Horticultural Oil), and 4) no spray treatment. Spray solutions were applied until run-off. Blackspot disease severity, plant vigor, and flower production were rated weekly.

Results and Discussion: In 1992, disease was not observed until mid-August and remained low. However, by 1994, high disease was consistently observed on all plants. There were statistically ($\underline{P} < 0.05$) significant effects on disease accumulated over the growing season due to ground cover (in 1992 and 1994), foliar treatment (each of three years), and the 2-way interaction between foliar treatment and ground cover (1992 and 1993). Lowest disease was consistently observed on plants with oat straw ground cover and plants treated with chlorothalonil. Vigor was significantly affected by foliar treatment (all three years), ground cover (1993), and the 2-way interaction (1993). Greatest vigor was consistently observed on plants treated with chlorothalonil either weekly or after > 0.63 cm rain. In 1993 and 1994, flower production was significantly affected by foliar treatment, with either chlorothalonil application regime allowing greatest flower production. The sodium bicarbonate plus oil solution did not provide effective disease control or improve plant vigor. Flower production was generally correlated to plant vigor.

Significance to Industry: Data indicate that ground cover choice can make a difference in blackspot disease development. Plants with oat straw ground cover consistently had lower disease and greater vigor than others. In addition, results showed that long-term maintenance of plant vigor is improved through appropriate fungicide applications.

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Responses of *Cornus amomum* and *Raphanus sativus* to *Discula destructiva* and Toxic Metabolites

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Nature of Work: Recognition of a plant pathogen is the first step in establishing whether a suspected pathogen is responsible for a given disease. This is done with a series of steps known as Koch's postulates (Agrios 1969). The fungus, *Discula destructiva,* is known to be the causative agent for dogwood anthracnose in *Cornus florida* (Hibben and Daughtrey 1988). The purpose of this experiment was to determine if another dogwood species, *C. amomum,* was susceptible to *D. destructiva* and if toxic metabolites of *D. destructiva* were involved in the disease syndrome.

Fungal cultures were inoculated with conidia (1.0 X 10^7/100ml) in 250 ml flasks containing potato-dextrose broth (PDB). Still cultures were grown at 23 $\pm$ 2^0 C for four weeks under low level indirect cool fluorescent lights with a 12-hr photoperiod. Culture filtrate was partially purified (PPCF) by ultrafiltration, lyophilization, and rotary evaporation (Wedge 1994). *C. amomum* and *Raphanus sativus* seeds were germinated on Murashige and Skoog (MS) (1962) basal medium. *R. sativus* was included because it is a standard species used for detecting allelopathic chemicals. Tubes containing 10 ml of MS medium and individual plants were grown for four weeks.

C. amomum and *R. sativus* seedlings were inoculated with a conidial solution of *D. destructiva*, PPCF, water, or PDB. PDB and water were used as controls for PPCF and *D. destructiva*, respectively. Two of four established plants were wounded prior to incoluation by burning small lesions into the upper leaf surface with a flamed hypodermic needle. Two seedlings were inoculated without wounding. Leaves were evaluated for signs or symptoms of infection and for resulting necrosis typical of dogwood anthracnose. Leaves which produced anthracnose symptoms were then cultured on potato-dextrose agar. Each plate contained one treated leaf and the opposite untreated leaf.

Results and Discussion: Wounded and non-wounded leaves of both *C. amomum* and *R. sativus* treated with PPCF (1:50) produced symptoms of anthracnose. Conidial inoculations produced symptoms of infection only on wounded leaves of both species. *D. destructiva* was recovered from infected leaves of *C. amomum.* Recovery of the fungal agent was not attempted in *R. sativus*. Controls of both wounded and non-wounded leaves were negative for anthracnose.

Significance to Industry: This preliminary study indicates that *C. amomum* is susceptible to infection by *D. destructiva* and that toxic metabolites produced by *D. destructiva* may be involved in the disease process. Results of this study further our knowledge of dogwood anthracnose in *C. amomum,* which was previously reported to be resistant to dogwood anthracnose (Brown *et al*. 1992).

