SECTION 5

Pathology & Nematology

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Section 1 and Section 13 may contain related titles.

Monitoring Irrigation Ponds for *Phytophthora* sp.

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Nature of Work: Root rot in ornamental plants is caused by several species of Phytophthora. Phytophthora root rot is one of the most common and devastating diseases of ornamental plants in container nursery production. Symptoms of this disease include shoot die back, chlorosis, slow growth, root rot and frequently plant death. Roots infected with Phytophthora usually are black and rotten.

Many container nurseries are watered by overhead irrigation from a containment pond. Excess irrigation water, drains back to the containment pond. This system is beneficial for water conservation and may be required to meet environmental regulations. Disease organisms are also recycled in the irrigation water and have the potential of causing damage to nursery crops (1). Phytophthora is a pathogen that can live in irrigation water. Therefore, once the fungus is present in the irrigation water it can be re-introduced to disease free plants via the irrigation water.

This study was conducted to investigate the activity of Phytophthora in irrigation water. Three green pears were placed in a wire cage and thrown into a containment pond near the irrigation pump, each month for one year. The cage was weighed with rocks and an empty clean sealed pesticide container was used as the float. The pear cage was thrown approximately 50 feet into the containment pond and tied to a post on the shore with a heavy string. The pears were left in the pond for approximately three days. The water temperature was taken each month with a DeltaTRAK soil thermometer. Lesions on the pears were recorded each month. Pears were then wrapped and sent to the North Carolina State University Plant Disease and Insect Clinic to be assayed for Phytophthora. Lesions were cut from the pear and placed on Phytophthora selective media.

Results and Discussion: Out of the twelve months tested Phytophthora was detected for all except November 22, January 2 and January 21 when water temperatures were below 55 degrees F.

Phytophthora cryptogea, Phytophthora cinnamomi and Phytophthora parasitica were detected during this experiment. Pythium was also detected on the Jan. 2, Feb. 25 and May 22 dates.

Significance to Industry: Results of this experiment indicate that irrigation water should be assayed for Phytophthora when the water temperature is above 55 degrees F. If Phytophthora is present in the irrigation water the nurserymen should monitor his/her plants more closely for symptoms of root rot. Nurserymen can grow Phytophthora resistant plants in the area irrigated by contaminated water or consider investing in water treatment systems.

Literature Cited

1. MacDonald, J.D., M.S. Ali-Shtayeh, J. Kabashima, and J. Stites. 1994. Occurrence of Phytophthora Species in Recirculated Nursery Irrigation Effluents. Plant Disease 78:607-611.

DATE	PHYTOPHTHOTA SPECIES	LESION AVERAGE OF 3 PEARS	WATER TEMP (F)
June 6, 1996	P. cryptogea	*	
July 29, 1996	P. cryptogea	*	
August 21, 1996	P. cryptogea P. parasitica	125	73
September 25, 1996	P. cryptogea P. cinnamomi	108	65
October 18, 1996	P. cryptogea	651	60
November 22, 1996	NONE	20	
January 2, 1997	NONE	0	52
January 21, 1997	NONE	0	
February 25, 1997	P. cryptogea	45	
March 21, 1997	P. cryptogea	165	55
April 28, 1997	P. cryptogea P. cinnamomi P. parasitica	42	64.2
May 22, 1997	P. cryptogea P. cinnamomi	46	76.6

* Did not quantify.

Reactions of *Cornus* Species to Powdery Mildew

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Nature of Work. Powdery mildew epidemics have been common in fields of flowering dogwood, *Cornus florida*, since 1993. These epidemics have been attributed to *Phyllactinia guttata* (2) and *Microsphaera pulchra* (3, 4). The objectives of this research were to 1) screen dogwood cultivars (*C. florida and C. kousa*) for resistance to powdery mildew and evaluate dogwood species for immunity or degree of susceptibility to powdery mildew.

Twenty four cultivars on lines of *C. florida*, 18 cultivars of *C. kousa* and four members of the Stella Series were evaluated for disease resistance in 1996. Trees were planted in randomized complete blocks with five replications. Disease severity was estimated using the following scale: 0 = healthy, 1 = <2% diseased foliage, 2 = <10% diseased foliage, 3 = <25% diseased foliage, 4 = <50% diseased foliage, and 5 = >50% diseased foliage.

Ten species of *Cornus* were examined for signs and symptoms of powdery mildew. Ascocarps were used to identify fungi to genus. Plants were rated as immune - no signs of powdery mildew, resistant - signs of mildew on less than 10% of foliage, or susceptible - signs of mildew on more than 10% of foliage.

Results and discussion. 'Cherokee Brave' was the only cultivar rated as disease resistant on June 13 (Table 1). By June 26, all cultivars had averaged more than 10% diseased foliage, but 'Cherokee Brave' had significantly less diseased foliage than other cultivars and lines of flowering dogwood. The lack of resistance in cultivars of *C. florida* is in agreement with previous studies (1, 4). All cultivars of *C. kousa* observed in this study were resistant to powdery mildew (Table 2). Members of the Stella Series were generally resistant, but could not be statistically separated on the June 26 sampling date (Table 3). However, no member of this series was as resistant as *C. kousa* cultivars (Tables 2 and 3).

Cornus species varied in susceptibility to powdery mildew. The species *C. alternifolia, C. alba*, and *C. sericea* were rated as immune (Table 4). Cornus nuttallii, western dogwood, was as susceptible as most cultivars of *C. florida*.

Significance to Nursery Industry. Resistance to powdery mildew is high in *C. kousa* cultivars and in some “blue-berry” species of *Cornus*. Little resistance, other than ‘Cherokee Brave’, is available in *C. florida.* The susceptibility of *C. nuttallii* in these studies indicates that this plant may be at risk if dogwoods with powdery mildew are shipped into its native range.

Literature Cited

1. Hagan, A. K., Gilliam, C. H., Keever, G. J. and Williams, J. D. 1995. Reaction of dogwood selections to powdery mildew. Ala. Agric. Exp. Sta. Res. Rep. Ser. No. 10:24-25.

2. McRitchie, J. J. 1994. Powdery mildew of flowering dogwood. Plant Path. Cir. Gainesville. No. 368.

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

4. Windham, M. T. 1996. Resistance to powdery mildew in flowering dogwood. Proc. SNA Res. Conf. 41:197-199.

Table 1. Levels of resistance to powdery mildew in cultivars on lines of C. florida in 1997.

Cultivar	June 13[1]	June 26
Cherokee Brave	0.8 a	2.6 a
Green Glow	2.3 b	4.3 bc
LangdonY	3.0 b	3.8 b
Cherokee Princess	3.5 b	5.0 c
Northern Providence	3.6 bc	4.5 bc
Presidential	4.0 bcd	5.0 c
Ozuic Spring	4.2 bcd	4.8 c
Eddie's White Wonder[2]	4.5 cd	5.0 c
Cherokee Daybreak	4.4 cd	5.0 c
Double Delight	4.5 cd	5.0 c
Head Quarters	4.5 cd	5.0 c
Hog 1	4.8 cd	5.0 c
Autumn gold	5.0d	5.0 c
Cherokee Sunset	5.0d	5.0 c
Hog 2	5.0d	5.0 c
Pink flame	5.0d	5.0 c
Girard's Pink	5.0d	5.0 c
Poinsett	5.0d	5.0 c
Pygmy	5.0d	5.0 c
Rainbow	5.0d	5.0 c
Red Beauty	5.0d	5.0 c
Snow Princess	5.0d	5.0 c
Spring Time	5.0d	5.0 c
Sweet Water Red	5.0d	5.0 c
Wonderberry	5.0d	5. 0c

[1] Disease ratngs estimated with scale listed in Nature of Work

[2] Cultivar is hybrid of *C. florida* and *C. nuttallii*

abed - all means followed by the same letter do not differ according to Duncan's New Multiple Range Test (p. = 0.05).

Table 2. Resistance in *C. kousa* to powdery mildew in 1997.

Cultivar	June 13[a]	June 26[a]
Angustata	0	0
Autumn Rose	0	0.4
Beni Fuji	O	0
Blue Shadow	0	0.2
Bodent Form	0	0
Bush's Pink	0	0
China Girl	0	0
Doubloon	0	0
Elizabeth Lustgarten	0	0
Emerald Star	0	0
Milky Way	0	0
Milky Way Select	0	0
Miss Satomi	0	0
Moon Bean	0	0
National	0	0
Porlock	0	0
Stardust	0	0
Willamette	0	0

[a] - No significance differences were noted among cultivars according to Duncan's New Multiple Range Test.

Table 3. Resistance to powdery mildew in four members of the Stella Series in 1997.

Cultivar	June 13[1]	June 26
Aurora	0.6 a	2.0 a
Celestial	0.8 a	1.6 a
Ruth Ellen	1.6 b	2.4 a
Stella Pink	1.5 ab	2 a

[1] Ratings were made using scale given in Nature of Work.
ab Means followed by the same letter do not differ according to Duncan's New Multiple RangeTest.

Table 4. Reactions of ten Cornus species to powdery mildew.

Species	Type of Powdery Mildew	Susceptibility Index[2]
alternifolia	NONE	I
alba	NONE	I
alba elegantissma	?	S
amomum	M/P	S
capitata	M	S
florida	M/P	S/R
kousa	M	R/S[3]
macrophylla	P	S
nuttallii	?	S
sericea	NONE	I

[1]abbreviations are: NONE = no powdeq mildew found, ? = genus of powdery mildew is unknown, M = ascocarps of Microsphaera were observed, P = ascocarps of *Phyllactina guttat*a were observed.

