Pathology and Nematology

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Susceptibility of Atlantic White Cedar Cultivars to Botryosphaeria and Seiridium Cankers

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Index Words: Atlantic White Cedar, *Chamaecyparis Thyoides* (L.) BSP, Canker, *Botryosphaeria*, *Seiridium Unicorne*, Leyland Cypress

Nature of Work: Leyland cypress (*Cupressocyparis leylandii* Dallim.) is perhaps the most popular screening evergreen on the market today. However, its longevity in Southeastern landscapes may be limited by *Botryosphaeria* and *Seiridium* cankers which are found extensively throughout Georgia. Canker disease development is reported to be associated with drought stress (3) and wounding (2,4). Symptoms of *Botryosphaeria* canker are reddish-brown branch discoloration and dieback, and sunken, sometimes resinous cankers (5). *Seiridium* canker causes irregular, sunken, frequently oozing cankers and branch dieback with straw-colored foliage (1).

A possible alternative plant to Leyland cypress is Atlantic white cedar [*Chamaecyparis thyoides* (L.) BSP]. Atlantic white cedar is native from Maine to Florida and west into Mississippi, and it represents a wide range of genetic diversity. Leyland cypress and Atlantic white cedar are both members of the Cupressaceae family and may be susceptible to the same diseases. Therefore, Atlantic white cedar should be screened for its disease susceptibility before being promoted as an alternative plant.

Five taxa of Atlantic white cedar, selected based on their potential as Leyland cypress alternatives, and one cultivar of Leyland cypress were screened for their susceptibility to *Botryosphaeria* and *Seiridium* cankers. The experiment was conducted in the greenhouse using 3.785 liter containerized plants with an average 1.0 cm stem diameter. Ten single-plant replications of each plant were inoculated per treatment. There were four treatments including *Botryodiplodia* sp. (Sacc.) Sacc. [anamorph of *Botryosphaeria rhodina* (Cooke) Arx], *Fusicoccum* sp. Corda in Sturm. [anamorph of *Botryosphaeria dothidea* (Moug.:Fr.) Ces. & De Not.], *Seiridium unicorne* (Cooke & Ellis) Sutton and the non-inoculated control. All isolates were recovered from infected Leyland cypress branches.

Each plant was wounded on a main stem using a 12 mm-wide wood rasp. A 12 mm Leyland cypress stem section, pre-colonized with the

respective treatment, was placed directly on the wound and wrapped in layers of moist cheese cloth, parafilm and tinfoil. Plants were misted for two weeks following inoculation. After the initial two week period, stem sections were removed and the plants were water stressed by maintaining the experiment at an average of -12 bars.

Plants were monitored throughout the experiment for indications of canker development such as stem discoloration, sunken tissue, resin flow and callus formation. After 8 weeks, the plants were harvested and measured for changes in plant height, changes in caliper at the wound site, length and width of the visible canker on the stem surface (surface canker) and the length, width and depth of cambial discoloration on the stripped stems (interior canker).

Results and Discussion: Multiple categories of data were collected, but the most indicative of infection and pathogenicity was the extension of surface and interior cankers. Surface and interior canker lengths were adjusted by subtracting the average measured wound length from non-inoculated plants.

Surface and interior canker lengths of the Atlantic white cedar cultivars were not significantly different from the Leyland cypress cultivar indicating that they were just as susceptible to *Fusicoccum* sp. (Table 1). Among the Atlantic white cedar cultivars, 'Bluesport' interior canker length was significantly less than 'Okefenokee', indicating that it may be slightly less susceptible to *Fusicoccum* sp.

Surface canker measurements from plants inoculated with *Botryodiplodia* sp. indicated that the Atlantic white cedar cultivars were just as susceptible as the Leyland cypress cultivar (Table 1). However, interior canker measurements of 'Bluesport' and 'Okefenokee' were significantly less than the Leyland cypress cultivar, indicating that they may be less susceptible.

Both surface and interior canker lengths were much greater for all plants following inoculation with *S. unicorne* than with *Fusicoccum* sp. or *Botryodiplodia* sp. (Table 1). Surface canker measurements of the Atlantic white cedar cultivars inoculated with *S. unicorne* were significantly less than the Leyland cypress cultivar with surface cankers of Leyland cypress extending approximately 20 mm further than on the Atlantic white cedars. However, interior canker measurements of the Atlantic white cedar cultivars were not significantly different from the Leyland cypress cultivar indicating that they were as susceptible to *S. unicorne* as Leyland cypress, but none of the cultivars showed extensive surface canker symptoms. The Atlantic white cedar cultivars also did not

ooze sap from the cankers as was seen on the Leyland cypress. From the preceding results, we conclude:1) that *Seiridium unicorne* is more pathogenic than *Fusicoccum* sp. or *Botryodiplodia* sp. on Atlantic white cedar and Leyland cypress, 2) that symptoms of *Seiridium* canker differ on Leyland cypress and Atlantic white cedar and 3) that the Atlantic white cedar cultivars tested do not exhibit resistance to *Seiridium* or *Botryosphaeria* cankers.

Significance to Industry: Atlantic white cedar has potential as an alternative evergreen plant in Southeastern landscapes. Results from this experiment indicate that of the Atlantic white cedar cultivars tested, all appear to be susceptible to *Seiridium* and *Botryosphaeria* cankers which may limit its selection as an alternative to Leyland cypress for stressful sites.

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Table 1: Adjusted surface and interior canker lengths (mm) of Atlantic white cedar taxa and Leyland cypress inoculated with *Fusicoccum* sp., *Botryodiplodia* sp. and *Seiridium unicorne*.

	Fusicoccum sp.		*Botryodiplodia* sp.		*Seiridium unicorne*	
Plant Taxa	surface[1](mm)	interior[2](mm)	surface(mm)	interior(mm)	surface(mm)	interior(mm)
Leyland cypress	3.46 a[3]	12.29 ab	2.22 a	12.60 a	22.77 a	60.99 ab
Atlantic white cedar:						
'Bluesport'	3.49 a	5.57 b	2.00 a	6.12 c	1.86 b	43.05 ab
Webb #1	4.74 a	14.63 ab	2.38 a	11.39 ab	3.91 b	28.95 b
Webb #2	2.08 a	9.42 ab	1.54 a	9.85 abc	2.23 b	41.49 ab
Raulston form	3.45 a	12.88 ab	3.01 a	12.15 ab	2.49 b	81.76 a
'Okefenokee'	4.29 a	15.82 a	0.46 a	7.41 bc	1.20 b	42.62 ab

[1] Surface canker lengths were evaluated by measuring the length of the discolored or sunken bark tissue in a longitudinal direction along the axis of the stem and adjusted by subtracting the original average wound length.
[2] Interior canker lengths were evaluated by stripping away the outer bark and measuring the length of the discolored interior tissue in a longitudinal direction along the axis of the stem and adjusted by subtracting the original average wound length.
[3] Numbers followed by the same letter within each column are not significantly different based on Tukey means separation test. ($P<0.05$)

Enhancement of Growth of Flowering Dogwood by Using Fungicides to Control Powdery Mildew

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Index Words: Dogwood, *Cornus florida*, Powdery Mildew, *Microsphaera pulcha*

Nature of Work: Powdery mildew of flowering dogwood, *Cornus florida*, is difficult to control in nursery environments without the use of fungicides. Five fungicide treatments were compared to an unsprayed set of controls in a block of *C. florida* 'Rubra' in Warren County, TN. Fungicide treatments and rates were Systhane 20EW(8fl oz/100 gal), Systhane 40WP (4.0 oz/100 gal), Banner Maxx (8.0 fl oz/100 gal), Cygnus (1.6 oz/100 gal), and Sentinel 40WG (2.0 oz/100 gal). Treatments and control were arranged in a randomized complete block design with six replications. Each replication consisted of 8 trees (total 48 trees /treatment). Latron B-1956 was added to all treatments following label directions. Treatments were applied with hand sprayers to the point of runoff at 2 wk intervals from May 28 until August 19, 1998.

For each tree, disease severity for powdery mildew was estimated using the following scale: 0=healthy, 1<2%, 2<10%, 3<25%, 4<50%, 5>50%, 6=100% of tree's foliage with symptoms or signs of powdery mildew. Tree height (total height of tree) and trunk diameter were measured at the beginning and end of the season and data were expressed as a percentage of the control.

Results and Discussion: All fungicide treatments significantly reduced disease severity of powdery mildew on *C. florida* (Table 1.). No symptoms of phytotoxicity were observed. All fungicide treatment with the exception of Systhane 20EW increased height of trees when compared to controls (Table 2). All fungicide treatments increased trunk diameter when compared to controls.

Significance to Industry: Although powdery mildew epidemics can be severe and adversely affect the growth of dogwoods, fungicide treatments can reduce the impact of this disease significantly.

Table 1. Effects of fungicide treatments on powdery mildew severity in flowering dogwood.

Treatment	Powdery Mildew Severity			
	July 8	July 15	August 9	August 19
Control	2.6 b	4.3 c	5.8 b	5.0 b
Systhane 20EW	0.8 a	1.4 ab	1.1 a	1.4 a
Systhane 40 WP	0.0 a	1.2 b	1.6 a	1.2 a
Banner Maxx	0.0 a	0.5 a	1.1 a	1.1 a
Cygnus 50 WG	0.0 a	1.2 b	1.0 a	1.5 a
Sentinel 40 WG	0.0 a	0.5 a	1.1 a	1.0 a

[abc] For each column of data, means followed by the same letter do not differ according to Duncan's New Multiple Range Test, $p \leq 0.05$.

Table 2. Effects of fungicide treatments on growth of flowering dogwood by powdery mildew.

Treatment	% increase of untreated controls	
	Trunk caliper	Tree height
Systhane 20EW	+20	0
Systhane 40 WP	+47	+45
Banner Maxx	+13	+27
Cygnus	+53	+82
Sentinel	+33	+18

Control of Powdery Mildew on Flowering Dogwood Using Soybean Oil

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Index Words: *Cornus florida*, Flowering Dogwood, Powdery Mildew, Soybean Oil

Nature of Work: Powdery mildew can devastate a crop of flowering dogwood by reducing annual growth of the trees to nearly zero. In addition, small trees that suffer severe infections often have numerous dead branches in the following growing season or may not break bud at all. Currently, control strategies consist only of labelled fungicides. Most of those compounds contain warning labels that suggest the chemical may be harmful to people and or the environment. Soybean oils an environmentally safe, renewable resource that has been used to control insect pests without producing phytotoxic symptoms on many plant species (1). This study was undertaken to determine if soybean oil could control powdery mildew on flowering dogwood.

Two soybean oil concentrations (1% and 2%) combined with either of two emulsifiers (Latron B1956 and monostearate) were compared with a chemical standard (Banner Maxx) for reducing powdery mildew disease severity in a block of C. florida 'Rubra'. Oil treatments, fungicide standard, and control were arranged in a randomized complete block design with six replications. Each replication consisted of eight trees. Soybean oil plus Latron B1956 and Banner Maxx was first applied on June 10, 1998. Soybean oil plus monostearate was first applied June 17. Treatments were applied with hand sprayers to runoff on both surfaces of leaves every two weeks with the last treatments applied August 19.