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Discula destructiva, an Introduced Pathogen of North American Dogwoods

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Tennessee

Nature of Work: *Discula destructiva* Redlin (4) and an undescribed species of *Discula* (Windham unpublished data) are the fungal pathogens that cause anthracnose on native and ornamental populations of Flowering dogwood (*Cornus florida* L.) in the eastern United States (US) and on Pacific dogwood (*C. nuttalli* Aud.) in the western US. Certain lines or cultivars of Chinese dogwood (*C. kousa* Hance) also are susceptible to attack from these pathogens. Interestingly, dogwood anthracnose was first described from eastern and western US at about the same time (mid-late 1970s) and consequently spread quickly throughout much of the ranges of each of the dogwoods on both coasts. The sudden appearance, severity of the epidemic and rapid expansion of the areas affected by the disease has led to much speculation that the pathogen(s) was (were) recently introduced into North America (3).

Our interest in the disease was to investigate the genetic variability of the two *Discula* species in different parts of the US. In a preliminary study, we used DNA amplification fingerprinting (DAF) to analyze 8 isolates of *D. destructiva* and 3 isolates of *Discula* species, all from the eastern US. We tentatively concluded that genetic make-up of the two species was very different and that the genome of *D. destructiva* appeared to be conserved (5). The present report includes data from 28 isolates of *D. destructiva*, 14 from both west and east coasts of North America and 3 isolates of the undescribed species of *Discula*.

The thirty-one isolates of the fungi were grown in potato dextrose - V8 juice liquid medium. Mycelia were isolated and DNA extracted as described previously (5). Genomic DNA from each isolate or bulks of isolates was amplified using 10 arbitrary oligonucleotide primers, each consisting of either 7 or 8 bases, and the products separated on 4.5 % polyacrylamide gels (2). DNA amplification profiles were generated at least three times for each fungal isolate/ primer combination and visualized using a silver stain (1). Data were entered as either 1 (band present) or 0 (band absent) and evaluated using principle coordinate and cluster analyses.

Results and Discussion: The following is a brief synopsis of the results and discussion appearing in Trigiano et al. (6). Isolates of *D. destructiva* from the east and west coasts appear to be very similar showing very little genetic differences (0.5 to 6%) despite their widely dispersed locations in North America. Using principle coordinate analysis, it is very difficult to graphically resolve individual isolates of *D. destructiva* (Figure 1A) and cluster analysis only minimally distinguishes isolates from each other (Figure 1B). Conversely, isolates of the undescribed species of *Discula* display considerable genetic variability and are easily separated from isolates of *D. destructiva* as well as each other (Figure 1A and B). Clearly, the genome of *D. destructiva* in North

America is highly conserved and this along with the sudden onset of the disease, the ferocity of the disease, the apparent lack of disease resistance in native trees, and the rapid spread of the disease throughout most of the range of the two *Cornus* species, indicate that *D. destructiva* is probably an introduced pathogen to North America. However, the undescribed species of *Discula* is probably naturally occuring, at least in the eastern US.

Significance to Industry: The lack of genetic variability in isolates of *D. destructiva* would support the development of similar management and control strategies for dogwood anthracnose in the southeastern US. Control strategies would include adjusting environmental and cultural practices and possible use of fungicides.

Acknowledgements

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Phytophthora Suppressed by Pine Bark Extracts

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Nature of Work: Biocontrols and/or naturally-occurring compounds that are ecologically acceptable are of increasing interest as a means of reducing the need for chemical pest control. Perhaps the first suggestion of pathogen suppression using pine bark, a major component of container media in the South, was reported by Gugino et al. (2). Mechanisms of pathogen suppression by tree barks may be: 1) physical, by altering physical properties of the container medium, thus creating a favorable environment for root development, 2) biological, by supporting high levels of organisms antagonistic to soil-borne pathogens, and/or 3) chemical, because tree bark contains natural compounds which may be fungistatic in nature. Hoitink et al. (3) suggest that the reduced incidence of soil-borne pathogens rests primarily with the biological and chemical complex. The objective of this work was to evaluate the efficacy of pine bark extracts for suppression of *Phytophthora* growth.