[2] Abbreviations are: I = immune, R = resistant, S= susceptible as de scribed in Nature of Work.

[3] *C. kousa* line *C. kousa* 'Chinensis' (Owens Farms, Ripley, TN) used in this study and was susceptible to powdery mildew.

Fireblight and Frogeye Leaf Spot Resistance in Crabapple Cultivars

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Nature of work. Fifty-five cultivars of crabapples, *Malus* species, were evaluated for resistance to five diseases, cedar apple rust, apple scab frogeye leaf spot, fireblight, and powdery mildew. The trees were in a planting at the Tobacco experiment Station, Greeneville, TN and arranged in a randomized complete block design with five replications. Each replication consisted of three trees.

Disease ratings were conducted in early and late summer for four years, (1994-97). Apple scab and cedar apple rust severity was estimated by the following scale: 0 = healthy, 1 = <2% leaves symptomatic, 2 = <10% of leave symptomatic, 3 = <25% of leaves symptomatic or some defoliation, 4 = >25% of leaves symptomatic or lots of obfoliation. Fire blight severity was estimated by counting the number of “hits” (branches with symptoms of fire blight). Frogeye leaf spot and powdery mildew severity was estimated using the following scale: 0 = healthy, 1 = <2% diseased foliage, 2 = < 10% diseased foliage or fruit, 3 = < 25% diseased foliage or fruit, 4 = < 50% diseased foliage or fruit, and 5 = >50% diseased foliage or fruit.

Results and Discussion. All cultivars were resistant (>10% foliage affected) to apple scab and powdery mildew. Only ‘Brandy Wine’ and ‘ Klehm’s Improved Bechtel’ were susceptible to cedar apple rust. Many cultivars were susceptible to fireblight, frogeye leaf spot, or both diseases (Table 1). Only ‘Baccata Jackii’, ‘Bob White’, ‘Candied Apple’, ‘Profusion’, ‘Sargent’, and ‘Sargent-dwarf’ were highly resistant to both diseases.

Significance to Nursery Industry. The only diseases that caused severe symptoms over a four year period were fireblight and frogeye leaf spot. The cultivars ‘Baccata Jackii’, ‘Bob White’, ‘Candied Apple’,

Table 1. Resistance ratings of crabapple cultivars for fireblight and frogeye leaf spot.

Cultivar	FB[a]	FE[b]	Cultivar	FB[a]	FE[b]
Adams-dwarf	-	-	Jewel Berry	++	+++
Floribunda-dwarf	++	-	Klehm's Imp. Bechtel	+++	+
List-dwarf	++	-	List	+	+
Red Splender	+	++	Louisa	+	+++
Robinson	-	+	MaryPotta	+++	+
Royalty-dwarf	+	++	Ormiston Roy	+	+
Sargent-dwarf	-	-	Pink Princess	+++	+
Snowdrift-dwarf	+++	++	Pink Spires	+	+++
Spring Snow-dwarf	-	+++	Prairi Fire	+	-
Red Jade	+++	+	Professor Sprenger	++	+
Adams	-	+	Purple Prince	++	-
Adirondack	-	+	Radiant	-	+
Baccata Jackii	-	-	Red Baron	-	+++
Baskstong	-	+++	Red Jade-Weeping	++	+
Beverly	-	+	Red Jewel	++	+
Bob White	-	+	Sargent	-	-
Brandy Wine	++	+	Selkirk	+	++
Candied Apple	-	-	Sentinel	+	-
Centurion	+	+	Silver Moon	++	-
Coral Burst	-	+	Sinai Fire	+	+
David	-	-	Snowdrift	+++	+
Dolgo	-	+	Spring Snow	+	+++
Donald Wyma	+	++	Strawberry Parfait	++	+
Doubloons	+	+	Sugar Tyme	++	-
Floridbunda	+++	-	Velvet Pillar	+	-
Tea	++	+	White Angel	-	++
Indian Magic	++	+	Profusion	-	-
Indian Summer	+	-			

[a] Fireblight - where 0-1 hits = resistant (-), 2-<5 hits = mod. resistant (+), 5 - <10 hits = mod. susceptible (++), and 10 or more hits = susceptible (+++).

[b] Frogeye leaf spot - where 0-<2 % diseased foliage = resistant (-), 2-<10% diseased tissue = mod. resistant (+), 10 - <25% diseased fissue = mod. susceptible (++), and >35% diseased tissue = susceptible(+++).

Reaction of Selected Ground Cover Roses to Black Spot Disease

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Nature of Work: Black spot of rose (Diplocarpon rosae) is the most important disease of roses in the world'. Black spots form on the upper leaf surface. These spots are roughly circular with an irregular margin and range in size up to 1/2 inch.. The tissue surrounding the spot will turn yellow and this chlorosis often extends throughout the leaf, causing the leaf to drop off.

A study was initiated in 1996 to observe the reaction of selected ground cover roses to black spot. Bare root roses were potted in a pine bark:peat moss medium,3:1 vol:vol, amended with 14 lb of 17-7-12 Osmocote, 6 lb of limestone, 2 lb gypsum, amd 1.5 lb Micromax per cubic yard. Plants were maintained in full sun and watered daily with overhead impact sprinkler irrigation. One application of Orthene 75S at 1 Ib/100 gallons water was applied to control aphids and no other pesticides were applied. Visual ratings to determine the incidence of disease and the amount of premature defoliation were made on Nov 24 using a Horsfall Barratt rating scale (Table 1).

Results and Discussion: Disease incidence was significantly less on the cultivar Ralph's Creeper than on the other five rose cultivars. Baby's Blanket and Ralph's Creeper had significantly less disease related defoliation than the other four cultivars (Table 1).

Significance to Industry: Although preliminary, this study indicates that there are sign)ficant differences in resistance to black spot among ground cover roses. Of the cultivars observed, Ralph's Creeper and Baby's Blanket had the least disease and the least disease related defoliation.

Literature Cited

1. Horst, R. Kenneth, ed. 1983. Compendium of Rose Diseases. American Phytopathological Society, St. Paul, MN.

Table 1. Incidence and defoliation caused by black spot on 6 ground cover rose cultivars.

Rose Cultivar	Disease Incidence	Defoliation
Magic Carpet	7.4	7 5
Jeeper's Creepers	7.4	7.2
Red Ribbons	6.9	7.3
Central Park	5.3	7.6
Baby Blanket	5.0	4.2
Ralph's Creeper	3.6	3.7
LSD (P=0.05)	0.5	0.5

Incidence and defoliation assessed using Horsfall Barratt system: 1=0%, 2=0-3%, 3=3-6%, 4=6- 12%, 5=12-25%, 6=25-50%, 7=50-75%, 8=75-87%, 9=87-94%, 10=94-97%, 11=97-100%,12=100% of leaves diseased or prematurely defoliated respectively.

Susceptability of crapemyrtle Cultivars to Powdery Mildew and Cercospora Leaf Spot

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Nature of Study: Two diseases, powdery mildew and Cercospora leaf spot, often mar the beauty of crapemyrtle in landscape plantings across the Southeastern U.S (1,2). Both diseases may cause discoloration and distortion of the leaves as well as premature defoliation of field and container- grown crapemyrtle. Disease resistance offers an effective, less costly and fungicide-independent method of producing and maintaining plantings of crapemyrtle. Over the last three decades, the National Arboretum (3,4) along with land-grant universities and private individuals have released a number of cultivars of crapemyrtle (Lagerstroemia indica and L. indica x fauriei), many of which are reportedly resistant to powdery mildew. The sensitivity of many cultivars of crapemyrtle to Cercospora leaf spot is largely unknown. This report summarizes the reaction of 45 cultivars of crapemyrtle, maintained in a simulated landscape planting, to powdery mildew and Cercospora leaf spot.

Bare-root crapemyrtle were established in March 1993 in a Marvyn loamy sand in Auburn, AL on 8-foot centers in rows spaced 12 feet apart. Planting holes were dug to a depth of 24 to 30 inches. A randomized complete block with 6 two-plant replications was used. Each plant was watered as needed with a trickle irrigation system. To suppress weeds, aged pine bark was evenly distributed around the base of each plant. Hand weeding and directed applications of recommended rates of Roundup herbicide were also used to control weeds. The alleys between each row of trees was periodically mown. Twice each spring, each tree was topdressed with 3.2 ounces of 13-13-13 analysis fertilizer. Each winter from 1993 through 1996, all plants were lightly pruned. No pesticides were applied to control any insect pests or diseases. Visual ratings of powdery mildew and Cercospora leaf spot were made, respectively, on July 28 and September 15 in 1995 and on June 4 and September 20 in 1996. The rating scales used to evaluate both diseases are listed under Table 1.

Results and Discussion: By mid-May, powdery mildew could be seen on the young leaves and shoots of susceptible cultivars of crapemyrtle. Symptoms of Cercospora leaf spot usually did not become noticeable on most cultivars until August or early September. In 1996, the severity of powdery mildew declined while that of Cercospora leaf spot was higher than levels seen in the previous year.