Disease severity was estimated using the following scale: 0 = heathly, 1<2%, 2<10%, 3<25%, 4<50%, 5>50%, 6=100% of tree's foliage with symptoms or signs of powdery mildew. Tree height (total height of tree) and trunk diameter were measured at the beginning and end of the season and data were expressed as a percentage of the control.

Results and Discussion: Soybean oil treatments were not as effective in controlling powdery mildew as Banner Maxx (Table 1). Although disease severity scores for the oil treatments were considerably lower than the scores for the controls, differences were not significant in

August. The lack of significant differences was probably due to the large amount of variation that occurred within each replication for the oil treatments (scores of 1-6). This variation is thought to be due in part to the difficulty of keeping the oils in suspension within the hand held sprayers.

Better success may be achieved if a different type of sprayer is used or a better emulsifier is found. Soybean oil treatments enhanced tree growth when compared to the controls, but were not as great as the enhancement of growth by Banner Maxx (Table 2).

Significance to Industry: The use of soybean oil, which is much more environmental friendly than most fungicides, may become a viable control strategy for powdery mildew on flowering dogwood. However, more work must be done to identify better emulsifiers that will keep the oils in suspension.

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Table 1. Effects of soybean oil treatments on powdery mildew severity in flowering dogwood.

Treatment	Powdery Mildew Severity			
	July 8	July 15	August 9	August 19
Control	2.9 c	4.9 c	5.8 b	5.2 b
1% oil + Latron B1956	0.9 b	2.2 b	3.1 b	3.1 b
2% oil + Latron B1956	0.3 bc	1.8 b	2.2 b	2.6 b
1% oil + monostearate	0.9 b	1.7 b	2.6 b	3.6 b
2% oil + monostearate	1.0 b	2.1 b	2.7 b	2.9 b
Banner Maxx	0.1 c	0.6 a	1.1 a	1.1 a

[abc] For each column of data, means followed by the same letter do not differ according to Duncan's New Multiple Range Test, $p \leq 0.05$.

Table 2. Effects of soybean oil treatments on growth of flowering dogwood by powdery mildew.

Treatment	% increase of untreated controls	
	Trunk caliper	Tree height
1% oil + Latron B1956	+27	+ 22
2% oil + Latron B1956	+20	+ 22
1% oil + monostearate	+ 7	0
2% oil + monostearate	+13	+ 33
Banner Maxx	+53	+111

Control of Powdery Mildew and Cercospora Leaf Spot on Hydrangea

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Index Words: Powdery Mildew, *Erysiphe*, *Cercospora*, Hydrangea, Azoxystrobin

Nature of Work: Powdery mildew, caused by *Erysiphe polygoni* and leaf spot, caused by Cercospora sp. are common and serious diseases on bigleaf hydrangea (*Hydrangea macrophylla*). Powdery mildew can cause stunting and severe leaf disfiguration. Cercospora leaf spot can cause defoliation and both diseases can greatly decrease the aesthetic value of the plant. This test was initiated to evaluate several fungicide treatments for the control of these two diseases.

Liners of *Hydrangea macrophylla* 'Nikko Blue' were potted in 2 gallon containers in a pine bark/peat moss amended medium. Plants were maintained under 40% shade cloth, and irrigated with overhead impact sprinklers. The test was arranged in a randomized complete block design with 10 single plant replications per treatment. Treatments were applied to run-off using a CO_2 pressurized sprayer at intervals listed in Table 1. Fungicides tested were Heritage (Azoxystrobin), Cleary's 3336 (Thiophanate-methyl), and Eagle (Myclobutanil). Treatments were initiated on June 2 and continued through October 6, 1998. Plants were rated for powdery mildew on September 23 and for leaf spot on November 12. Incidence of both diseases was evaluated using the Horsfall and Barratt rating system (Table 1.)

Results and Discussion: All fungicide treatments reduced the incidence of powdery mildew and *Cercospora* leaf spot when compared to the untreated control (Table 1). Heritage 50W was effective in controlling both diseases at the lowest rate tested (4 oz per 100 gal applied every 3 weeks). Eagle 40W reduced incidence of both diseases when applied every 2 weeks at 8 oz per 100 gal. Cleary's 3336 was also effective in controlling both diseases at the rates tested; however it gave reduced control compared to the other two fungicides.

Significance to Industry: Powdery mildew and *Cercospora* leaf spot can greatly reduce the ornamental value of *Hydrangea* and in severe cases, render the plants unsaleable. The introduction of effective

fungicides which can be alternated with existing fungicides of different chemistry is an important tool in disease management. These data indicate that Heritage, Eagle, and Cleary's 3336 were all effective in controlling both diseases at the rates and spray intervals evaluated.

Table 1. Efficacy of fungicide treatments for powdery mildew and leaf spot control of hydrangea.

Treatment and Rate/100 gal	Treatment Interval wk	Powdery Mildew Disease Rating[1]	Leafspot Disease Rating[1]
Untreated Control	–	7.8a*	5.7a*
Heritage 50W 4.0 oz	1	1.1c	1.0c
Heritage 50W 4.0 oz	2	1.0c	1.0c
Heritage 50W 4.0 oz	3	1.0c	1.0c
Heritage 50W 8.0 oz	1	1.0c	1.0c
Heritage 50W 8.0 oz	2	1.0c	1.0c
Heritage 50W 8.0 oz	3	1.0c	1.0c
Cleary's 3336 4.5F 20 fl oz	1	3.3b	2.8b
Eagle 40W 8.0 oz	2	1.0c	1.0c

*Mean separation within the column was according to Fisher's protected least significance difference(LSD) test (P=0.05)
[1]Horsfall and Barratt rating scale: 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.

Pest Management Recommendations for Ornamental Crops - A New Approach

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Index Words: Pest Management Recommendations

Nature of Work: Most States publish pest management recommendations to provide information to the public about plant and animal pesticides and biological and cultural management options for specific pest situation(s). These recommendations are intended for use by county agents, pest management professionals, distributors and retail outlets. The books generally are organized by host and it's pest problems or problem classes and to some extent are check lists of common problems found in the state. They provide the user with a shopping list of strategies, quantities needed to execute the strategy, method of application, and frequency of application that is unbiased, frequently giving some expectation of performance. The user is then able to evaluate price versus the attributes of efficacy, frequency of use, application method, integration with other pest management systems and severity of the problem in the cultural system under use. Private information sources are incomplete listing only information of the sponsors of the publication or web site.

The task of updating this information can be a horrendous undertaking because of the large number of hosts and pests that need to be reviewed. The task is usually done annually. The reasons are: the information is constantly changing; the quantity of information is great; a single situation can change more than once in a year; the information becomes lost; many of the manufacturers/distributors do not have an active system to update the authors; the manufacturers do not know who is responsible in each state; and the authors do not have a way of storing the information when they come across it in their day-to-day performance of their duties. The retyping of this information, even with modern day word processors is huge. The decline in secretarial services with most authors doing their own typing makes this task even more arduous.

The publication is an extension publication and despite it importance to the user community is not appreciated by administrators responsible for evaluation of the authors. Because of the above mentioned problems, and the amount of time it takes the responsible parties try to simplify the presentation of the information by making recommendations by active

ingredient only omitting labeled trade names and integrations of other strategies. Since the use of a product must be on its label it puts the person making the recommendation in a legally compromising position by purposely omitting information for the user. Emphasis is made in the publications that it is the responsibility of the user to read the label. The user is presented with the temptation to use the active ingredient labeled for another situation.

To avoid the error of omission the user should be presented with trade names and strategies to the best of the ability of the author. The user should know if it is legal to use the product in the intended site, limitations for the site, restricted entry intervals, preharvest intervals if the product is for food use, common and specific names of hosts and pests, and the existence of cultural or biological strategies of management.

To solve this situation the authors have developed a Word 97 template that puts tags on important information that should be part of a pest management suggestion. These tags enable reformatting for multiple uses including printed hard copy, web copy and compact disc publication. By using a shared drive on the university server the authors are able to maintain their section on their local hard drive, update the information as they come across it, update the server as they make changes then the information is automatically reformatted for use and updated daily on the web and is not the horrendous task when printed or compact disc copies are prepared.

Results and Discussion: The presentation included an interactive presentation of the template and the tool bars used by the authors to develop their sections of the Clemson University Pest Management Handbook. Ornamentals will be used as an example. An example of the printed text from a template created by an author was presented.

It is proposed that a regional pest management guide be developed for the southeast using this system. That the task of updating individual sections either be divided up between authors where the sections are large or where the sections are smaller they be rotated between coordinating authors over years.

Disease Resistance of Selected Cultivars of Ground Cover and Shrub Roses

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Index Words: Disease Resistance, Ground Cover Rose, Shrub Rose

Nature of Work: Few flowering shrubs can match the beauty, versatility, and popularity of roses. In recent years, more attention has been focused on the use of the ground cover and shrub roses that have flooded the marketplace in low maintenance landscapes.

Diseases particularly black spot, have a detrimental impact on the aesthetics and health of the vast majority of rose cultivars. Alabama's typically wet and warm growing season, which favors the rapid development and spread of foliar diseases, mandates an intensive season-long fungicide spray program, particularly on black spot-susceptible Hybrid tea, Grandiflora, and Florabunda roses. Recently released ground cover and shrub roses have not been widely planted. As a result, cultivar reaction to diseases commonly seen in the South is not well known. The objective of this study was assess the resistance of selected cultivars of ground cover and shrub roses to disease as well as their adaptability to Alabama's hot summers.

Bare-root roses were potted in a pine bark/peat moss media (3 :1 v/v) amended with 14 pounds of 17-7-12 Osmocote, 6 pounds of dolomitic limestone, 2 pounds of gypsum, and l.5 pounds of Micromax per cubic yard of mix. After one month, the potted roses were transplanted into raised beds at the Brewton Experiment Field where the fertility and pH has been adjusted according to the results of a soil assay. The majority of cultivars were planted in January 30 and March 19, 1998. *Rosa mutabulis* (butterfly rose) was planted on June 4, 1998 while the cultivars 'Carefree Wonder', 'Hansa', and 'Pink Grootendorst' were established on February 11, 1999. The beds were mulched with aged pine bark. A drip irrigation system was installed and the roses were watered as needed. A tank-mix of one pound of Gallery and two quarts of Surflan per acre was broadcast over the beds for preemergence weed control. Hand weeding and directed applications of recommended rates of Roundup or MSMA was used to control escape weeds. Ammonium nitrate at the rate of 40 pounds per treated acre was broadcast monthly during the growing

season over the beds. The severity of black spot and Cercospora leaf spot was rated on a scale of 1 to 10 on April 25, June 3, August 5, October 16, and December 3, 1998 and on March 23, May 6, and June 24, 1999. Leaf samples collected on June 24, 1999 were examined to confirm the occurrence of black spot and Cercospora leaf spot on selected rose cultivars. The data from December 3, 1998 and June 24, 1999 is presented in the tables. Data for 'Double Delight', 'Carefree Wonder', 'Hansa', and 'Pink Grootendorst' is not included.

Results and Discussion: In 1998, weather conditions from late April through much of August were unusually hot and dry. As a result, the development of both black spot and Cercospora leaf spot was slowed. In September, two tropical storms resulted in an excess of 30 inches of rain. Then, relatively wet, mild conditions from October through December favored further the onset and rapid spread of disease. From March thorough May, rainfall totals were below seasonal norms and temperatures were near normal. In June, rainfall and temperature patterns were near normal.

