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Screening Registered Fungicides and Compass 50W for the Control of Powdery Mildew on Flowering Dogwood

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Introduction

Since 1994, powdery mildew, which is caused by the fungus *Microsphaera pulchra* (syn. = *M. penicillata*), has emerged as the most common disease observed on native and cultivars of flowering dogwood (*Cornus florida*) in landscapes and nurseries across Alabama and adjoining southern states (1,2,4). Although disease-related damage to established flowering dogwood is largely cosmetic, slowed growth, reduced vigor, and the deaths of year-old seedlings in field plantings have been attributed to severe outbreaks of powdery mildew (Mark Windham, personal communication).

Cultivars and native 'seedling' flowering dogwoods differ considerably in their susceptibility to powdery mildew. Several cultivars of flowering dogwood, particularly 'Cherokee Brave', 'Cherokee Chief', 'Welch's Bay Beauty', and 'Weavers White', have a high level of resistance not only to powdery mildew, but also to the common disease spot anthracnose (2). However, the vast majority of trees in Alabama's landscapes are native 'seedling' trees or cultivars that are often highly susceptible to powdery mildew. Since powdery mildew has recently emerged as a widespread and damaging disease, limited information is available concerning the efficacy of fungicides for its control in production or landscape settings (5,6,7).

In response, trials were initiated in 1997 to identify efficacious fungicides for the control of powdery mildew in the nursery and landscape. In addition, the efficacy of the new strobilurin fungicide Compass 50W (trifloxystrobin) for the control of powdery mildew was evaluated over a range of application rates and treatment intervals.

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Material and Methods

Establishment and Management: In the 1997, 1999, and 2001 trials, bare-root flowering dogwoods were potted in #3 containers either in pine bark/peat (3:1 v/v) or 100% pine bark amended with 14 pounds of 17-7-12 Osmocote, 6 pounds of dolomitic limestone, 2 pounds of gypsum, and 1.5 pounds of Micromax per cubic yard of mixture. While seedling flowering dogwoods were used in 1997, the cultivars 'First Lady' and 'Cloud 9' were chosen in 1999 and 2001, respectively. Potted plants were placed under 40% shade on oyster shell beds and were irrigated daily using overhead impact sprinklers. A randomized complete block design with six or eight replications of one plant per treatment was used. Blocks of plants were re-randomized following each fungicide application. Fungicides were applied to run-off with a CO₂-pressurized backpack sprayer at the intervals specified in the paragraphs below. Incidence of powdery mildew on the leaves was visually assessed using the 1 to 12 Horsfall and Barratt rating scale where 1 = no disease, 2 = 0 to 3%, 3 = 3 to 6%, 4 = 6 to 12%, 5 = 12 to 25%, 6 = 25 to 50%, 7 = 50 to 75%, 8 = 75 to 87%, 9 = 87 to 94%, 10 = 94 to 97%, 11 = 97 to 100%, and 12 = 100% of the leaves colonized by the powdery mildew fungus *M. pulchra*. In 1999 and 2001, canopy height and width were recorded for calculation of a growth index according to common horticultural practice (3).

Fungicide comparisons: In 1997 and 2001, recommended rates of commercially available fungicides were evaluated for the control of powdery mildew. Treatments in 1997 included Bayleton T/O (triadimefon), Triforine EC (triforine), 3336 4.5F (thiophanate-methyl), Domain 50W (thiophanate-methyl), Banner Maxx (propiconazole), Rubigan AS (fenarimol), Phytan 27 (copper sulfate pentahydrate), and Eagle 40W (myclobutanil). For the 2001 trial, Triforine EC and Domain 50W were deleted from the above treatment list, while Immunox (myclobutanil), Heritage 50W (azoxystrobin), and Sunspray Ultrafine Oil were added. In both years, a non-ionic surfactant (0.06% v/v) was added to tank mixes of Domain 50W, Eagle 40W, and Bayleton T/O. All fungicides were applied at two-week intervals beginning on June 18 and ending on September 17, 1997 and again from April 23 until July 24, 2001. The incidence of powdery mildew was recorded on October 1, 1997 and on May 29, July 10, August 8, and August 24, 2001. Data collected on the July 10 rating date is displayed in Table 1. Tree dimensions were logged on August 14, 2001.

Application rate and timing comparisons for Compass 50W: In 1999, the efficacy of selected rates of Compass 50W was compared with the fungicide standards Banner Maxx, Eagle 40W, and Heritage 50W for the control of powdery mildew on 'First Lady' flowering dogwood. The 0.5-oz (ounce) per 100-gallon rate of Compass 50W was applied on a 7-day schedule, compared to a 14-day schedule for the 1.0 and 2.0 oz per 100-gallon rates of the same fungicide. While the application interval for Eagle 40W and Heritage 50W was 14 days, Banner Maxx was applied on a 21-day schedule. Fungicides were applied from April 12 through October 6, 1999. Powdery mildew incidence and tree dimensions were recorded on July 7 and September 29, respectively.