Significant differences in the severity of powdery mildew and Cercospora leaf spot were noted among the 45 cultivars of crapemyrtle screened (Table 1). Over a two-year period, foliage of the cultivars 'Sarah's Favorite', 'Cherokee', 'Caddo', 'Comanche', 'Osage', and 'Acoma' remained free of powdery mildew. An additional 17 cultivars of crapemyrtle were mildew-free in either 1995 or 1996. When powdery mildew was found on any of the above cultivars, disease development on the leaves, shoots, and flower buds, as indicated by disease ratings of 0.5 or below, were very light. In both years, light and unobtrusive powdery mildew development occurred on the cultivars 'Dodd #1', 'Pecos', 'Catawba', 'Basham's Party Pink', 'Biloxi', 'Tuskegee', and 'Glendora White'. Light to moderate mildewing of the foliage and shoots of an additional 7 cultivars were seen in 1995 and 1996. In 1995, severe mildew outbreaks, which were characterized by the noticeable and heavy colonization of the leaves and tender shoots, were noted on 'Country Red', 'Gray's Red', 'Orbin's Adkins', 'Raspberry Sundae', 'Carolina Beauty', 'Wonderful White', 'William Toovey', and 'Potomac' crapemyrtle. With the exception of the 'Country Red' crapemyrtle, the mildew ratings of the above cultivars declined in 1996. Year to year variations of powdery mildew ratmgs were due to either differences in rainfall patterns, temperature, or a combination of these two weather parameters.

Several mildew-resistant cultivars of crapemyrtle also suffered light damage due to Cercospora leaf spot. Typical symptoms of this disease on the cultivars 'Tuscarora', 'Tuskegee', 'Tonto', and 'Fantasy' were confined to light spotting of a handful of leaves around the base of the tree (Table 1). Light spotting of the leaves along with no noticeable defoliation was observed on 'Basham's Party Pink', 'Dodd #1', 'Apalachee', 'Glendora White', and 'Caddo'. Heavy spotting of the leaves, which extended well up into the mid-canopy along with considerable defoliation, was seen in one or both years on the cultivars 'Souix', 'Hopi', 'Acoma', 'Comanche', Near East', 'Dodd #2', and 'Yuma'. The cultivars 'Caroline Beauty', 'Wonderful White', 'Raspberry Sundae', 'Powhatan', 'Peppermint Lace', 'Majestic Beauty' and 'Orbin's Adkins' were heavily damaged by both powdery mildew and Cercospora leaf spot.

Significance to Industry: Good resistance to both powdery mildew and Cercospora leaf spot was identified in nine of the forty five crapemyrtle cultivars screened. The beauty and vigor of these particular cultivars can easily be maintained in both a production nursery and landscape without the need for costly protective fungicide treatments. Fifteen cultivars, which were heavily damaged by either powdery mildew, Cercospora leaf spot or both diseases, would be poor choices to establish in residential or residential landscapes.

Literature Cited

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3. Eglof, D. R. 1987. 'Apalachee', 'Comanche', 'Lipan', 'Osage', 'Souix', and 'Yuma' Lagerstroemia HortScience22:674-677.

4. Eglof, D. R. 1991. In the Pink. American Nurseryman 177(2):87-92.

Table 1. Reaction of Crapemyrtle Cultivars to Powdery Mildew and Cercospora Leaf Spot.

	Disease Rating			
	Powdery Mildew[1]		Cercospora Leaf Spot[2]	
Cultivar	95	96	95	96
County Red	2.8	2.5[3]	4.0	4.6
Caroline Beauty	2.3	1.6	5.8	6.3
Raspberry Sundae	3.1	1.5	4.6	5.7
Wonderful White	2.4	1.5	5.0	6.8
William Toovey	1.9	1.3	3.7	4.4
Regal Red	0.6	1.2	2.1	4.0.
Powhatan	1.3	1.1	3.4	5.5
Hardy Lavender	1.1	1.1	4.2	5.1
Majestic Beauty	1.7	1.0	3.7	5.3
Pepermint Lace	1.7	1.0	4.0	5.6
Gray's Red	2.2	0.8	3.5	3.9
Orbin Adkins	2.4	0.7	5.8	6.7
Velma's Royal Delight	1.2	0.6	2.0	3.3
Glendora White	0.4	0.4	2.3	3.7
Tuskegee	0.1	0.4	1.8	1.5
Biloxi	0.4	0.3	4.4	5.3
Zuni	1.3	0.3	4.8	4.4
Seminole	0.8	0.3	3.3	5.6
Potomac	1.8	0.3	2.7	4.5
Basham's Party Pink	0.2	0.2	2.8	2.5
Dodd #2	0.4	0.2	N.R.	6.3
Catawba	0.7	0.1	3.6	4.6
Natchez	0.0	0.1	4.3	4.6
Choctaw	0.0	0.1	4.5	4.6
Pecos	0.4	0.1	2.8	5.1
Dodd #.1	0.1	0.1	3.3	2.7
Acoma	0.0	0.0	5.3	6.3
Hopi	0.2	0.0	3.9	5.7
Comanche	0.0	0.0	5.6	6.6
Lipan	0.3	0.0	2.9	5.1
Osage	0.0	0.0	2.8	4.0
Souix	0.1	0.0	4.3	5.2
Apalachee	0.2	0.0	2.7	2.8
Yuma	0.4	0.0	4.9	5.0
Miami	0.1	0.0	3.5	4.7
Muskogee	0.2	0.0	4.7	4.8
Tuscarora	0.5	0.0	1.7	2.4
Wichita	0.3	0.0	2.8	3.6
Near East	0.3	0.0	5.0	5.4

Centennial Spirit........................	1.6	0.0	2.2	4.8
Fantasy	0.4	0.0	1.4	1.1
Caddo	0.0	0.0	2.4	2.9
Cherokee	0.0	0.0	2.3	4.0
Sarah's Favorite	0.0	0.0	3.5	3.8
Tonto..	0.1	0.0	2.3	1.3

[1]The severity of powdery mildew as assessed on a scale of 0 to 4 where 0 = no disease, 1 = 1 to 25%, 2 = 26 to 50%, 3 = 51 to 75%, 4 = 76 to 100% of the leaves damaged or colonized by E. Lagerstroemia. [2]Cercospora leaf spot was evaluated on using the Barratt and Horsfall System: I = 0%, 2 = 0-3%, 3 = 3-6%, 4 = 6-12%, 5 = 12-25%, 6 = 25- 50%, 7 = 50-75%, 8 = 75-87%, 9 - 87-94%, 10 = 94-97%, 11 = 97-100%, 12 =100% of leaves diseased. [3]Mean separation within columns according to Fisher's protected least significance (LSD) test (P = 0.05).

Chemical Control of Fireblight on Crabapple

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Nature of Work: Fireblight, which is caused by the bacterium *Erwinia amylovora,* is a common and often damaging disease of crabapple and other closely related members of the Rose family. In Alabama this past spring, disease severity was especially high in plantings of crabapple, flowering pear, and Indian hawthorn. Few studies have been done to determine the activity of available bactericides against this disease on landscape ornamentals. The objective of this study was to assess the effectiveness of several commercially available bactericides and experimental pesticides against fireblight on crabapple.

Bare-root crabapple (Malus sp.) Snowdrift were planted in March 1995 in a Benndale sandy loam soil at the Brewton Experiment Field on 10 foot centers with 10 feet between each row. Prior to planting, soil fertility and pH were adjusted according to soil assay recommendations. After planting, all trees were mulched with pine bark. Each spring for the past two years, each bed has been topdressed with fresh pine bark. In March and June, approximately 50 lb. of a 164-8 fertilizer was broadcast down each row of trees. A tank-mixture of 1 lb. of Gallery and 2 qt. of Surflan per acre was broadcast down each row. The plots were also hand weeded and spot treated with Roundup herbicide as needed. The experimental design was a randomized complete block with 5 two-plant replications. All treatments, which are listed in Table 1, were applied to run-off using and ATV-mounted electric sprayer set at 45 psi using a single nozzle on a hand-held wand. Each year, the dormant application of Kocide 101 77W was made in early March just prior to bud break. All other treatments were applied weekly from mid-March until mid-May. Fireblight severity was rated on May 29, 1996 and May 19, 1997 using the scale listed below Table 1.

Results and Discussion: Significant reductions in the severity of fireblight below the levels observed on the untreated control were obtained in both years only with Agri-Strep 21W. In both years, blighting of a few scattered shoot tips and bloom clusters was often noted on many of the crabapples treated with Agri-Strep 21W. None of the other treatments tested significantly reduced fireblight as compared to that of the untreated control. Disease severity ratings for the trees treated with Kocide 101 77W and Phyton 27 significantly differed from those of the Agri-Strep 21W-treated trees in 1997 but not in 1996. No symptoms of phytotoxicity was observed either year with any of the treatments tested.

Significance to Industry: Of the bactericides tested, only Agri-Strep 21W controlled fireblight on crabapple in 1996 and 1997. Phyton 27 and Kocide 101, which are registered for the control of fireblight on woody ornamentals and apple, respectively, did not consistently reduce disease severity.

Table 1. Chemical control of fireblight on 'Snowdrift' crabapple.