Although none of the 25 rose cultivars screened were immune to either black spot or Cercospora leaf spot, considerable differences in the severity of these diseases were noted (Table 1). In 1998, black spot was disease most commonly observed. Black spot-related spotting of the foliage and premature leaf shed was seen on all cultivars except 'Petite Pink Scotch', which remained free of this disease all season. With December 1998 disease ratings of 2.6 to 3.8, 'Flower Carpet', 'Ralph's Creeper', 'Magic Carpet', *R. wichuraiana, R. mutabulis,* and 'Red Cascade' generally suffered light to moderate spotting of the leaves in the lower to mid-canopy and some light defoliation around the base of the plant. Moderate spotting of the leaves along with increasingly heavier leaf shed was recorded for 'White Flower Carpet', 'Nozomi', and 'Fushia Meidiland', 'Bonica', 'Carefree Delight', 'First Light', 'Sevillana', and 'Betty Prior', and 'Royal Bonica'. On the remaining cultivars with disease ratings of 5.0 to 5.8, black spot-related leaf spot and premature leaf shed was extensive.

In addition, Cercospora leaf spot was also identified on the cultivars 'Petite Pink Scotch' and 'The Fairy'. With disease ratings of 5.0 and 5.6 for 'The Fairy' and 'Petite Pink Scotch', respectively, spotting of the foliage as well as defoliation in the lower and midcanopy was extensive. Also, aerial web blight caused by the fungus *Rhizoctonia solani* damaged much of the foliage in the center of the canopy.
Observations concerning the appearance of the foliage and overall plant

vigor were also made. Some cultivars tolerated the unusually hot summer of 1998 better than did some of the others. 'Magic Carpet' suffered greatly from the high summer temperatures. By August, this cultivar had shed nearly all of its leaves and shoot growth has stopped. Extensive bronzing or yellowing of the leaves was also seen in that same month on 'White Flower Carpet' and 'Flower Carpet'. Like 'Magic Carpet', both of these roses had partially to fully recovered from the heat stress by December. Some light bronzing of the older leaves was recorded on the majority of the remaining cultivars. Leaves of 'Fushia Meidiland', which appeared to have suffered from an unknown mineral deficiency, remained yellow throughout much of the growing season. Among the remaining roses, *R. mutabulis, R. wichuraiana,* 'Bonica', 'Jeeper's Creepers', 'The Fairy', 'Ralph's Creeper', 'Nozomi', 'Petite Pink Scotch' 'Livin' Easy' 'Nearly Wild', and 'Mystic Meidiland' appeared to have the best heat tolerance.

In 1999, significant differences in the susceptibility of rose cultivars to black spot and Cercospora leaf spot again were seen. Many but not all of the cultivars evaluated were highly sensitive to either black spot or Cercospora but not to both diseases. At of late June 1999, neither black spot nor Cercospora leaf spot has damaged 'Petite Pink Scotch'. However, a sizable percentage of the inner canopy [disease rating of 5.6] of this cultivar was blighted by *Rhizoctonia solani.*

Of the remaining 24 cultivars, the least black spot and Cercospora leaf spot damage was noted on *R. wichuraiana,* followed by 'Mystic Meidiland', 'Red Cascade' and 'Nozomi' (Table 2). Moderate blacks spot-related spotting of the leaves and some defoliation was recorded on 'Sea Foam'. 'Flower Carpet' and 'Happy Days' suffered from moderate to heavy spotting of the foliage and premature defoliation due to Cercospora leaf spot. Defoliation levels in excess of 50% along with heavy spotting of many of the leaves was noted on the remaining 17 rose cultivars. On 'Fushia Meidiland', 'Carefree Delight', 'White Flower Carpet' and 'The Fairy' rose, Cercospora leaf spot was responsible for the extensive spotting and premature defoliation while black spot was the cause of similar damage on the remaining 13 cultivars of rose.

In both years, powdery mildew and downy mildew were both observed in the spring on several cultivars but the damage on any single cultivar was negligible.

Overall, black spot was identified on the majority of rose cultivars, particularly in 1998. In 1999, Cercospora leaf spot, however, caused extensive damage to 6 ground cover and shrub type roses. The level of leaf spot and premature defoliation attributed to Cercospora leaf spot

was similar to that noted on the black spot-susceptible cultivars. In addition, Cercospora leaf spot may be a more common and damaging disease of rose than was previously thought. Mixed outbreaks of black spot and Cercospora leaf spot were not obvious to the observer but may have occurred.

Several cultivars exhibited good to excellent resistance to both diseases. The ground cover rose *R. wichuraiana* demonstrated the best overall disease resistance. Little if any spotting of the foliage or premature leaf shed was noted in either 1998 or 1999, nor does this cultivar appear sensitive to high temperatures. In addition, Red Cascade and Nozomi have over the two-year evaluation period suffered less black spot-related leaf spot and early leaf shed than the majority of other cultivars screened. So far, both of these cultivars also appear to be highly resistant or nearly immune to Cercospora leaf spot. Any of the above roses could probably be maintained in the landscape without supplemental protective fungicide treatments. All remaining cultivars would require bimonthly to perhaps monthly fungicide treatments in order to protect them from black spot or Cercospora leaf spot.

Significance to Industry: High maintenance requirements have always limited the use of roses in many landscape settings, particularly in Alabama and surrounding states where weather patterns often favor diseases. Most landscape contractors and homeowners simply do not have time to apply the fungicides needed to maintain the health, vigor, and beauty of most roses. Over two growing seasons, several roses, including *R. wichuraiana,* 'Red Cascade' and 'Nozomi' have demonstrated good resistance to the diseases black spot and Cercospora leaf spot. All the remaining ground cover and shrub roses screened were heavily damaged by either black spot or Cercospora leaf spot and would require numerous fungicide sprays to maintain their beauty and vigor in the landscape.

Table 1. Reaction of selected cultivars of ground cover and shrub roses to blackspot, December 1998.

Cultivar	Black spot Rating[1]	Cultivar	Black spot Rating
Royal Bonica	6.6[2]	Livin' Easy	5.2
Betty Prior	6.6	Fushia Meidiland	4.8
Sevillana	6.4	Nozomi	4.4
First Light	6.4	White Flower Carpet	4.2
Carefree Delight	6.2	Red Cascade	3.8
Bonica	6.1	*Rosa mutabulis*	3.8
Cherry Meidiland	6.0	*Rosa wichuraiana*	3.6
Nearly Wild	5.8	Happy Trails	3.4
Jeeper's Creepers	5.6	Magic Carpet	3.0
Pearl Meidiland	5.6	Ralph's Creeper	3.0
Sea Foam	5.2	Flower Carpet	2.6
Mystic Meidiland	5.2	Petite Pink Scotch	1.0
		The Fairy	1.0
LSD (P=0.05)	1.1	LSD (P=0.05)	1.1

[1] Black spot and Cercospora leaf spot were rated on a 1 to 10 scale where 1 = no disease, 2 = very few spots in lower canopy, 3 = a few spots in lower and upper canopy, 4 = some spots with light defoliation in lower canopy, 5 = spots noticeable with noticeable defoliation, 6 = spots numerous with significant (50% or more) defoliation, 7 = spots numerous with severe defoliation (75% or more), 8 = upper canopy badly diseased with high defoliation (90% or more), 9 = very few remaining leaves covered with spots, 10 = plant defoliated. [2]Mean separation is according to Fisher's protected least significance (LSD) test (P=0.05).

Table 2. Susceptibility of ground cover and shrub roses to black spot and Cercospora leaf spot, June 1999.

Cultivar	Disease Rating[1]		Cultivar	Disease Rating[1]	
	BLS[2]	CLS[3]		BLS[2]	CLS[3]
Jeeper's Creepers	6.6[4]	1.0	Sea Foam	4.2	1.0
Ralph's Creeper	6.4	1.0	Nozomi	3.2	1.0
Royal Bonica	6.4	1.0	Red Cascade	3.0	1.0
Nearly Wild	6.4	1.0	Mystic Meidiland	3.0	1.0
Betty Prior	6.2	1.0	*R. wichuraiana*	1.8	1.0
Sevillana	6.0	1.0	Fushia Meidiland	1.0	6.0
Magic Carpet	6.0	1.0	Carefree Delight	1.0	6.0
Livin' Easy	6.0	1.0	Petite Pink Scotch	1.0	1.0
Cherry Meidiland	6.0	1.0	Flower Carpet	1.0	4.4
Pearl Meidiland	5.8	1.0	White Flower Carpet	1.0	5.7
Rosa mutabulis	5.6	1.0	Happy Trails	1.0	4.6
First Light	5.6	1.0	The Fairy	1.0	6.0
Bonica	5.4	1.0			
LSD (P=0.05)	1.0	0.6		1.0	0.6

[1] Black spot and Cercospora leaf spot were rated on a 1 to 10 scale where 1 = no disease, 2 = very few spots in lower canopy, 3 = a few spots in lower and upper canopy, 4 = some spots with light defoliation in lower canopy, 5 = spots noticeable with noticeable defoliation, 6 = spots numerous with significant (50% or more) defoliation, 7 = spots numerous with severe defoliation (75% or more), 8 = upper canopy badly diseased with high defoliation (90% or more), 9 = very few remaining leaves covered with spots, 10 = plant defoliated. [2]BLS = black spot. [3]CLS = Cercospora leaf spot. [4]Mean separation is according to Fisher's protected least significance (LSD) test (P=0.05).

Fungicide Performance Against Phytophthora Shoot Blight on Vinca is Erratic

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Index Words: Fungicide Performance, Phytophthora Shoot Blight, *Phytophthora parasitica*, Vinca, *Calharanthus roseus*

Nature of Work: In recent years, Phytophthora shoot blight has emerged as a common and often destructive disease of both landscape and greenhouse plantings of annual vinca *(Calharanthus roseus)* (2). The causal fungus *Phytophthora parasitica is* usually introduced into landscape beds in symptomless but infected flat or pot-grown annual vinca. Once introduced into the soil, this fungus, which is impossible to eradicate, causes not only shoot blight but also root rot on this popular summer annual. So far, all commercial lines of annual vinca have proven susceptible to Phytophthora shoot blight.

Little work has been done to assess the effectiveness of fungicides for the control of Phytophthora shoot blight on annual vinca. Simone and Jones (3) reported that Aliette T/O applied as a foliar spray alone at 5.0 pounds per l 00 gallons of spray volume or a tank mixture of Aliette T/O at 1.25 or.2.5 pounds plus 2.5 pounds of Fore 80W per 100 gallons of spray volume gave good control of Phytophthora shoot blight on pot-grown vinca. Foliar sprays of Aliette T/O were also shown in 1995 to be effective in controlling this disease in a simulated landscape planting of annual vinca (1). In the first study, selected registered and experimental fungicides were screened for the preventative control Phytophthora shoot blight in a simulated landscape planting of annual vinca while the efficacy of soil drenches and foliar sprays of several rates of Heritage 50W were compared in the second study.