Preparation of pine bark extracts: Pine bark was collected from standing trees of *Pinus taeda* L., *P. virginiana* Mill. and *P. echinata* Mill. and ground in a Wiley Mill to pass a 20 mesh sieve. A saturated paste was created by mixing 100 ml Ethanol (ETOH) with 100 ml ground bark. The beaker containing ETOH saturated bark was covered with aluminum foil and allowed to equilibrate for 1 hr with periodic stirring.

The bark-ETOH slurry was transferred to a Waring blender and homogenized for 3 min and transferred to a Buchner funnel containing a double layer of Whatman #1 filter paper. Filtrate was collected, refiltered 3 additional times and transferred to a porcelain drying pan. Filtrate and pan were placed in a vented hood at room temperature to evaporate ETOH. Residue remaining in the drying pan was scraped, ground to a fine powder, and stored dry at room temperature in an amber, air tight bottle.

Source of Phytophthora: An isolate of *Phytophthora cinnamomi* Rands, originally recovered from rhododendron, was obtained from N. C. State University. *Phytophthora parasitica* Dostur was isolated from *Aphelandra squarrosa* Nees in Apopka, FL. *Phytophthora palmivora* (E. J. Butler) E. J. Butler was contributed by Dr. Gene Moody, University of Georgia. These species were maintained on lima bean agar (LBA).

Medium preparation and organism transfer: Flasks containing autoclaved molten LBA were amended with pine bark extract solutions of 0, 250, 500, 750, and 1000 mg/l. Controls consisted of LBA amended with ETOH. Treatments were replicated 5 times. Experimental design was completely randomized. ETOH was added to each flask such that the total volume of ETOH was held constant. Extract/agar pH was approximately 5.6. The molten amended agar was then distributed to petri dishes which were left open under sterile conditions to promote ETOH evaporation.

An agar disc, 0.5 mm dia., was removed from the margin of a *Phytophthora* colony and placed in the center of a pine bark amended LBA dish. Colony diameter was measured after 24, 48, 72 and 96 hr incubation at 25^0C_2^0C.

Results and Discussion: Colony growth of *Phytophthora cinnamomi*, *P. parasitica*, and *P. palmivora* was significantly retarded by adding *Pinus taeda*, *P. virginiana*, or *P. echinata* extract to the agar substrate at concentrations ranging from 250 to 1000 mg/l.

The most effective concentration of *Pinus virginiana* extract was 500 mg/l for suppressing *Phytophthora palmivora*. *Pinus taeda* and *P. echinata* were most effective at 750 mg/l on the same organism.

Maximum reduction in colony growth of *Phytophthora cinnamomi* occurred when 1000 mg/l *Pinus virginiana* and *P. taeda* extract were added to an agar medium. With *Pinus echinata* extract, 750 or 1000 mg/l concentrations suppressed *Phytophthora cinnamomi* the most.

Greatest inhibition of *Phytophthora parasitica* colony growth was obtained with a concentration of 1000 mg/l of *Pinus virginiana*, *P. taeda*, or *P. echinata* bark extracts.

Mycelial growth of several *Phytophthora* species was suppressed by pine bark extracts, but the cause of suppression was not ascertained. However, Gerrettson-Cornell and Humphreys (2) also report suppression of *Phytophthora cinnamomi* by *Pinus radiata* bark in artificially inoculated nursery soils and suggest that the mechanism of reduction apprears to be a cessation of sporangia production by *Phytophthora*.

Significance to Industry: Results of these laboratory studies indicate the possible use of pine bark extracts for suppression of certain soil-borne pathogens. Additional research is needed to determine the effectiveness of these extracts for retarding soil-borne pathogens under container production conditions.

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