	Disease Severitv[1]	
Treatment and Rate per 100 gal.	1996	1997
Agri-Strep21W 0.5 lb.	1.2	1.5
Fluazinam 500F 12.0 fl. oz.	2 7	2.4
Aliette 80WDG 2 lb.	2 8	2.7
Phyton 27 12.5 fl. oz.	1.9	2.8
Kocide 101 77W 12 lb.	1.6	2 3
Untreated Control	2.3	2 6
LSD (P=0.05)	0.8	0.6

[1]Fireblight severity was assessed on a scale of O to 5 with 0 = no disease, 1 = one or a few diseased branch tips, 3 = numerous diseased branch tips with a few major branches killed, 4 = major portion of tree killed, 5 = tree killed.

Dogwood Selections Differ intheir Susceptability to Powdery Mildew and Spot Anthracnose

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Nature of Work: Prior to 1994, powdery mildew was a disease rarely seen on flowering dogwood (*Cornus florida*). That year, this disease, which is caused by the fungus Microsphaera penicillata, appeared simultaneously in landscape and nursery plantings of flowering dogwood throughout the eastern U.S (2). In Alabama, powdery mildew has displaced spot anthracnose as the most common disease of flowering dogwood in residential landscapes. Although damage to flowering dogwood is largely cosmetic, slowed growth and in some cases death of year-old field stock has been attributed to powdery mildew. In Alabama, native flowering dogwoods differ considerably in their reaction to this disease; trees with heavily colonized foliage may be found next to those showing few signs of powdery mildew.

Spot anthracnose, which is caused by the fungus *Elsinoe (corni)*, occurs where flowering dogwood are found and is most prevalent on trees grown in full sun. Although the impact of this disease on tree vigor is minor, the bracts and leaves of susceptible trees may be badly defaced and distorted.

Selections of Kousa (C. kousa) and Kousa x florida hybrid (*C. kousa* x *florida*)dogwoods have been shown to be highly resistant to *M. penicillata*-incited powdery mildew (2). Information concerning the reaction of many cultivars of flowering dogwood to powdery mildew and spot anthracnose is limited (3). The objective of this study was to determine the reaction of selections of flowering, kousa, *C. kousa* x *florida* dogwoods as well as single selection of *C. nuttallii* x *florida* and giant dogwood (*C. controversa*) to powdery mildew and spot anthracnose. A preliminary report has been published (1).

Bare-root dogwoods were planted on March 3, 1993 into a Marvyn loamy sand on 8 foot centers in rows spaced 12 feet apart. A trickle irrigation system with two emitters per tree was installed at the time of establishment. Twice each spring, approximately 0.2 lb. of 13-13-13 analysis fertilizer was uniformly distributed around the base of each plant. Directed applications of Roundup herbicide at recommended rates were made to control weeds. Weeds were also pulled by hand. Alleys between the rows were periodically mown. In 1996, all trees were mulched with aged pine bark. Visual ratings of spot anthracnose and powdery mildew, respectively, were made on April 4 and May 23, 1995, April 29 and May

30, 1996, and April 14 and May 16, 1997. The disease rating scales for spot anthracnose and powdery mildew are listed below Table 1.

Results and Discussion: The flowering dogwood and pacific x flowering dogwood 'Eddie's White Wonder' were more susceptible to both powdery mildew and spot anthracnose than the other dogwood selections. Overall, powdery mildew disease ratings for the flowering dogwood cultivars and 'Eddie's White Wonder', which declined between 1995 and 1996, sharply increased again in 1997. (Table 1). Spot anthracnose-incited spotting of the leaves and bracts has progressively increased in intensity from 1995 to 1997. Low spot anthracnose and powdery mildew ratings for the kousa, giant, and kousa x flowering dogwoods are a strong indicator of their high level of resistance to these two diseases.

Sizable differences in the level of powdery mildew were seen among the cultivars of flowering dogwood (Table 2). Of these, 'Cherokee Brave' consistently remained free of powdery mildew. Over all three years, the highest mildew ratings were usually noted on cultivars with either pigmented bracts or variegated leaves such as 'Autumn Gold', 'Stokes Pink', 'Rubra Pink', 'Pink Beauty', 'Red Beauty', 'Purple Glory', end 'Pink Flame'. Little or no powdery mildew development occurred on the foliage of any of the cultivars of kousa, kousa x flowering, or giant dogwood (Table 3).

Among the 26 cultivars of flowering dogwood, only Rainbow suffered severe spot anthrancose-related leaf spotting and distortion in 1995, 1996 and 1997 (Table 2). In 1995, damage on the leaves of the remaining cultivars was negligible. Over the next two years, considerable spotting and distortion of the leaves and bracts was noted on the cultivars 'Cherokee Princess', 'Cloud 9', 'Ozark Spring', 'Springtime', and 'Barton White'. On the remaining cultivars of flowering dogwood and pactfic x florida hybrid 'Eddie's White Wonder', light to moderate spotting of the bracts and leaves was seen in 1996 and 1997. In 1997, Cultivars of flowering dogwood with the least spot anthracnose damage on the bracts and leaves included 'Cherokee Chief, 'Cherokee Brave', 'Weaver's White', 'Cherokee Sunset', Junior Miss' and 'Welch's Bay Beauty'. With the exception of 'Rush Ellen in 1996 and 'Constellation' in 1997, the leaves and bracts of the kousa and kousa x flowering dogwoods remained largely free of spot anthracnose (Table 3). Some light spotting of the leaves was noted on the giant dogwood 'Controversy' in 1996 but not in 1995.

Although year to year variations in the severity of powdery mildew appear to be weather related, the severity of spot anthracnose has intensified as the trees have aged. Overall, the cultivars of flowering and pactfic x flowering dogwood proved to be more susceptible to spot anthracnose and powdery mildew than cultivars of the kousa, kousa x flowering, or giant dogwood. However, several flowering dogwood cultivars such as 'Cherokee Brave', 'Cherokee Chief, 'Cherokee Sunset', 'Welch's Bay Beauty' and 'Weaver's White' have good resistance to both powdery mildew and spot anthracnose. Although the kousa, kousa x flowering and giant dogwoods have superior resistance to powdery mildew and spot anthracnose, they apparently are much more sensitive to winter injury than the flowering dogwoods. After the bitterly cold winter of 1996, significant tree death was noted in nearly all cultivars of kousa, kousa x flowering, and giant dogwood. By mid-May 1997, few individuals among any of these dogwood taxa have remained healthy.

Significance to Industry: The production, marketing, and establishment of disease resistant flowering dogwoods makes good economic and environmental sense for nursery producers as well as retail outlets, landscape managers, and homeowners. Disease resistance allows the nursery producer to grow a quality container or field-grown dogwood with fewer costly pesticide and labor inputs. For consumers, a disease resistant dogwood means into an attractive, relatively pest-free, low maintenance tree.

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Table 1. Response of dogwood taxa to spot anthracnose and powdery mildew.

		Disease Ratings							
					Spot Anthracnose				
	No.	Powdery Mildew[1]			Bracts		Leaves		
Dogwood Taxa	Cultivars	95	96	97	96	97	95	96	97
Flowering dogwood	26	1.4	0.9	1.7	1.5	1.8	0.3	1.3	1.8
Kousa dogwood	3	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Kousa x flowering hybrid	7	0.1	0.0	0.3	0.6	0.8	0.0	0.3	0.4
Pactfic x flowering hybrid	1	1.7	0.5	1.9	2.0	N.R.	0.2	1.4	1.3
Giant dogwood	1	0.0	0.0	N.R.	N.R.[2]	N.R.	0.0	0.7	N.R.
LSD(P=0.05)		0.7	0.6	0.6	1.2	0.6	N.S.	0.7	0.7

[1]Severity of powdery mildew and spot anthracnose was assessed on a scale of O to 4 where 0= no disease, 1 = 1 to 25%, 2 = 26-50%, 3 = 51 to 75%, 4 = 76-100% of leaves damaged.[2]N.R. = not recorded.

Table 2. Reaction of cultivars of flowering dogwood to powdery mildew and spot anthracnose.

	Powdery Mildew[1]			Spot Anthracnose[1] Bracts		Spot Anthracnose[1] Leaves		
Cultivar	95	96	97	96	97	95	96	97
Flowering dogwood								
Dwarf White	3.0	0.0	2.0	2.0	4.0	0.0	2.0	2.0
Autumn Gold	2.9	1.0	1.8	N.R[2]	N.R.	0.7	1.4	1.8
Pink Beauty	2.6	1.5	2.8	1.6	2.4	0.0	1.1	1.8
Pink Flame	2.5	1.2	2.7	2.0	1.5	0.0	1.2	2.0
Wonderberry	2.2	0.5	1.8	1.8	2.2	0.4	0.6	2.1
First Lady	2.1	0.6	2.4	1.8	2.0	0.3	1.5	2.2
Rubra Pink	2.0	1.6	2.0	0.5	1.5	0.3	1.1	2.0
Red Beauty	2.0	1.4	1.8	1.0	0.8	0.3	1.4	2.0
Purple Glory	2.0	1.3	2.3	1.5	2.0	0.0	1.0	1.1
Welch's Bay Beauty	1.8	0.0	1.1	0.9	0.3	0.2	0.4	0.2
Ozark Spring	1.8	1.2	2.0	2.3	2.8	0.2	2.0	2.9
Fragrant Cloud	1.8	1.0	1.3	1.3	1.7	0.0	1.3	2.1
Welch's lunior Miss	1.7	0.9	2.2	1.3	1.3	0.0	2.6	1.1
Cloud 9	1.7	1.3	1.4	2.6	2.3	0.0	2.6	2.4
World's Fair	1.6	0.8	1.8	1.9	2.0	0.0	1.8	1.8
Rainbow	1.6	1.3	1.1	2.0	1.9	2.8	3.0	3.7
Barton White	1.5	0.7	1.6	3.3	3.5	1.0	2.7	2.0
Double White	1.5	0.5	1.2	0.5	0.8	0.5	1.3	2.2
Cherokee Princess	1.5	1.1	1.8	2.3	2.3	0.0	1.3	2.1
Stokes Pink	1.5	1.8	2.6	1.5	2.8	0.0	0.9	0.2
Cherokee Sunset	1.4	0.4	2.4	0.0	0.5	0.2	0.0	1.4
Cherokee Chief	1.4	0.6	1.6	0.7	1.0	0.0	0.6	1.3
Weaver's White	1.1	1.0	1.4	1.1	1.5	0.0	0.8	1.1
Cherokee Daybreak	0.9	0.0	1.5	3.0	1.7	0.5	1.1	1.4
Springtime	0.8	0.3	1.0	2.3	2.4	0.0	2.3	2.6
Cherokee Brave	0.2	0.0	0.0	1.0	1.1	0.0	0.6	1.5
LSD (P=0.05)	0.8	0.9	0.7	0.9	1.0	0.6	0.6	0.8