In early May of 1998, approximately 400 pounds per acre of 13-13-13 fertilizer was broadcast and incorporated pre-plant over raised beds in a Benndale sandy loam at the Brewton Experiment Field (Zone 8a) that were infested with *P. parasitica.* Soil populations of *P. parasitica* may have been higher in the first than in the second study. Four vinca cv. 'Peppermint Cooler' and 'Tropical Rose' were planted in the first and second study, respectively, on May 29 on a 1 foot square with a fifth plant added in the center of each square. For both studies, the experimental design was a randomized complete block with 4 five-plant replications. At two-week intervals, calcium nitrate was applied at a rate of 10 pounds

per acre through the drip-irrigation system and the plots were irrigated as needed. With the exception of the monthly drenches of Subdue 2E, all remaining fungicide treatments in the first study were applied as directed sprays at the rates specified in Table 1 beginning three weeks after planting on June 15 and continuing at two-week intervals through August 24. In the second study, Heritage 50W was applied at two and four weeks intervals as a soil drench at 0.2 and 0.4 ounces per 1000 square feet of bed area and as a directed spray at 0.6 and 1.1 pounds per 100 gallons of spray volume. Aliette T/O, which was applied as a directed spray at the rate of 1.1 pounds per 100 gallons of spray volume, was also included. In the second study, applications were begun on May 30 and repeated at the intervals listed in Table 2 through August 24. In both studies, plant survival was assessed on June 23, July 17, and August 5.

Results and Discussion: Over much of the late spring and early summer of 1998, unusually hot and dry weather patterns suppressed the onset and development of Phytophthora shoot blight on annual vinca. Rapid disease development followed the return of more seasonal rainfall patterns in late July. By August, symptoms in many of the plots were quite advanced and numerous plants, particularly in the first study, had succumbed to Phytophthora shoot blight.

In the first trial, survival of annual vinca cv. 'Peppermint Cooler' was statistically similar for all fungicide treatments and the unsprayed control at the June 23 and July 17 rating dates (Table 1). By early August, severe stand losses were recorded in all the fungicidetreated plots and none gave effective disease control. Among all fungicide treatments, the highest survival rate of 50% was obtained with the directed sprays of the 1.0 pound per 100-gallon rate of Heritage 50W. Otherwise, the level of plant survival in the remaining fungicide-treated plots, which ranged from 5 to 35%, did not significantly differ from the 0% recorded in the untreated control plots.

On June 23, survival of annual vinca cv. 'Tropical Rose' for all fungicide treatments of Heritage 50W, Aliette T/O and the untreated control, were similar (Table 2). By the July rating date, the percentage of surviving plants in plots receiving Aliette T/O and the monthly drench of Heritage 50W at 0.7 ounces per 1000 square foot of bed area were significantly below those of most remaining treatments, including the unsprayed control. On August 5, selected treatments of Heritage 50W increased the survival of vinca in *P. parasilica* infested landscape beds as compared with the 10% survival rate recorded for the untreated control. When applied at two-week intervals, drenches and directed sprays of both rates of Heritage 50W proved equally effective in controlling Phytophthora shoot blight. At the same spray interval, directed sprays of Heritage 50W

gave numerically but not statistically better disease control than the soil drenches. Heritage 50W, when applied either as a directed spray or drench usually gave significantly better disease control when applied at two rather than at four-week intervals. Aliette T/O, which was applied at the unusually low rate of 1.1 pounds per 100 gallons, failed to protect vinca from Phytophthora shoot blight.

Overall, the first study demonstrates that fungicides alone are not the answer to Phytophthora shoot blight on annual vinca. Aliette T/O, which gave effective disease control applied alone or in combination with Fore 80W in two previous trials (1,3) failed to protect vinca from this disease. Extremely high inoculum pressure may be one explanation for the poor performance of Aliette T/O. In addition, delaying the initial treatment until two weeks after planting may also have contributed to the failure of either fungicide to protect vinca from *P. parasitica.* Among the remaining fungicides, directed sprays of Daconil 2787 and Fluazinam as well as the Subdue 2E drench proved equally ineffective in both the 1995 and 1998 Alabama studies in controlling Phytophthora shoot blight on vinca (1).

The effectiveness of Heritage 50W against Phytophthora shoot blight was as erratic as that of Aliette T/O. In the first study, the intermediate rate of 1 pound of Heritage 50W per 100 gallons of spray volume was as ineffective in controlling this disease as was Aliette T/O. In the second study, however, directed sprays of 0.6 and 1.2 pounds of Heritage 50W applied at two-week intervals provided excellent disease control. As was the case with Aliette T/O, differences in inoculum pressure, initial application date, or possibly cultivar selection probably accounted for the differences in effectiveness of Heritage 50W. Despite the relatively poor showing of Heritage 50W in one study, this fungicide may prove to be as, if not more, effective against Phytophthora shoot blight as Aliette T/O.

Significance to Industry: For landscape contractors, fungicides may not be the best strategy for controlling Phytophthora shoot blight. In landscape plantings where annual vinca has not previous been grown, biweekly preventative treatments using fungicides such as Aliette T/O or Heritage should provide good protection from this disease. As clearly demonstrated in the first study, fungicides may, however, do little to slow disease spread in beds where stands of vinca were wiped out in previous years. In the greenhouse, several fungicide applications made at bi-weekly intervals through the production cycle will protect flat and pot-grown annual vinca from catastrophic outbreaks of Phytophthrora shoot blight during production, shipping, and sales. Such protective fungicide treatments should also reduce the risk of spreading this dis-

ease from the greenhouse into the landscape.

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Table 1. Comparison of selected fungicides for the control of Phytophthora shoot blight on annual vinca 'Peppermint Cooler'.

Fungicide and rate/100 gal.	Plant Survival %[1]		
	Jun 23	Jul 17	Aug 5
Nontreated Control	70[2]	45	0
Aliette T/O 2.5 lb.	70	60	5
Aliette T/O 5.0 lb.	100	95	25
Aliette T/O 2.5 lb. + Fore 80W 2.0 lb.	95	70	25
Aliette T/O 5.0 lb. + Fore 80W 2.0 lb.	100	90	35
Fluazinam 500F 12.0 fl. oz.	90	80	35
Daconil Ultrex SDG 1.4 lb.	85	70	5
Heritage 50W 1.0 lb.	90	80	50
Subdue 2E 1.25 fl. oz.	80	65	20
LSD (P=0.05)	NS[3]	NS	38

[1]Dates when stand count was taken. [2]Mean separation within a column was tested according to Fisher's protected least significance (LSD) test (P=0.05). [3]NS = differences not significant.

Table 2. Comparasion of directed and drench applications of Heritage 50W for the control of Phytophthora shoot blight on 'Tropical Rose' annual vinca.

Treatment and Rate	Placement	Spray Interval wks	Plant Survival %[1]		
			Jun 23	July 17	Aug 5
Untreated control			90[2]	90	10
Heritage 50W 0.4 oz./1000 sq.	Drench	2	100	100	70
Heritage 50W 0.4 oz./1000 sq.	Drench	4	100	85	30
Heritage 50W 0.7 oz./1000 sq.	Drench	2	100	100	75
Heritage 50W 0.7 oz./1000 sq.	Drench	4	100	75	45
Heritage 50W 0.6 lb./100 gal.	Dir. Spray	2	100	100	90
Heritage 50W 0.6 lb./100 gal.	Dir. Spray	4	100	100	35
Heritage 50W 1.2 lb./100 gal.	Dir. Spray	2	95	90	85
Heritage 50W 1.2 lb./100 gal.	Dir. Spray	4	100	95	70
Aliette T/O 1.1 lb./100 gal.	Dir. Spray	4	100	65	0
LSD (P=0.05)			NS[3]	19	37

[1]Dates when stand count was taken. [2]Mean separation in a column was tested according to Fisher's Protected Least Significance (LSD) test (P=0.05). [3]NS = differences not significant.

Fusarium Root and Crown Rot of Hosta

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Index Words: Fusarium, Root and Crown Rot, Hosta

Nature of Work: Hosta is one of the most popular perennials planted in landscapes around the country and, therefore, has become widely grown in nurseries. In 1997 and 1998, two wholesale nurseries growing ornamental crops in containers in South Carolina suffered losses due to a root and crown rot disease of hosta plants. Up to 10% of the plants growing in one nursery were affected and thousands of plants were culled. Symptoms included leaf yellowing, plant stunting, necrosis in roots, and decay in crowns. *Fusarium* spp. consistently were detected in the roots and crowns of diseased plants. This study was undertaken to investigate the etiology of this previously unreported disease.

Fifteen diseased plants, belonging to six cultivars, were collected in October 1998. Three to five pieces were cut from discolored vascular tissue of roots and crowns and plated onto modified Nash-Snyder medium (2) and potato dextrose agar (PDA) containing 0.1% of PCNB and 0.03% of streptomycin sulfate. The plates were incubated at 25°C for 1 week. Then all suspected *Fusarium* colonies were subcultured and identified based on morphological characteristics (2).

The predominant species of *Fusarium* that were isolated, each represented by four isolates, were tested for pathogenicity on hosta cultivars Francee and Albo marginata. Inocula were prepared by growing the fungi in potato dextrose broth at 25°C for 1 week, filtering the cultures to remove hyphal fragments, diluting the filtrates to yield 5.0×10^{6} conidia/ml, and combining the conidium suspensions of the four isolates of each species. The pH values of suspensions were adjusted to 5.0 with 0.05 N HCl. Plants with four to six leaves were removed from pots, and roots were cleaned of adhering debris. Roots were cut off 5 cm from the rhizome, and crowns were wounded using a scalpel. Plants were inoculated by dipping the roots and crowns into conidium suspensions for 5 min. Distilled water was used as the control. Five plants were used for each treatment. The plants then were transplanted into fresh container mix (75% bark, 25% peat) and grown in a growth chamber at 20–22°C with a 14-hr photoperiod for 5 weeks. Disease was assessed by cutting the plants longitudinally through the roots and crown and rating severity on a scale of 0–5, where 0 = no discoloration, 1 = slight discoloration in

roots, 2 = extensive discoloration in roots, 3 = slight discoloration in crown, 4 = extensive discoloration in crown, and 5 = crown completely necrotic (1).

To complete the Koch's postulates, tissue pieces were cut from symptomatic roots and/or crowns, surface-sterilized in a 0.5% NaOCl solution for 1 min, and plated onto $^1/_4$-strength PDA. The plates were incubated at 25°C for 1 week and the presence of Fusarium species was determined by morphological characteristics.

Results and Discussion: *Fusarium* spp. were recovered from all of the 15 plants. Five species were found and 51 isolates were obtained. *F. solani*, an unidentified species (*Fusarium* sp.), and *F. oxysporum* were predominant, making up 88% of the isolates recovered. Additionally, *F. solani* and *Fusarium* sp. were detected in 73 and 60% of the plants, respectively (Table 1).

The disease was observed only in the *F. solani* and *Fusarium* sp. treatments on cv. Francee plants but in all the Fusarium treatments on cv. Albo marginata plants. However, disease always was most severe on plants inoculated with Fusarium sp. with a disease severity rating of 2.4 on cv. Francee plants and 3.2 on cv. Albo marginata plants, which were significantly greater than those caused by either *F. solani* (0 and 1.2) or *F. oxysporum* (0.2 and 1.0) (Figure 1). Furthermore, only *Fusarium* sp. was successfully reisolated from the symptomatic plants.