1Severity of powdery mildew and spot anthracnose was assessed on a scale of 0 to 4 where 0 = no disease, 1 = 1 to 25%, 2 = 26-50%, 3 = 51-75%, and 4 = 76 to 100% of leaves damaged or diseased. [2]N.R. = not recorded.

Table 3. Reaction of several dogwood taxa to powdery mildew and spot anthracnose.

	Powderv Mildew[1]			Spot Anthracnose[1] Bracts		Spot Anthracnose[1] Leaves		
Cultivar	95	96	97	96	97	95	96	97
Pactfic x flowering dogwood								
Eddie's White Wonder	1.3	0.5	1.9	2.0	N.R.	0.3	1.4	1.3
Kousa dogwood								
Milky Way	0.3	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Satomi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Milky Way Select	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
National	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kousa x flowering dogwood								
Star Dust	0.2	0.0	0.4	0.0	0.7	0.0	0.0	0.0
Ruth Ellen	0.1	0.1	0.2	1.1	0.9	0.0	0.3	0.8
Galaxy	0.1	0.0	0.8	0.0	0.5	0.0	0.0	0.1
Constellation	0.0	0.1	0.0	1.0	1.8	0.2	1.1	0.8
Stellar Pink	0.0	0.0	0.0	0.0	0.3	0.0	0.2	0.0
Aurora	0.0	0.0	0.8	0.0	0.8	0.0	0.0	0.7
Giant dogwood								
Controversv	0.0	0.0	N.R	N.R.	N.R.	0.0	0.7	N.R.
LSD(P=0.05)	0.8	0.9	0.7	0.9	1.0	0.6	0.6	0.8

[1]Severity of powdery mildew and spot anthracnose was assessed on a scale of O to 4 where 0 = no disease, I = I to 25%, 2 = 26-50%, 3 = 51-75%, and 4 = 76 to 100% of leaves damaged or diseased.[2]N.R. = not recorded.

Optimizing Detection of *Phytophthora* spp. in Nursery Container Mixes

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Nature of Work: Phytophthora root rot is one of the most economically important diseases affecting ornamental crops grown in South Carolina nurseries and elsewhere (Blake, 1996; Jones & Lambe, 1982). The disease affects a wide variety of woody ornamentals such as azalea, boxwood, camellia, juniper, pine, and rhododendron (Blake, 1996; Jones & Lambe, 1982). Detection of *Phytophthora* spp. in nursery container mixes before symptoms develop could be an important factor in the development of an integrated management strategy for Phytophthora root rot. To this end, we are developing a baiting bioassay to detect Phytophthora spp. in naturally-infested container mixes. Our results to date are reported here.

Condition of the container mix, bait types, baiting durations, and baiting temperatures were compared to determine the optimum conditions for detecting *Phytophthora* spp. in container mixes. The effect of container mix condition at the time of baiting (i.e., either fresh or air-dried then remoistened) was compared because, in previous studies, detection of homothallic *Phytophthora* spp. was enhanced in soils that were air-dried and then remoistened prior to baiting (Jeffers & Aldwinckle, 1987). Leaf disks of silver dollar eucalyptus, *Camellia japonica*, and azalea as well as whole leaves of shore juniper, Japanese holly, and Gumpo azalea were tested as potential baits. Whole leaf baits were evaluated to determine if they would reduce the amount of contamination by fast-growing *Pythium* spp. that tends to be a problem with leaf disks. To be most useful, any bait selected should be available year-round so soils can be baited at any time. Eucalyptus leaf disks are the standard bait used by the Clemson University Plant Problem Clinic to assay soils for *Phytophthora* spp. Eucalyptus leaf disks, azalea leaf disks, and conifer needles have been used successfully in other studies to detect Phytophthora spp. in soil (Tsao, 1983). *Camellia japonica* and Japanese holly have not been tested as baits before, but both plants are susceptible to *Phytophthora* root rot. Baiting temperatures of 15 C [59 F], 20 C [68 F], and 25 C [77 F] and baiting durations of 24 hr, 48 hr, and 72 hr were compared for effects on detection of *Phytophthora* spp. and interference from other contaminating fungi.

Naturally-infested container mixes submitted as samples to the Clemson University Plant Problem Clinic were used for all experiments; 5-10 different mixes were used in any one experiment. At least three replicates were used for each treatment in all experiments, and each experiment was replicated at least once. Prior to use, baits were surface disinfested in 10% bleach solution and rinsed in distilled water. Baits then were floated in deep glass Petri plates containing 30 ml (1 fl oz) of container mix and 50 ml (1.7 fl oz) of distilled water. Plates were held at a constant temperature for 1-3 days. After the appropriate duration, baits were placed on PARPH, a medium selective for *Phytophthora* spp. (Jeffers and Martin, 1986) that was modified by using clarified V-8 juice instead of cornmeal as the basal medium . Isolation plates then were placed at 20 C and examined over a 7-day period for mycelium growth typical of *Phytophthora* spp. or contaminating fungi. The number of baits positive for P*hytophthora* spp. and contaminants were recorded, and percentages were calculated.

For all experiments, percentage data were transformed to arcsin-squareroot values prior to analysis to stabilize variances. Transformed data were analyzed by two-way analysis of variance using SAS statistical software. Treatment means were separated by Fisher's Protected Least Significant Difference (P<0.05).

Results and Discussion: Container Mix Condition. In many trials, soils were baited both fresh (i.e., as they were collected in the field) and after air-drying and then remoistening. In one container mix sample, *Phytophthora* sp. was detected only in the air-dried and remoistened sample. Consequently, condition of the container mix prior to baiting can affect detection of *Phytophthora* spp. in some container mixes.

Bait Type. In trials to determine which type of bait was most effective for detecting *Phytophthora* spp., all baiting was done at 22 C (71.5 F), and baits were moved to isolation plates after 24 hr. Initially leaf disks of azalea, eucalyptus, and camellia were compared. Both eucalyptus and camellia leaf disks detected *Phytophthora* spp. more consistently and frequently than azalea leaf disks. Leaf disks of camellia and eucalyptus then were compared to entire leaves of Japanese holly and Gumpo azalea and entire needles of shore juniper. As expected, entire leaves and needles usually were less contaminated than leaf disks. Overall, camellia leaf disks detected *Phytophthora* spp. most consistently and frequently. Camellia baits frequently were contaminated, but contamination was limited and usually did not interfere with detection. Camellia leaf disks detected *Phytophthora* spp. whenever other baits did except in one container mix. Of the whole leaf baits, juniper needles were most consistent and successful as baits for *Phytophthora* spp. Consequently, using camellia leaf disks and juniper needles together to bait *Phytophthora* spp. in container mixes should detect a greater array of species than either bait used alone and should minimize interference from other contaminating fungi.

Baiting Duration. In the trials to determine the optimum baiting duration, baiting was done at 22 C [77 F] with five camellia leaf disks and five juniper needles used in each replicate. In these trials, *Phytophthora* spp. usually were detected more frequently at 72 hr than at 24 or 48 hr, but baits also were more contaminated at 72 hr. Therefore, removing some baits at 24 hr may improve detection in container mixes where contamination is a problem.

Baiting Temperature. In the baiting trials to compare temperatures, five camellia leaf disks and five juniper needles were used in each replicate plate, and plates were held at the specified temperature for 48 hr. Temperature did not have a dramatic effect on detection. However, in some trials, *Phytophthora* spp. were detected less frequently at 15 C than at 20 or 25 C. Therefore, baiting should be done between 20 and 25 C, which includes normal room temperature, for the most consistent results.

In conclusion, we currently are using both *Camellia japonica* leaf disks and shore juniper needles in a baiting bioassay to detect and isolate *Phytophthora* spp. from nursery container mixes. Container mix samples are baited fresh and after air-drying and remoistening to enhance the diversity of species detected. Baiting is done at 20-25 C; half of the baits are removed at 24 hr and the remainder are removed at 72 hr. Currently, this method is being used to identify species of *Phytophthora* and sources of inoculum present in South Carolina nurseries. Representative isolates of *Phytophthora* spp. from container mixes have been retained in a collection for identification. So far, the species detected appear to be predominantly *P. cinnamomi* and *P. nicotianae* (= *P. parasitica*) although other species also have been found. In the near future, we plan to investigate the sensitivity of these two baits to zoospores of *Phytophthora* spp. known to attack nursery crops and to compare the efficacy of various cultivars of Camellia japonica as baits for *Phytophthora* spp.

Significance to the Industry: We are developing a bioassay to detect species of *Phytophthora* that attack nursery crops in container mixes before symptoms occur on plants. This assay will be used to identify potential sources of pathogen inoculum in South Carolina nurseries. In addition, the assay will have an important role in devising an integrated strategy for managing Phytophthora root rot in nurseries in South Carolina and elsewhere. It will enable us to identify infested nursery stock and recommend appropriate control measures before epidemics occur and economic loss is incurred.

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Melia volkensii Extract: A Natural Product Inhibitor of *Agrobacterium tumefaciens* Induced Tumors

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Nature of Work: Crown gall is a neoplastic disease of plants induced by specific strains of the Gram negative bacterium, *Agrobacterium tumefaciens* [1]. Crown gall is found world wide and effects 140 genera of more than 60 families of woody and herbaceous plants, causing economically significant damage to stone and pome fruit trees such as almond, apple, cherry, peach and plum, as well as damaging ornamental plants and grapes [2]. The disease is characterized by the formation of tumors or galls, of varying size and form. These tumors occur most frequently just below the soil surface at the root collar. Young plants with large or numerous galls tend to be stunted and predisposed to drought damage or winter injury. Floral display or fruit production may also be suppressed. Although mature trees often seem to be able to support large galls without noticeable debilitation, these severely diseased plants are subject to attack by secondary pathogens [3].

Melia volkensii (Meleacea) is a subtropical tree that naturally occurs in East Africa. Extracts from several parts of the tree are biologically active. Extracts of the seed kernels and fruits have insecticidal and antifeedant activity [5,6,7]. A limonoid in the root bark was shown to have activity against certain human tumor cell lines, and high activity against human breast tumor cell lines [8]. In our continuing interests in natural product discovery, an extract of the fruit known as MV-extract was screened for inhibition of *A. tumefaciens*-induced tumors using the potato disc assay. This bioassay is useful for the examination of plant extracts and purified compounds that may inhibit crown gall disease [4]. Antitumor activity of MV-extract and ellagic acid was compared to that of camptothecin. Camptothecin, a lead compound for two anticancer drugs from *Camptothecia accuminata*, and ellagic acid, a common hydrolyzable tannin found in several small fruits, were included for comparison because they inhibit human and plant tumors [7, D. E. Wedge unpublished data].

The potato disc assay described by Gatsky and Wilsey [10] and modified by Ferrigni et al. [11] was used to evaluate plant-derived compounds for inhibition of tumors induced by *A. tumefaciens*. Fresh, disease-free potato tubers (red varieties) were surface sterilized by immersion in 1% sodium hypochlorite and cored using a sterile 1.5 cm cork borer to remove a cylinder shaped core of tissue. A 1 cm section was cut from each end of the cored tissue and discarded. The remaining core was cut into 3-4 mm thick discs with a sterile scalpel and discs were transferred to 1.5% water agar plates. The experiment was a completely randomized design with 5 discs per plate and 3 replicates for each test sample. Extracts were applied in a dose-response format where 5.0, 10.0, and 20.0 g/disc were used for MV-extract, ellagic acid and Camptothecin. Camptothecin was used as the experimental standard and dimethyl sulfoxide (DMSO; 10, 20 and 40%) was used as the control in the same concentrations as in test samples. Each disc was inoculated with 50 of each test solution containing a particular dose of test compound, DMSO, water and *A. tumefaciens* B6 at 1.0 x109 cells. Plates were incubated at room temperature for 12 days. Tumors were stained with Lugol's solution (iodine/potassium iodide) and counted under a dissecting microscope. The results are expressed as percentages versus the number of tumors on control discs. Meaningful activity is indicated when a natural product compound gave a consistent value of 20% or greater inhibition when compared with the control.

Results and Discussion: Ellagic acid and MV-extract show dose-dependent activity against *A. tumefaciens* induced tumors (Figure 1). Inhibition of tumor initiation and development by Camptothecin was similar for all doses tested and consistent with its anticancer activity. Ellagic acid has greater antitumor activity at each concentration when compared to MV-extract, but the lowest dose tested 5.0 g had significantly less activity when compared to that of Camptothecin. Further investigations are strongly indicated because both ellagic acid and MV-extract showed greater than 20% inhibition for all doses tested.

Significance to the Industry: Control of crown gall disease will decrease the economic losses suffered by nurseries in which crown gall has proliferated. Several control methods are currently practiced which include painting galls with a mixture of hydrocarbons, soaking germinated seeds in a suspension of an antagonistic strain of *A. radiobacter*, or drenching the soil with the antagonist. Unfortunately, these controls have failed in some places. Our preliminary data suggests that MV-extract and ellagic acid may represent a more effective method of control for crown gall disease. Future studies should evaluate in vivo activity of these compounds as natural product controls for crown gall disease in ornamentals.

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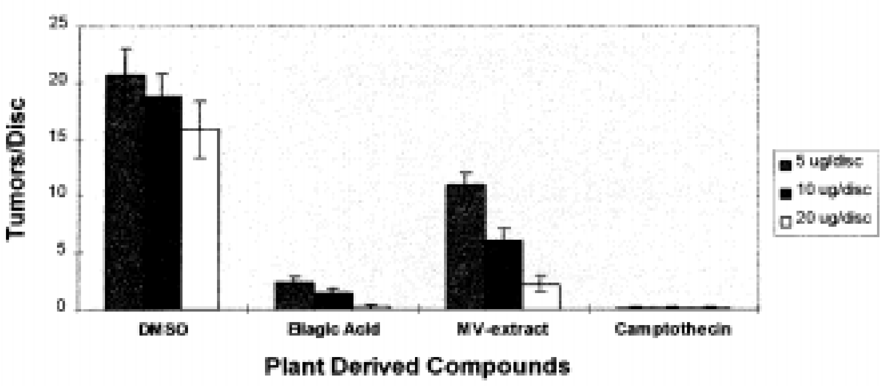

Figure 1. Inhibition of crown gall tumors induced by *Agrobacterium tumefaciens* in potato tissue. Test materials applied to potato tissue were ellagic acid, MV-extract and Camptothecin. Dimethyl sulfoxide (DMSO) (10, 20 and 40%) in the same respective concentration as for each dose (5, 10 and 20 ug) was used as the control.

Table 1. Percentage tumor inhibition by plant-based materials when compared to the Dimethyl sulfoxide (DMSO) control. Meaningful activity is indicated when the assay gives a consistent value of 20% or greater inhibition.

INHIBITION OF TUMORS INDUCED BY *A.Tumefaciens*			
MATERIALS TESTED	DOSE		
	5.0 µg/disc	10.0 µg//disc	20.0 µg/disc
ELLAGIC ACID	88%	92%	97%
MV-EXTRACT	47%	67%	86%
CAMPTOTHECIN	100%	100%	100%

A Comparison of *Discula* Species Toxicity

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Nature of the Work: Anthracnose diseases caused by *Discula* have a major impact on the health of trees in forest and urban landscapes. *Discula* species are especially destructive pathogens of dogwood, maple, ash, oak and other major forest trees. However, because their importance has only recently been recognized, they are poorly understood. Diseases such as anthracnose that are characterized by chlorosis, necrosis or wilting are prime candidates for phytotoxin research. Anthracnose diseases, once thought to be innocuous leaf blemishes, may have a serious toxicological component important in pathogenesis (3). Our research demonstrates that the dogwood anthracnose fungus, *Discula destructiva* Redlin, produces toxins that appear to be involved in the disease process in flowering dogwood (*Cornus florida*) (5). The purpose of our research was to probe deeper into the toxicology of *Discula* and evaluate the production of toxic metabolites for three members of the genus *Discula* known to produce anthracnose symptoms.

Anthracnose fungi representing different *Discula* species were obtained from cooperators. *D. destructiva* isolates from flowering dogwood were obtained from S. D. McElreath (Isolate100, Type I) and M. L. Daughtrey (Isolate 123, Type I); and an unknown *Discula* sp. (Type 2) from R. L. Anderson (Isolate 99). *D. campestris* (Williams Hollow, Bloss Mountain) was collected by T. J. Hall from sugar maple and *D. fraxinii* collected by Scott Redlin (96001, 96003, 96004) from green ash.

Conidial suspensions were prepared for each respective *Discula* isolate. Each of two 500-ml flasks containing 250 ml of Murashige and Skoog medium (MS), modified with 30 g sucrose, were inoculated with 1.0 x 10^6 conidia (5). The MS control flask was inoculated with 1.0 ml of sterile water instead of conidial suspension. Stationary cultures were grown for 4 months and maintained at 23±2°C under ambient laboratory lighting (3±1µmol) using cool white flourescent lights with 12-hr photoperiods.

A modification of the procedure of Desilets and Belanger to study toxins associated with *Pythium* spp. was used for extraction and separation of *Discula* culture filtrates (1). Cultures were initially filtered through Whatman #1 and #44 filter papers to remove fungal hyphae. They were then run through a YM100 (>100,000 da.) ultrafiltration membrane. Samples were obtained at each stage of the purification procedure and evaluated for activity using the radish seedling root bioassay (2, 5).