Previously, there has been only a brief mention in the literature of leaf yellowing and crown rot of hosta caused by *F. oxysporum* (3). Our study has demonstrated that the root and crown rot of container-grown hosta plants occurring in South Carolina nurseries was caused primarily by an unidentified species of *Fusarium*, *Fusarium* sp. This species is similar to *F. oxysporum* but differs in the manner of chlamydospore formation. Consequently, this is a disease of hosta not reported previously. Further studies are in progress including identification of the pathogen, etiology of the disease, and disease management.

Significance to Industry: Fusarium root and crown rot has been identified as a potential threat to hosta production in nurseries. So far, this disease only has been identified in South Carolina, but it probably occurs in other states where it has not yet been detected. By investigating this disease before it has significantly affected many nurseries, we hope to prevent serious economic losses to nurseries in the Southeast.

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Table 1. Isolation and incidence of *Fusarium* spp. from 15 diseased host plants.

Species	Number of isolates	Incidence (%)
F. solani	24	73
Fusarium sp.	13	60
F. oxysporum	8	27
F. subglutinans	4	27
F. moniliforme	2	13
Total	51	100

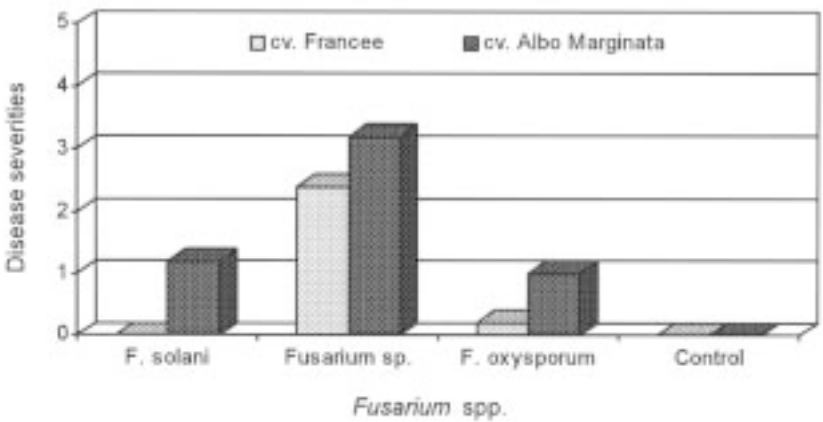

Figure 1. Disease severity on plants inoculated with three species of *Fusarium*

Factors Influencing Ascocarp Formation And Development In *Microsphaera pulchra* of Flowering Dogwood

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Index Words: Ascocarp Formation and Development, *Microspoera pulchra*, Flowering Dagwood, *Cornus florida*, Powdery Mildew

Nature of Work: This study was conducted to provide some epidemiological information on factors that influence the formation and maturation of ascocarps in *Microsphaera pulchra* of dogwood. Two studies were conducted:(a) to determine the effect of temperature and day-length on ascocarp formation and maturation, and (b) assess the effect of temperature on winter survival of ascocarps of different maturity stages.

Ascocarps of *Microsphaera pulchra* constitute the main mechanism of winter survival and source of primary inoculum for powdery mildew in *Cornus florida*. Environments that are generally unfavorable to the pathogenincluding cold and drought have been shown to trigger the formation of cleistothecia in some cases; host physiology has also been implicated as a factor in ascocarp formation. In *Uncinula necator* of grapes, the meeting of compatible mating types solely influenced cleistothecia formation and the timing of ascocarp formation was dependent on the meeting of the mating types. In Lilac, ascocarp formation occurs quite early in the season and by mid July, mature ascocarps are evident on infected plants. In dogwood, ascocarp formation occurs late in the growing season when plants are nearing senescence, and vary between mid September and mid November. Time is a factor in the maturation of ascocarps to a level that can survive winter, and winter survival has implications on the abundance of primary inoculum in the following spring. It is thus important to know the factors that influence ascocarp formation and development in dogwood and the survival rate of immature and mature ascocarps at different winter temperatures.

i) Effect of temperature and day-length on ascocarp formation and maturation: A factorial experiment design was used to test the effect of day-lengths; (12, 11 and 10 h) and day/night temperatures (18/10°C, 23/15°C and 28/20°C) on ascocarp formation. Four replicates were used for each treatment. The selection of temperatures for this study was based on weather conditions during a two-week period preceding ascocarp

formation in 1996 and 1997 in McMinnville, TN. In 1996, ascocarp initials were first observed in mid September and in 1997 they were observed in mid October, periods that was preceded by a two-week period of cool weather of maximum temperatures less than 26.4 °C (80°F). The study was started in mid August before ascocarp initials formed; plants were monitored for ascocarp formation and maturation.

Four leaves from each treatment were picked at random every seven days beginning 25 days after the commencement of the treatments. Ascocarp formation was evaluated by counting the number of leaves that had cleistothecia; ascocarp development and maturation was observed under a dissecting microscope and the developmental stage was categorized into three stages, a) immature stage, b) Intermediate stage, and c)mature stage. Immature ascocarps were cream to light yellow in color and did not contain asci or ascospores; intermediate stage had brown colored ascocarps that contained asci and no ascospores and are therefore partly developed; and mature ascocarps were dark-brown to black in color and contained asci and ascospores. The abundance of ascocarps at each developmental stage was assessed under a dissecting microscope using a scale of 1-3, where 1 =1<10 (few), 2 = 11<20 (moderate), and 3 = >20 (abundant).

ii) Effect of temperature on winter survival of ascocarps of different maturity stages. Ascocarps were collected from field and container grown plants and were observed under a dissecting microscope; the stage of ascocarp development was assessed. Leaves that carried ascocarps were cut into small pieces about 1x1 cm and separated into three groups: (a) leaf pieces with immature cream colored ascocarps, (b) light brown partly developed ascocarps, and (c) dark-colored mature ascocarps. Leaf pieces (100-200 for each treatment) were placed in separate Petri dishes; sealed with parafilm and stored at either 24/20°C, 4°C, -10°C, or –20°C. Ascocarps were retrieved from each treatment after 60 and 120 days, and assessed for viability and stage of development.

Results and Discussion:

i) Effect of temperature and day-length on ascocarp formation and maturation: All plants grown at 18/10°C and 23/15°C with 12, 11 and 10h day-lengths developed ascocarps. Plants grown at 28/20°C did not develop cleistothecia at any day-length (Table 1). At the cooler temperature of 18/10°C shorter days of 11 and 10 hours allowed ascocarp formation on all leaves in 39-45 days while at 23/20°C, and 12h day-length, all leaves formed cleistothecia in 25 days (Table 1). Day-length seemed to influence the rate of ascocarp formation but all the three day-lengths used supported ascocarp formation in 25-53 days. At the end of

sixty days, 23/15°C with 12 h day-length and 18/10°C, with 10 and 11h day-lengths supported the greatest number of ascocarps at all three developmental stages (Table 2). The high temperature of 28/20°C did not allow ascocarp formation.

Plants left outdoors in natural environment developed ascocarp initials when maximum temperatures dropped below 26°C for several weeks. By this time, all leaves in the cool temperature treatments had abundant mature ascocarps. These results strongly suggest that temperature plays a role in triggering cleistothecia development, but day length is less important.

ii) Effect of temperature on winter survival of ascocarps of different maturity stages. Immature cream-yellow colored ascocarps withered and became shriveled during storage at all temperatures, suggesting that this stage needs the nourishment of the host to survive. Some of the brown colored ascocarps that were not fully developed but had formed asci and no ascospores continued to develop and matured to form ascospores; their viability remained high at the room temperature and 4°C and declined at -10°C and -20°C (Table 3). Some ascocarps did not change during storage but most became degenerate and non-viable. A small percentage of those placed at 4°C and –10°C had asci that remained viable for two months and then degenerated. The best temperature for development and maintenance of viable brown ascocarps was 4°C. A high percentage of viable asci was maintained at – 10°C for two months and then declined sharply (Table 3). Ascospores that are fully mature before storage remained viable at all temperatures with a slight decline at –20°C (Table 4).

These results support earlier reports that ascocarps have to develop to a level of maturity that will allow them to survive winter temperatures. A sudden drop in temperature such as early frost when ascocarps are immature would kill the ascocarps and thus reduce the amount of primary inoculum for the following season. Since maturation of ascocarps is important in their survival during winter, formation of ascocarps in September versus November would have implications on the density of mature ascocarps and survival rate and consequently on inoculum density. However, the partly developed ascocarps formed late in the season may continue to develop during the gradual decline in temperature at the end of the season. This would allow them survive colder temperatures that normally come in winter. Mature ascocarps survived -20°C (Table 4), and thus constitute an important source of primary inoculum.

Significance to the Industry: Since ascocarps constitute an important source of primary inoculum, information on ascocarp formation and maturation in *Microsphaera pulchra* of dogwood will benefit disease control strategies. Time is a factor in the maturation of ascocarps to a level that can survive winter, information on factors that influence ascocarp formation and winter-survival have significance in disease prediction and on the timing of fungicide applications.

Table 1. The effect of temperatures and day-length on cleistothecia formation.

Number of days at each temperature	Percentage of leaves with cleistothecia at each temperature and day-length								
	18/10°C			23/15°C			28/20°C		
	12h	11h	10h	12h	11h	10h	12h	11h	10h
25 days	25	50	75	100	75	50	0	0	0
32 days	25	83	80	100	25	75	0	0	0
39 days	83	100	80	100	63	40	0	0	0
46 days	75	100	100	100	100	50	0	0	0
53 days	100	100	100	100	100	100	0	0	0
60 days	100	100	100	100	100	100	0	0	0

Table 2. The effect of temperature and day-length on ascocarp formation and development.

Temperature	Day-length	Abundance of ascocarp* of different maturity stages		
		Immature (Cream-yellow)	Intermediate (Brown)	Mature (Black)
18/10°C	12h	1.0ab	1.5bc	0.9ab
	11h	1.5a	2.2a	1.4a
	10h	1.4a	1.8abc	1.2a
23/15°C	12h	1.5a	1.9ab	1.3a
	11h	1.4a	1.5bc	0.6b
	10h	0.8b	1.3c	0.4b

*Means followed by different letters are different at p=0.05

Table 3. Assessment of the develoment of brown colored ascocarps stored at different temperatures.

Period of Storage	Storage temperature	State of ascocarp development during and after storage					
		Ascocarps that changed in storage from brown to black			Ascocarps that did not change in color while in storage		
		% that matured	% with viable asci	% with non-viable asci	% with no asci	% with viable asci	% with non-viable asci
2 months	24/20 °C	30	12.5	87.5	30	0	70
	4 °C	60	60	40	10	40	50
	-10 °C	30	80	20	20	20	60
	-20 °C	20	50	50	20	0	80
4 months	24/20°C	60	33.3	66.7	0	0	100
	4 °C	80	83.3	16.7	0	0	100
	-10 °C	50	25	75	0	0	100
	-20 °C	20	20	80	20	0	100

Table 4. Effect of storage temperature on the viability of mature ascocarps of *Microsphaera pulchra* two and four months of storage at different temperatures.