Results and Discussion. Following filtration, diluted culture filtrates from *D. destructiva* (100 and 123) and *D. campestris* (Williams Hollow) inhibited the root growth of radish seedlings (Figure 1). Root growth was not inhibited by culture filtrates from D. campestris (Bloss Mountain) or *D. fraxinii* (Df001, Df003, and Df004). Isolate 99, an unknown Discula sp., appeared to stimulate root growth relative to the culture filtrates from other fungal isolates, MS and water controls.

Following ultrafiltration (100,000 da.), root growth of radish seedlings was still inhibited when exposed to diluted culture filtrates from *D. destructiva* 100 and 123 (Figure 2). However, the D. campestris, Williams Hollow, was no longer inhibitory to root growth and was comparable to the other *D. campestris*, Bloss Mountain. *D. fraxinii*, Df004 activity appeared to be affected the most by ultrafiltration. The inhibitory activity of *D. destructiva* is consistent with the production of phytotoxins by this species (3, 6). The role of toxins associated with diseases caused by *D. campestris* and *D. fraxinii* are unreported and further investigations should focus on screening virulent strains for phytotoxicity.

Significance to the Industry. Knowing how or if fungal toxins are important in the development of anthracnose diseases caused by *Discula* species will provide a better understanding of these fungi that may lead to new approaches in disease control and forest and nursery management. Determining the role of *Discula* phytotoxins as virulence factors or determinants of pathogenicity could facilitate the development of anthracnose resistant varieties through breeding, genetic engineering or other in vitro techniques.

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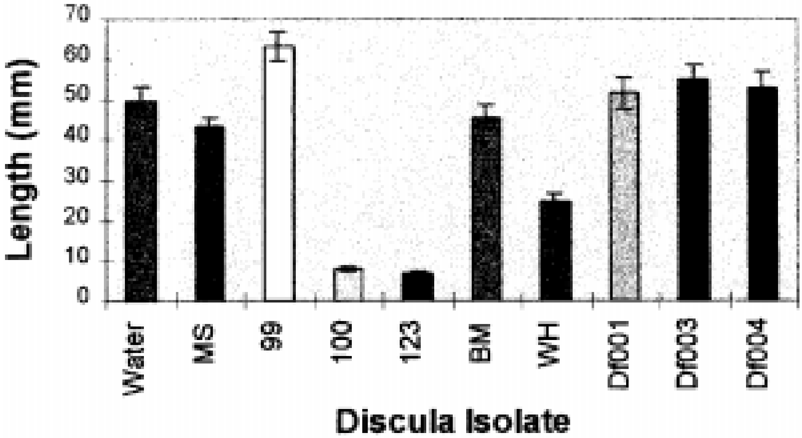

Figure 1. Seedling root growth inhibition in response to toxic metabolites from culture filtrates filtered through Whatman # 1 and # 44 paper. *Discula destructiva* (isolates 100 and 123) isolated from flowering dogwood, *D. campestris* [Williams Hollow (WH) and Bloss Mountain (BM)] from sugar maple, and *D. fraxinii* (Df001, Df003 and Df004) from green ash.

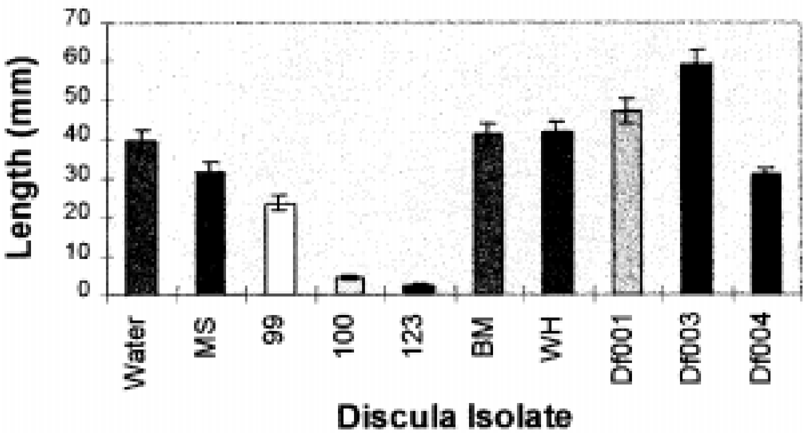

Figure 2. Seedling root growth inhibition in response to toxic metabolites from culture filtrates filtered through 100,000 dalton ultrafiltration membrane. *Discula destructiva* (isolates 100 and 123) isolated from flowering dogwood, *D. campestris* [Williams Hollow (WH) and Bloss Mountain (BM)] from sugar maple, and *D. fraxinii* (Df001, Df003 and Df004) from green ash.

Ethephon Suppression of Leafy Mistletoe Growth

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Nature of work: Leafy mistletoe, *Phoradendron flavescens*, is a parasite that attacks hardwoods and can become an economic problem from its excessive growth on urban trees. Mistletoe is a flowering plant which parasitizes other plants and is frequently seen on oak, hackberry, locust and elm trees. Mistletoe obtains water and nutrients from the tree's conductive system that would normally nourish the tree. Its attachment organs are closely associated with the vascular system of its host. This parasite can cause dieback and weakening of terminal limbs. It is spread by birds as well as wind and water. Mechanical control, by removing the infected portion of the tree is the recommended method of control of mistletoe. However, this may not be feasible in many situations. Merely removing the green portion has not been satisfactorily because it will develop at the point of removal and produce another clump of growth. Removal of a chip of host tissue at the point of attachment has been somewhat effective in controlling mistletoe. This method of control removes the generative portion of the parasitic plant . However, as a result of the removal of the protective bark, the host tissue may be subjected to wood rotting fungi.

Four trees, on the Mississippi State University campus, Starkville, MS, infested with mistletoe were selected and two or more clumps of mistletoe per tree were sprayed to the point of run off with ethephon, Florel® Brand Fruit Eliminator, at a 5400 ppm solution (32 ounces per 4 gallons of water. A hand held compressed sprayer was used for all applications. Treatments were made on April 16, 1996 and identified with marking ribbon. Observations were made four days later and again June 27, 1997. The same treatments were applied on selected trees in Tupelo, MS on March 19, 1997 using a trombone sprayer.

Results and discussion: By April 19, 1996, leaves of sprayed mistletoe had dropped leaving only the stems of the plant. Observations made on June 27, 1997 revealed that young leaves are just beginning to appear on some of the treated clumps. However, there were several clumps that did not appear to be growing at all and were not disturbed in order to determined the length of time they would remain in this state. For some treatments, the limbs that contained the treated mistletoe had died. This does not appear to be associated with the treatment because of lack of consistency among treatments. Treatments made this spring in Tupelo, MS seem to be consistent with the results obtained from treatments made at MSU. There was no limb dieback on any treatments made in 1997.

Significance to Industry: Research has been conducted with the use of some herbicides to control this parasite. Because of the close association to its host, there has been little success with such methods. Where control is warranted, removal of the parasite from the host is recommended. This may leave the tree unsightly or require major pruning to remove all the mistletoe. The removal of the mistletoe at the point of union to its host only results in seasonal control. This practice must be conducted yearly to suppress development of mistletoe. Florel is recommended, not as a control, but to suppress the growth and spread of leafy mistletoe. This method of suppression is quicker than removing any mistletoe by hand, and may not require spraying as regular as hand pruning. By eliminating the top growth, seed production does not occur, thus reducing the spread of this parasitic plant.

Reaction of Herbaceous Perennials to Root-knot Nematodes

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Nature of Work: Information on disease resistance among ornamental plants becomes increasingly important for best management practices in today's landscape industry (1). Data are needed on reaction of plants to plant-parasitic nematodes because the planting of susceptible cultivars can increase nematode populations and fewer chemicals are now available for nematode control(3).

The objective of this research was to determine the reaction of 15 different cultivars of herbaceous perennials to two species of root-knot nematodes, *Meloidogyne incognita* and *M. arenaria*, under greenhouse conditions.

Individual plants, potted in 4 in. (11 cm) plastic pots containing a mixture of pasteurized soil and Pro Mix BX (2:1), were inoculated with 2700 eggs of *M. arenaria* or *M. incognita*, obtained from galled roots by the sodium hypochlorite method (2). Control plants were not inoculated.

Six to eight weeks following inoculation the plants were removed from each pot, the root systems gently washed free of soil, and the number of root-galls present were counted. Data were analyzed by the General Linear Model Procedure (SAS).

Results and Discussion: Six of 15 herbaceous perennials evaluated did not develop root-galls from inoculations with either root-knot nematode species (Table 1). These included Fragaria 'Pink Panda', Monarda 'Blue Stockings', three cultivars of Phlox ('Eva Cullum', 'Franz Shubert', 'Oakington Blue'), and Polygonium 'Dimity'. The highest number of root-galls caused by *M. arenaria* occurred on three cultivars of Penstemon ('Purple Passion', 'Ruby', and 'Sour Grapes'); the highest number caused by *M. incognita* was on Penstemon 'Ruby' and Salvia 'Miss Indigo'. Nematode egg masses were very evident on this salvia. Other perennials which were intermediate in their reaction and therefore, are considered suitable hosts for these root-knot species were Achillea 'Anthea', Heuchera 'Green Ivory', Heucherella 'Bridget Bloom', and two cultivars of Geranium, 'Ann Folkard' and 'Laurence Flatman'.