Period of storeage	Percentage of ascocarps that had viable or none viable asci		
	Storage temperature	Viable asci	Non viable asci
2 months	24/20	90.9	9.1
	4 °C	100	0
	-10 °C	100	0
	-20 °C	85	15
4 months	(24/20)	94.1	5.9
	4 °C	100	0
	-10 °C	100	0
	-20 °C	78.6	21.4

Use of the Biological Fungicide RootShield™ in Commercial Poinsettia Production

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Index Words: Biological Fungicide, *Trichoderma harzianum*, Poinsettia, Rootshield

Nature of Work: Rootshield™, which contains the fungus *Trichoderma harzianum* strain T-22, is a biological fungicide that is labeled to manage root rot diseases caused by species of *Pythium*, *Rhizoctonia*, and *Fusarium* on a variety of crops—including those grown in nurseries and greenhouses. To date, most of the research on and use of this product with ornamental crops have been in the greenhouse. Preliminary research conducted by Clemson Extension Service at Baucom's Nursery in South Carolina has demonstrated that RootShield™ can be effective as a preventative fungicide in commercial production of poinsettias.

On 27 July 1998, 80 vegetative cuttings of Spotlight Dark Red poinsettias were stuck in bark mix in 6-inch containers and were placed under mist to root. On 10 August, all cuttings had initiated roots. At this point, 20 plants were randomly selected and treated with a single drench application of RootShield™ at a rate of 11.3 grams (0.4 oz) of product per 18.9 liters (5.0 gallons) of water; 236 ml (8.0 fl oz) of RootShield™ suspension were added to each pot. In addition, 20 other plants were selected randomly for the untreated control treatment.

On 3 August, the remaining 40 plants were treated with a drench of Banrot 40% WP (active ingredient [a.i.] = thiophanate-methyl plus etridiazole) at the recommended label rate. This group of plants then was divided in half. One group of 20 plants received no additional application of fungicide. The second group of plants received additional drench applications of a tank mix of Cleary's 3336 WP (a.i. = thiophanate-methyl) plus Subdue Maxx (a.i. = mefenoxam), both used at recommended label rates, once every four weeks (three applications in all). All 80 plants were arranged in a completely randomized design in the greenhouse and were maintained under Baucom's standard poinsettia production program. On 1 December 1999, plants were visually evaluated for root development and growth. Due to production needs, only a limited quantity of plants were sacrificed to collect quantitative data. For three of the treatments (Control, RootShield, and Banrot then Cleary's/

Subdue Maxx mixture) five plants were selected arbitrarily and heights and dry weights of shoots and foliage (i.e., all above-ground growth) were measured. These data were analyzed by one-way analysis of variance (ANOVA) using Minitab statistical software (ver. 12.2), and treatment means were separated by Fisher's Protected Least Significant Difference (LSD; P=0.05).

Results and Discussion: There were no obvious symptoms of root rot on any of the plants in this trial. However, there were obvious differences among the treatments in overall plant growth and development (Figure 1). There was no significant difference in height among the three treatments, but there was a significant difference among treatments in size as measured by above-ground dry weight (Table 1).

Treatment 1—Control: The root systems on these plants were poorly developed; both root quality and quantity were low. Root systems lacked good branching, color, and root hairs. Plant height averaged 34.0 cm. Shoots and foliage on these plants had an average dry weight of 25.9 grams, which was significantly less than the dry weights of the other treatments (P=0.001).

Treatment 2—One drench of Banrot:: Root systems on these plants also were poorly developed. Root quality and quantity appeared better than those on plants in the Control treatment but inferior to those on plants in the other two treatments. Dry weights and heights were not recorded for plants in this treatment.

Treatment 3—One drench of Banrot and three drenches of Cleary's plus Subdue Maxx: Root systems on these plants were well developed; both root quality and quantity were good. Roots had increased branching, good color, and plentiful root hairs compared to Treatments 1 and 2. Plant height averaged 33.8 cm. Shoots and foliage on these plants had an average dry weight of 38.4 grams, which was significantly greater than that of the Control treatment and not significantly different from that of the RootShield™ treatment (P=0.001).

Treatment 4—One drench of RootShield: Plants in this treatment had developed the best root systems, which were visually superior to those on plants in all other treatments. Both root quality and quantity were excellent. Roots had excellent branching, color, and root hair development. Plant height averaged 36.3 cm. Shoots and foliage on these plants had an average dry weight of 44.5 grams, which was the greatest of the three treatments measured but was not significantly different from that of plants treated with one initial drench of Banrot and three additional drenches of Cleary's 3336 plus Subdue Maxx.

Results from this initial experiment suggest a chronic, sublethal level of root rot (i.e., "root nibbling") was present on the poinsettias used in this trial without obvious symptom expression. Consequently, routine applications of fungicides for root disease management were beneficial—even in the absence of noticeable disease symptoms. The causal agent of root rot on these plants was not determined. Under these conditions, a single drench with RootShield™ was as effective as repeated applications of chemical fungicides. Plants treated with RootShield™ were larger than untreated plants and had excellent root development. However, under heavier disease pressure, results from previous studies conducted by other researchers suggest that RootShield™ may not be as effective as chemical fungicides. Based on the results reported here, additional trials using RootShield™ were initiated on selected nursery crops that are either highly susceptible to root diseases or have difficulty developing roots. To date, trials are being conducted on *Rhododendron* spp., *Juniperus procumbens*, *Gardenia jasminoides* 'Radicans', and *Ilex vomitoria* 'Shillings'.

Significance to Industry: Use of RootShield™ in commercial poinsettia production offers several potential benefits:

- it is economical—cost of the single application is less than the cost of repeated applications of chemical fungicides;
- it has a shorter REI period than chemical fungicides; and
- it reduces environmental concerns because there is little or no problem with movement in runoff water.

Additional investigations are needed to determine how and when to use this biological fungicide most effectively in the nursery and greenhouse. It certainly appears to have a role in the production of at least some ornamental plants—like poinsettias.

Table 1. Effects of a single RootShield™ application and repeated chemical fungicide applications on height and above-ground dry weight of Spot Light Dark Red poinsettias

Treatment	Height (cm)	Dry Weight (g) [y]
Control	34.0 a	25.9 a
Fungicide	33.8 a	38.4 b
RootShield™	36.3 a	44.5 b
P value [z]	0.169	0.001
LSD	Not significant	8.5

[y] Means within columns followed by the same letter are not significantly different (LSD).
[z] P values of *F* statistics from one-way ANOVAs.


CONTROL
BANROT
BANROT WISUBDUE & CLEARY'S 3336 MONTHLY DRENCHES
ROOTSHIELD DRENCH

Distribution of Water-Facilitated Entomopathogenic Nematodes in Soil Columns

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Index Words: Entomopathogenic Nematode, *Steinernema carpocapsae*, Bio-control Agent

Nature of Work: Entomopathogenic nematodes (EN) are potential biological control agents of soil-inhabiting insects like Japanese beetle grubs. Infective stage juveniles of EN belonging to the families Steinernematidae and Heterorhabditidae have been reported to search for and kill soil-dwelling pests (Gaugler, 1981; Klein, 1990; Simoes et. al., 1993 Jackson and Brooks, 1995). Their distribution in soil is important for successful control of targeted insect pests. Therefore, the primary objective of this study was to investigate the distribution of *Steinernema carpocapsae* (Weiser) (TN25 strain) in three different media (soil types) packed in soil columns. The nematodes were subjected to relatively low water flux delivered from a compact rain simulator. The rain simulator devices (Ogden et al., 1997; Dennis et. al., 1998) were made of clear acrylic plastic with coiled capillary tubing at the bottom. The tubing served as drippers. The rain simulator devices were calibrated to deliver a darcian flux of 0.4 cm/hr, which amounted to a water delivery rate of approximately 120 ml/hr. The soil columns were made of PVC pipe 6 inches (id) x 16 inches long. The base was fitted with a plastic sieve that had greater pore size than the nematodes. Two elbow tensiometers were also fitted into the sides of the columns to monitor the water status of the soil. The columns were saturated with water dripping from the rain simulator devices. The devices allowed the columns to become saturated evenly without the occurrence of surface ponding. The soils used for the study were collected from the Tennessee State University Nursery Crop Research Station in McMinnville, Tennessee, and from the Winfred Thomas Research Station at Alabama A&M university, Normal, Alabama. The Tennessee soil was classified as Waynesboro sandy loam soil; while the Alabama soil was classified as Decatur silt loam soil. The sand sample (Horticultural sand) was purchased from a local hardware store. The soil samples were crushed and passed through a 2-mm sieve. The soil samples and sand were analyzed for particle size (texture), organic

matter and pH. Sub-samples of the collected soils and of the sand were sterilized in an autoclave at 254°F for 60 minutes (to kill existing nematodes). These sub-samples were used to pack the soil and sand samples into the PVC columns. All three media were packed to a bulk density of 1.20 gm/cm^3. The entomopathogenic nematodes (*Steinernema carpocapsae*, Tn25) used in the study were isolated from soils collected from commercial nursery fields in Middle Tennessee. The nematodes were baited with greater wax moth larvae to verify their pathogenicity. The pathogenic isolates were used for the study. The nematodes were uniformly applied to the surface of the soil columns. Each column received approximately 11,000 nematodes, an amount equivalent to a field application rate of about 1 billion nematodes per acre. The nematodes were left to equilibrate with the soil for 24 hrs. After this time, the rain simulator devices with water dripping from them were placed on top of the soil columns to facilitate the movement of the nematodes. Leachate samples were collected and assayed for the presence of nematodes that may have been transported through the soil columns. The experiment was run for 48 hours, after which the soil columns were cut into 6 depth increments at 2-inch intervals (0-2, 2-4, 4-6, 6-8, 8-10, and 10-12 inches). The nematodes in each depth increment were extracted and counted under a stereomicroscope connected to an image analyzer programmed for nematode recognition. The distribution of nematodes at each depth increment was then determined.

Results and Discussion: The results of some soil physical and chemical properties of the study sites are shown in Table 1. Entomopathogenic nematode assays from each depth increment of all the soil types studied suggested transport of the nematodes in porous media. As shown in Figure 1, the distribution of nematodes decreased with depth. The percent of EN recovered was greater in the surface depths than in the sub-surface depth increments, especially at the 0-2 inch depth of all the soil types studied. Additionally, the distribution of nematodes at this depth (0-2 inches) was more with the sand sample than the other two media. Nematodes prefer to live in water films of soils. The fact that sand has greater pore space than field soils probably accounts for the higher percentage of nematodes at the 0-2 inch depth of the sand samples. The distribution of the nematodes at the 4 to 12 inch depths of all the three media were relatively uniform.

Significance to Industry: It appears that entomopathogenic nematodes, a potential bio-control agent of some soil inhabiting pests, are capable of movement in the direction of water flow. However, field trials with EN have generally produced inconsistent results. The efficacy of these nematodes probably diminishes because when they are applied to soil, the majority of the entomopathogenic nematodes stayed near the

soil's surface as evidenced by this study. Thus, the targeted pests, which are usually around the root zone of the plants, are circumvented by the nematodes. The goal of most growers is to maximize the effectiveness of these nematodes around the root zone of the crop. This is the area where recalcitrant pests like the Japanese beetle grubs do the most damage. Therefore, research of this nature tends to shed some light on some of the reasons why field trials with EN have been unpredictable.

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Table 1. Some soil physical and chemical properties of the media.

		Organic	Texture		
Media	pH	Matter	% Sand	% Silt	% Clay
Alabama Soil	5.40	1.10	21	52	27
Tennessee Soil	5.90	1.80	66	30	4
Horticultural Sand	6.70	0.00	100	0	0

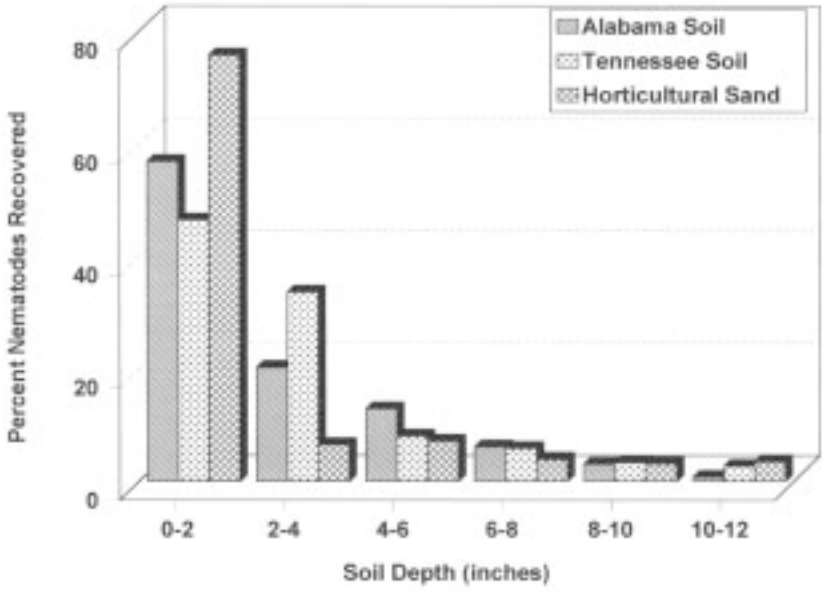

Figure 1. Vertical distribution of nematodes in soil columns.

Susceptibility of Indian Hawthorn Selections to Entomosporium Leaf Spot in South Georgia

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Index Words: Defoliation, Disease, Entomosporium, Indian Hawthorn, *Rhaphiolepis*

Nature of Work: I initiated a study in March of 1996 to evaluate the ornamental characteristics (growth, flowering, etc...) and disease susceptibility of eleven Indian hawthorn selections to Entomosporium leaf spot. The cultivars 'Elizabeth'; a popular selection from Mississippi, and 'Pink Pearl' were added in the spring of 1997. Many new selections of Indian hawthorn have become available since Will Corley published his evaluation work with the genus in the mid 80's. Disease pressure is also greater in the Coastal Plain compared to the Piedmont where Corley's evaluations took place.

Plants were established at the Coastal Plain Station (USDA 8a) in Tifton on a Tifton loamy sand. Four single plant replicates were placed on 7.5' centers within the rows and 12.5' between the rows. The plants were fertilized in April of 1996-1998 using IMC 16-4-8 + minors at the rate of 50 lb. N/A. Plants have been watered as needed using drip irrigation (Bowsmith 1.0 gal/hr emitters). Weeds have been controlled by directed sprays of RoundUp herbicide as needed and by preemergent applications of Gallery and Factor in the spring and Gallery and Surflan in the fall. Disease and defoliation were evaluated in May and June of 1997 and 1998. Disease and defoliation were visually evaluated on a scale of 1 to 5 where 1 = no disease, 2 = 1% to 25% of the leaves diseased or defoliated, 3 = 26% to 50%, 4 = 51% to 75%, and 5 = >76%. For simplification, disease and defoliation ratings have been listed as (A) acceptable, (F) fair, and (U) unacceptable. Disease and defoliation ratings less than 3 were considered acceptable, 3 to 3.9 was fair, and 4 or greater was unacceptable. Only rankings from 1998 are shown (Table 1).

Results and Discussion: At both dates in 1998 the selections Gulf Green, Georgia Petite, Olivia, and Georgia Charm demonstrated good resistance to leaf spotting and defoliation. Results for these four selections were similar in 1997. The selection Pink Pearl showed moderate disease and defoliation. Disease development was excessive while leaf drop was fair for Clara, the most commonly used Indian hawthorn in south Georgia landscapes. Snow White had fair disease ratings in June but dropped fewer leaves than Clara in May and June. The selection

Eleanor Tabor, new from Flowerwood Nurseries, received all acceptable ratings in 1997 but had unacceptable disease development in May of 1998 with fair defoliation ratings for both months.

The selections Ballerina, Bay Breeze, Cameo, Elizabeth, and Kathy have been considered unacceptable due to extensive disease development and defoliation. The fair disease rating for Cameo in June of 1998 was due to the fact that the plants had completely defoliated and only new growth was left to evaluate. One of the four Cameo plants died in 1998 from repeated defoliation.

Future articles will discuss the growth habits and flowering periods for Indian hawthorns in south Georgia. Entomosporium appears to be primarily a spring disease problem in our trials as selections such a Bay Breeze seem to recover from complete defoliation in the spring by late summer. However, plants in the landscape or in nurseries receiving regular overhead irrigation seem to have the problem a better part of the year. New entries for 1998 are Becky Lynne, a selection from Flowerwood Nurseries and seedlings of *Rhaphiolepis umbellata* which have good purple coloration of the foliage in the winter and excellent resistance to leafspot in our trials. Open-pollinated seedlings from the trials are also being evaluated in containers.

Significance to Industry: The selections Georgia Charm, Georgia Petite, Gulf Green (also sold as *R. umbellata* 'Minor'), and Olivia are superior selections for resistance to Entomosporium leaf spot. Unfortunately, Georgia Charm and Georgia Petite are not readily available in the nursery trade yet. Selections such as Ballerina (also known as Pink Flush), Bay Breeze, Cameo, Elizabeth, and Kathy are not acceptable due to extensive disease development and defoliation. Growers and landscapers wishing to implement IPM programs now have several disease resistant selections to choose from.

Table 1. Disease and defoliation ratings for 13 selections of Indian hawthorn in 1998. Rankings are (A) acceptable, (F) fair, and (U) unacceptable.

	May 1998		June 1998	
Selection	Disease	Defoliation	Disease	Defoliation
Ballerina	U	U	U	U
Bay Breeze	U	U	U	U
Cameo	U	U	F	U
Clara	U	F	U	F
Kathy	U	U	U	F
Elizabeth	U	U	U	U
Snow White	U	A	F	A
Eleanor Tabor	U	F	F	F
Pink Pearl	F	A	A	F
Georgia Charm	F	A	A	A
Olivia	A	A	A	A
Gulf Green	A	A	A	A
Georgia Petite	A	A	A	A

Leaf Blight Disease on *Cornus mas*

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Index Words: *Cornus mas*, Cornelian Cherry, Leaf Blight

Nature of Work: Cornelian Cherry *(Cornus mas)* is credited as an enduring dogwood that has brought beauty and flavor to the landscape. In North America, it is admired solely as an ornamental plant, but in some parts of Europe, it has a place on the table as a fruit (fresh or pickled), soft drink or even in the form of wine and liqueur. It is native to parts of Eastern Europe and Western Asia, and is one of the earliest blooming of the spring flowering trees and shrubs. Cornelian Cherry transplants easily and, once established, grows at a moderate rate offering attractive foliage as a specimen tree, shtub or large sheared hedge. It has demonstrated longevity and adaptability and has had no previous disease or pest problems.

In the last three years, a leaf blight disease has shattered the comeliness of Cornelian Cherry shrubs and caused significant damage. Fortunately, this disease was only observed in one nursery that had imported its plant stock from Europe. It appears the problem is here to stay, unless control measures can be found to eradicate the disease. Even though infections have been observed in just one nursery' the damage has been severe for three consecutive years and the disease has the potential to spread to other nurseries or landscape areas in plant cuttings generated from infected stock.

The pathogen was isolated in pure culture, characterized and tested for pathogenicity on disease-free plants of *C. mas* and *C. florida.* The pathogenicity of the bacterium was evaluated at different temperatures using young and mature leaves. Based on actual weather conditions that favored the disease in the field, day temperatures of 15, 20, 24 and 28°C and cool night temperature of 10, 15 and 20°C were selected for this study. Disease tree plants were spray inoculated using a suspension of 10^6 CFU/ml, mature leaves that were fully expanded were wounded by multiple needles and the bacteria suspension was introduced into the plant by using a sponge/ multiple needle inoculation method. inoculated plants were maintained at 100% relative humidity for 24 hours after which relative humidity was maintained at 85%. This report discusses the disease diagnosis, its apparent mode of spread, and the effect of temperature on disease severity.

Results and Discussion: *Disease symptoms and diagnosis.* First disease samples were obtained in early May 1996. The material was examined for signs and symptoms of the disease under a dissecting microscope. Bacteria streamed from the lesions as the only sign ofthe disease; it was isolated on pure culture. The colonies were cream colored on potato dextrose agar (PDA) and on nutrient agar (NA). The cells were rod-shaped and gram negative and fluoresced in King's B agar (KBA). These characteristics suggested *Pseudomonas* species (Schaad, 1988). *Pseudomonas syringne* has been reported to parasitize dogwood, and has caused severe damage in *Cornus florida* dogwood in the Northwestern United States (Sinclair et al., I 987). However, inoculation of *C. florida* seedlings with the bacteria did not produce any disease symptoms.

Assessment of the disease at the nursery was done in early May 1997 and 1998 and disease severity remained high in 1999. The disease occurred as a leaf blight, affecting mostly leaves and young shoots causing dark brown necrotic lesions and some die back (Fig 1). In early stages, leaf infection was in the form of discrete lesions, angular in shape and surrounded by a chlorotic halo; these coalesced to ffirm large dark brown patches of dead tissue that oflcen covered a large part of the leaf or entire leaf lamina (Fig 2). The disease seem to be restricted to early spring when temperatures were wet and cool; disease spread stopped when temperature warmed up, and new growth was free of visible symptoms. The disease started on lower leaves and moved up the plant and seemed to spread by water splashing. The disease was first observed on plant material that was imported from Europe and it is suspected that the disease may have been introduced with the plants. Propagation by cutting from apparently healthy twigs has perpetuated the disease to new cuttings and all new plants hacl some disease symptoms.

Disease diagnosis. A bacterium was isolated from the infected plants and reproduced similar symptoms on healthy plants of *Cornus mas* 'Redstone' in growth chamber conditions at 20/15°C and 85% relative humidity, but did not cause any disease symptoms on C. *florida.* The same bacterium was re-isolated from the inoculated plants, and was characterized as gram negative, rod-shaped and produced fluorescent pigment in King's B Agar. According to Schhad (1988), the bacterium was of *Pseudomonas* species. Laboratory tests showed the bacterium was of *P. syringae* (Table 1). Samples of the bacteria were sent to Texas A&M University for fatty acid analysis and results identified the bacteria as *P. syringae* pathovar *maculicola.*

Effect of temperature on disease severity. When the bacterium was applied on healthy plants by spraying, very mild infection was obtained on mature leaves but young leaves developed severe infection (Table 2). Wounding of mature leaves increased disease severity at all temperatures. This indicates that young and succulent tissue is particularly vulnerable to infection; mature leaves are resistant to infection and require wound sites for infection. The results also show that 24/15°C was most favorable to disease severity; 20/15°C and 15/10°C also allowed high disease severity while 28/20°C was too high for the disease (Table 2).