Significance to Industry: Propagators and producers may be unaware of the status of their plant material as hosts for the common root-knot nematodes. As new cultivars are introduced to the market, information on their susceptibility to these and other pests should provide landscapers with opportunities to utilize plant disease resistance as a part of their pest management arsenal.

Acknowledgement: The researchers are grateful to Yoder Bros. for providing plants.

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Table 1. Mean height, dry weight, and number of root-galls on herbaceous perennials inoculated with *Meloidogyne arenaria* (Ma), *M. incognita* (Mi) compared with controls (c).

	Height (cm)			Dry Weight (g)			Number Root-Galls	
Plant/'Cultivar'	C	Ma	Mi	C	Ma	Mi	Ma	Mi
Achillea 'Anthea'	18.1 b[1]	22.9 a	21.3 a	25.9 a	16.8 b	13.5 b	0.8 a	0.3 a
Fragaria 'Pink Panda'	15.3 c	21.8 a	18.5 b	12.4 a	14.4 a	15.4 a	0.0 a	0.0 a
Geranium 'Ann Folkard'	18.0 a	24.2 a	21.8 a	2.4 b	9.5 a	6.6 ab	0.0 a	0.5 a
Geranium 'Laurence Flatman'	13.2 b	15.0 a	14.6 a	2.6 a	2.2 a	2.3 a	0.3 a	0.0 a
Heuchera 'Green Ivory'	7.0 b	10.9 a	11.0 a	13.1 a	11.9 a	15.3 a	0.7 a	0.4 a
Heucherella 'Bridget Bloom'	8.0 b	10.5 a	9.1 ab	8.1 a	7.8 a	8.5 a	1.0 a	0.4 a
Monarda 'Blue Stockings'	15.5 b	19.7 a	16.8 ab	11.6 a	19.4 a	21.9 a	0.0 a	0.0 a
Penstemon 'Purple Passion'	26.2 b	34.0 a	31.8 a	9.8 b	13.5 ab	17.4 a	10.3 a	1.3 b
Penstemon 'Ruby'	31.7 a	37.3 a	34.8 a	18.5 a	22.7 a	23.7 a	8.8 a	5.9 a
Penstemon 'Sour Grapes'	39.0 a	40.4 a	31.3 b	18.8 a	18.2 a	21.4 a	6.1 a	0.5 b
Phlox 'Eva Cullum'	22.5 b	35.0 a	19.3 b	4.9 a	7.2 a	5.0 a	0.0 a	0.0 a
Phlox 'Franz Shubert'	24.8 b	31.9 a	26.8 ab	6.8 a	7.7 a	8.2 a	0.0 a	0.0 a
Phlox 'Oakington Blue'	11.1 ab	13.5 a	10.1 b	8.5 a	8.0 a	6.3 b	0.0 a	0.0 a
Polygonium 'Dimity'	17.1 ab	19.9 a	15.5 b	13.4 a	15.6 a	14.6 a	0.0 a	0.0 a
Salvia 'Miss Indigo'	5.4 b	18.6 a	9.3 b	15.8 a	6.8 b	6.5 b	6.0 a	7.1 a

[1]Dissimilar letters across columns within each category denote significant differences at $P = 0.05$.

Evaluation of Weather-Based Scheduling of Antitranspirant Treatments for Control of Rose Blackspot Disease

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Nature of Work: The rose (*Rosa* spp.) is one of the most popular garden plants. In the U. S. annual sales of garden roses exceed $300 million (6). Ten to thirteen percent of American households purchase at least one plant (2). Modern roses, particularly hybrid tea roses, are generally susceptible to rose blackspot (*Diplocarpon rosae*). This fungal disease rapidly defoliates infected plants greatly shortening their life span and reducing their flower production (1). Control of the pathogen, especially in the humid South with a prolonged growing season, requires frequent fungicide applications with chlorothalonil at seven to ten day intervals (3,4). Prolonged and frequent application of synthetic chemical fungicides gives rise to a number of concerns, including applicator safety, contaminated drainage water, consumer exposure to fungicide residues, decreased plant and flower quality, and the accelerated development of pathogen resistance (5). Increased environmental, safety, and regulatory pressures have led to a search for effective, yet more benign controls. Film-forming antitranspirants with very low mammalian toxicities, have been shown to be effective for controlling some foliar pathogens (5). The current study evaluates film-forming antitranspirants used to control rose blackspot with fewer fungicide applications while minimizing foliar damage.

Studies were conducted at the Horticultural Subunit of the E. V. Smith Research Center, Alabama Agricultural Experiment Station, near Shorter, Alabama. Beds of three rose cultivars 'Cary Grant', 'Princess Monaco', and 'Dolly Parton' were arranged in a randomized complete block design with four replications. Each plot consisted of one each of the three rose cultivars. Treatments included 1) nonsprayed control; 2) 1% horticultural oil (SunSpray Ultra-Fine Oil, Sun Company, Philadelphia, PA) applied weekly as long as there was rainfall greater than .25 cm (.1 inch) between applications, when no rain occurred chlorothalonil [Bravo 720® 1.3 g a.i./L (0.17 oz/gal)] was applied; 3) chlorothalonil (1.3 g a.i./L) applied weekly; 4) 1% NuFilm 17 (Miller Chemical Corp., Hanover, PA) alternated with chlorothalonil as in oil treatment except that antitranspirant was applied on two week intervals; and 5) 1% Vapor Gard (Miller Chemical Corp., Hanover, PA) alternated with chlorothalonil as in 4). Spray solutions were applied to run-off using a CO_2 backpack sprayer. Plants were rated weekly for severity of blackspot, defoliation, plant vigor, and flower production. Blackspot disease ratings were based on a scale of 0-5 where 0 = no disease, 1 = blackspot on 20% of leaves, 2 = 40% of leaves, 3 = 60% of leaves, 4 = 80% of leaves, and 5 = 100% of leaves infected with blackspot. Defoliation ratings were based on a similar scale of 0-5 with 0 = no defoliation and 5 = 100% defoliation. Plant vigor was rated on a scale of 1-3 with 1 = poorly formed plant with little or no new growth and 3 = well developed plant with abundant new growth. Flower production was the weekly sum of buds showing color, blooms, and spent flowers. Data were averaged over the season, May 3 to October 11, and treatment differences determined based on Fisher's protected least significant difference ($P<0.05$).

Results and Discussion: In 1996, rainfall amounts and the number of raindays were respectively 138% and 123% greater than normal with total rainfall of 31.7 in. (80.56 cm) and rain occurring on 54 days. Rainfall distribution was uneven with dry periods in May, June, and October, and a wet period during July, August, and September. Temperatures were near 30 year norms (1961-1990) with average monthly highs of 85.2 F (29.6 C) and lows of 62.5 F (17.0 C). Chlorothalonil was applied 21 times using the weekly schedule, six times when alternated with oil, and seven times when alternated with either NuFilm 17 or Vapor Gard (table 1).

Significantly less defoliation was observed on plants treated with any of the foliar sprays compared to untreated control plants. Plants sprayed weekly with chlorothalonil or Vapor Gard alternated with chlorothalonil had lowest defoliation. Plants sprayed weekly with chlorothalonil or NuFilm 17 alternated with chlorothalonil had significantly less disease compared to untreated control plants. Plants sprayed with Vapor Gard alternated with chlorothalonil had significantly less vigor and reduced flowering compared to plants receiving other treatments, indicating a stunting of plant growth.

Significance to Industry: Data indicate that either the NuFilm 17 or SunSpray Oil can be alternated with chlorothalonil to lessen total fungicide applications and provide effective blackspot control on hybrid tea rose cultivars. Alternating treatments around weather events also reduced foliar damage and residue accumulations on plant leaves.

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Table 1. Rose blackspot disease' defoliation, and vigor ratings with flower production due to spray treatments applied May 3 to October 11, 1996 on hybrid tea roses.

Treatment	Applied Interval	Total Applications	Defoliation^x	Disease^y	Vigor Rating^z	Flower Production
Untreated	-	0	2.22 a*	1.91 ab	1.78 a	4.35
SunSpray Oil 1% alternated with	weekly	15	1.97 b	1.95 ab	1.85 a	4.86
chlorothalonil	&**	6				
NuFilm 17 1% alternated with	weekly	9	1.84 bc	1.81 bc	1.84 a	4.87
chlorothalonil	&	7				
Vapor Gard 1% alternated w-ith	weekly	9	1.69 cd	2 02 a	1.48 b	3.46
chlorothalonil	&	7				
Chlorothalonil 1.3 ga.i/L	weekly	21	1.55 d	1.73c	1.96 a	4.96
LSD=			0.2113	0.1481	0.1827	1.147
Pr > F =			0.0030	0.0092	0.0292	0.3802

* Means followed by same letter are not significantly different according to least significant difference test.

** Ampersand indicates that application interval was based on the occurrence of rain (>0.25 cm) followinD a previous application,

^{Y} Defoliation was assessed on a scale where 1=20% canes defoliated and 5 = 100% defoliated.

^{Y} Disease was assessed on a scale where I = 20% plant leaves with blackspot and 5 = 100% of plant leaves with blackspot.

^{z}Vigor was assessed on a scale from 1-3 where I = poorly developed plants and 3 = wel1 developed plants with new growth.