Pseudomonas syringae is known to form an ice nucleus in some crops resulting in frost injury at temperatures that would not normally cause frost damage in the absence of the bacteria. Since spring night temperatures may be close to the freezing point, the role of this bacterium in ice nucleation and the role of subsequent frost injury on disease severity was suspected. Ice nucleation tests were conducted, but there was no evidence of ice nucleation. A copper-based fungicide “Bordeaux mixture”, was not successful in controlling the disease. Further work is needed on disease control.

Significance to the Industry: Cornelian Cherry transplants easily and offers attractive foliage, as a specimen tree or shrub, or even as a large sheared hedge. Even though it has demonstrated longevity and adaptability with no apparent disease and pest problems, it is important to be aware that it is not completely disease free and during wet and cool weather, the attractive foliage can be devastated by a leaf blight disease. Severe infections have been observed in just one nursery, but the damage has been severe for several consecutive years. The disease has the potential to spread to other nurseries or landscape areas and preventative measures should be taken to restrict the spread of this devastating disease.

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Table 1. The *Pseudomonas* species that produce fluorescent pigments and tests that distinguish the species. tests used to identify the leaf blight pathogen of *Cornus mas.*

	Pseudomonas species and their reactions in the various tests.					
Tests	*marginalis*	*tolaasii*	*agaaricae*	*cichorii*	*viridiflava*	*syrnigae*
Levan *	+	-	-	-	-	V
Oxidae	+	+	+	+	-	-
Arginine dihdrolase *	+	-	-	-	-	-
Nitrate to N_2	-	-	-	-	-	-
Growth at 41C	-	-	-	-	-	-
Potato rot *	+	-	-	-	+	-

*tests conducted for the bacteria causing leaf blight in C.mas showed + (positive reaction to Levan and a negative reaction on potato rot; the Arginine dihydrolase test was negative.

Table 2. Effect of temperature, leaf age and leaf wounding on leaf blight severity in *Cornus mas*

	Disease severity		
Temperature	Young leaves	Mature leaves	
	Spray inoculated	Spray inoculated	Wound inoculated
28/15	1.0c	0.0c	2.3b
24/15	4.8a	0.5c	3.3a
20/15	3.5b	1.5a	3.3a
15/10	3.0b	1.0ab	2.5b

Disease severity on a 0-5 scale where 1=1-10%, 2=11-25%, 3-26-50%, 4=51-75, and 5=75-100% plant infection. Disease severity readings followed by same letters in the column are statistically similar.

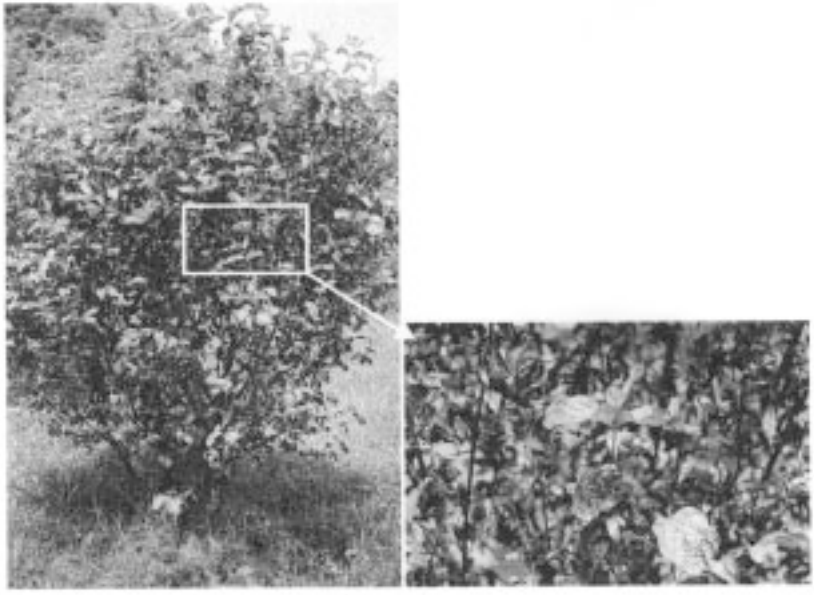

Fig 1. Symptoms of bacterial leaf blight on *Cornus mas*

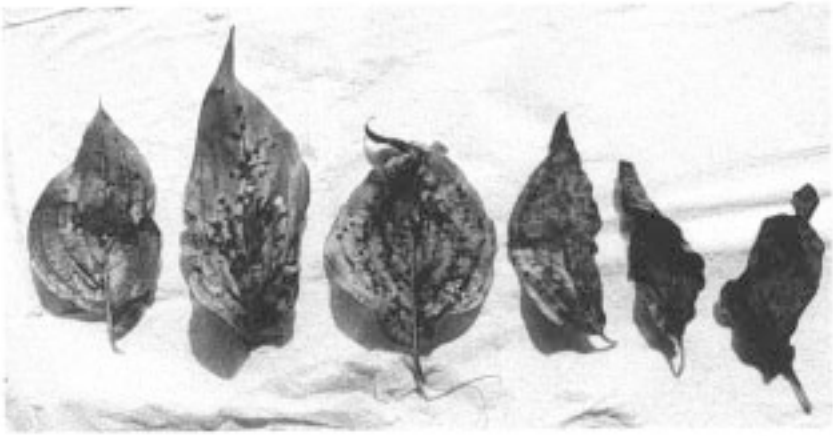

Fig 2. Bacterial leaf blight disease progress from discrete lesions to large necrotic tissue.

Susceptibility of Certain Herbs to Root-Knot Nematode and Lack of Nematicidal Activity from Dried Herb Powders

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Index Words: *Meloidogyne* sp., Plant Disease, Borage, Burnet, Chamomile, Chervil, Chicory, Chives, Lemon Balm, Parsley, Sorrel, Winter Savory, Valerian

Nature of Work: The increasing interest in herbs by the gardening public and horticultural industry suggests that we should learn more about the susceptibility of these plants to plant diseases, including plant nematodes (4). The purpose of this research was to expose eleven herb species to root-knot nematodes and determine their susceptibility by counting the number of root-galls formed or using a gall index, and comparing results with numbers formed on roots of a susceptible host (Rutgers tomato). Nematode eggs were added to individual pots (10 cm diam [4 in]) at two egg densities; 2 or 14-15 eggs per cm^3 with twelve replications in the experiment with *Meloidogyne incognita* and six replications in an experiment with both *M. arenaria* and *M. incognita*. Plant roots were examined for root-galls two months after inoculation. Plant heights and dry weights were recorded and data analyzed by analysis of variance. Herbal powders were evaluated by adding 300 to 1230 mg (0.3-1.2 oz.) per kg of soil infested with 6000 nematode eggs per kg (2.2 lbs.), and after one week, tomato seedlings were planted in treated and untreated soil as a bioassay of nematode survival. There were two replications of each treatment.

Results and Discussion: Chicory, chives, parsley, and valerian developed fewer root-galls than tomato when inoculated with 2 or 15 eggs of *M. incognita* per cm^3 of soil (Table 1). At the highest egg density, more galls developed on chicory than on parsley, and more on parsley than on chives and valerian. Little difference in height or dry weight occurred between inoculated and control plants, except for chicory and chives which were diminished in weight at the highest inoculum density. There were no differences in the gall indices of tomato and borage, burnet, chamomile, chervil, lemon balm, sorrel, or winter savory, although the gall index on savory was zero at both egg densities (Table 2). Egg masses were observed on sorrel and lemon balm, but were not seen on other species. The herbal powders of Echinaceae, ginseng root, St.

Significance to Industry: The expanding green industry needs information on the susceptibility of plants to pathogenic nematodes, because there are few chemicals available to control these pests. Considerable interest on plant or “natural products” for medical purposes is being generated in the pharmaceutical industry (3), and such products eventually could have applicability as “plant medicines” for nematode control (1, 2).

Literature Cited

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Table 1. Mean height, dry weights and number of root-galls on four herbs inoculated with *Meloidogyne incognita* compared with tomato, 'Rutgers'.

Herbs	Height (cm)			Dry wt. (g)			Number galls/plant	
	Initial Egg Density/cm3 (0.06 cu in.)							
	0	2	15	0	2	15	2	15
Chicory	10.6 bc[1]	6.5 cd	7.0 c	3.1 b	1.9 c	1.5 c	3.7 b	21.5 b
Chives	7.4 cd	7.2 c	8.0 c	0.5 c	0.4 d	0.2 e	0.3 b	0.9 d
Parsley	4.3 d	3.8 d	4.0 d	1.4 c	1.1 cd	0.9 d	4.6 b	10.9 c
Valerian	13.6 b	11.1 b	9.9 b	3.8 b	3.5 b	2.5 b	0.9 b	3.5 d
Tomato	48.3	52.0 a	47.3 a	6.2 a	6.7 a	7.6 a	40.5 a	109.0 a

[1] Mean of 12 replications with 4 - 6 plants per replication. Dissimilar letters within columns represent significant differences at P = 0.05 for LSD of each variable by General Linear Model procedure.

Table 2. Mean plant height, dry weights and gall indices of herbs inoculated with root-knot nematodes *Meloidogyne arenaria* (Ma) and *M. incognita* (Mi) at two egg densities.

Herbs	Height (cm)					Dry wt. (g)					Gall Index[1]			
		Ma		Mi			Ma		Mi		Ma		Mi	
	0	2	14	2	14	0	2	14	2	14	2	14	2	14
Borage (Borago officinalis L.)	14.7 [2]	12.6	11.8	13.0	13.2	16.2	11.2	10.9	12.2	14.2	0.0	0.1	0.0	0.2
Chamomile (Chamaemelum nobile L.)	6.8	6.7	6.0	7.7	7.8	6.4	4.2	4.1	4.9	4.7	0.0	0.2	0.0	0.1
Chervil (Anthriscus cerefolium L.)	15.0	13.3	9.8	11.5	11.8	17.3	5.3	7.3	13.3	11.5	0.2	0.5	0.2	0.2
Burnet (Sanguisorba officinalis L.)	14.3	15.3	14.3	13.8	14.0	8.7	4.8	7.9	6.2	7.2	0.1	0.2	0.0	0.1
Sorrel (Rumex acetosa L.)	14.3	12.3	14.0	12.5	14.7	11.1	6.0	8.4	9.1	6.7	0.1	0.2	0.0	0.1

Balm	10.2	7.3	7.3	7.7	7.3	4.0	2.3	2.8	3.3	2.5	0.2	1.2	0.1
0.2 (Melissa officinalis L.)													
Winter Savory	6.7	7.5	6.3	7.7	8.5	0.9	0.5	0.5	0.8	0.9	0.0	0.0	0.0
0.0 (Satureja montana L.)													
Tomato	30.7	23.8	26.7	22.0	25.8	7.0	6.8	6.1	5.5	5.2	0.2	1.3	0.2
1.3 (Lycoperson esculentum L.)													

[1] Gall Index based on 0 = no galls, 0.1 = 1 - 10, 0.2 = 11 - 50, 1.0 = 51 - 75, 3 = >75.

[2] Mean of 6 replications containing 4 plants/replication, except tomato 1 plant/replication.