In 2001, differential rates and treatment intervals were evaluated by applying 1, 2, and 4 oz of Compass 50W per 100 gallons of spray volume at 7, 14, and 28-day intervals to 'Cloud 9' flowering dogwood. Eagle 40W, which was applied at 8 oz per 100 gallons every 14 days, was included as the registered fungicide standard. A non-ionic surfactant (0.06% v/v) was added to all tank-mixes of Compass 50W and Eagle 40W. Fungicides were applied to run-off from April 23 until July 24. The incidence of powdery mildew was evaluated on May 29, July 10, August 8, and August 24, 2001. Only the data from the July 10 rating is presented in Table 3. Tree dimensions were logged on August 14, 2001.

Results

Disease Control: Although all treatments significantly reduced the incidence of powdery mildew, compared with the unsprayed control, noticeable differences in the level of disease control were observed among the fungicides screened in 1997. On flowering dogwood treated with Eagle 40W, Phyton 27, Rubigan AS, Domain 50W, and Banner Maxx, powdery mildew development, which was restricted to light colonization of a small percentage of leaves, was unobtrusive (Table 1). When compared with the above fungicides, 3336 4.5F, Triforine EC, and Bayleton T/O demonstrated less activity against powdery mildew. However, leaf colonization by *M. pulchra* on the 3336 4.5F, Triforine EC, and Bayleton T/O-treated flowering dogwoods was well below the nearly 90% level seen on the unsprayed trees.

Table 1. Efficacy of selected fungicides for the control of powdery mildew and on the growth of flowering dogwood.

Treatment	Rate per 100 gal	Growth Index ^w cm	Powdery Mildew Incidence ^x	
			1997	2001
Bayleton T/O	4.0 oz	116 ^y	5.3	4.2
Triforine EC	12.0 fl oz	-- ^z	5.3	--
3336 4.5F	20 fl oz	108	4.1	3.8
Banner Maxx	6 fl oz	99	2.5	2.0
Domain 50W	1.0 lb	115	1.9	5.0
Rubigan AS	10 fl oz	--	1.9	--
Phyton 27	40 fl oz	96	1.9	3.5
Eagle 40W	8 oz	115	1.6	3.2
Immunox	100 fl oz	113	--	2.2
Heritage 50W	4 oz	110	--	2.3
SunSpray Ultrafine Oil	1%	111	--	3.8
Unsprayed Control	---	99	9.0	7.8
LSD ($P=0.05$)		17	1.0	1.2

^wGrowth index = height + width + width /3 was recorded only in 2001.

^xincidence of powdery mildew was evaluated using a 1 to 12 Horsfall and Barratt rating system where 1 = no disease, 2 = 0 to 3%, 3 = 3 to 6%, 4 = 6 to 12%, 5 = 12 to 25%, 6 = 25 to 50%, 7 = 50 to 75%, 8 = 75 to 87%, 9 = 87 to 94%, 10 = 94 to 97%, 11 = 97 to 100%, and 12 = 100% of the leaves colonized by the powdery mildew fungus.

^yMean separation within columns was tested according to Fisher's Protected Least Significance (LSD) test ($P = 0.05$).

^zTreatment not tested = --.

As previously noted in 1997, significant differences in the efficacy were observed among the fungicides screened in 2001 (Table 1). Banner Maxx, Immunox, and Heritage 50W gave the best control of powdery mildew. Typically, only a few isolated colonies of the powdery mildew fungus *M. pulchra* were noted on a few scattered leaves of flowering dogwood treated with these fungicides. Eagle 40W was as effective in controlling powdery mildew as Immunox and Heritage. In addition, Eagle 40W, 3336 4.5F, SunSpray Ultrafine Oil, and Bayleton T/O, which all provided similar levels of disease control, gave a moderate level of protection from powdery mildew. Although Phyton 27 significantly reduced the incidence of powdery mildew, some tip burn was observed on the upper leaves of the trees sprayed with this fungicide. When compared to the unsprayed control, Domain 50W significantly reduced the incidence of powdery mildew but proved less effective in controlling this disease than five other fungicides.

Compared to the unsprayed control, all rates of Compass 50W, as well as Banner Maxx, Eagle 40W, and Heritage 50W, significantly reduced the incidence of powdery mildew (Table 2). As indicated by an incidence rating of 12.0, all of the leaves on the unsprayed flowering dogwoods were colonized by *M. pulchra*. Although the percentage of leaves on all of the fungicide-treated trees was low, significant differences in disease incidence were noted. The incidence of powdery mildew was higher on the flowering dogwood treated bimonthly with the 1.0 and 2.0 oz/100 gallon rates of Compass 50W than those with weekly applications of the 0.5 oz/100 gal rate of the same fungicide. Also, significantly fewer colonized leaves were observed on the flowering dogwood treated with Eagle 40W and Heritage 50W than on those trees with the two higher rates of Compass 50W. The highest rate of Compass 50W and Banner Maxx provided the same level of disease control.

Table 2. Comparison of Compass with selected fungicides for the control of powdery mildew on 'First Lady' flowering dogwood.

Treatment	Rate per 100 gal	Spray Interval wk	Growth Index ^x cm	Tree Caliper cm	Powdery Mildew Incidence ^y
Compass 50W	0.5 oz	7	141.1 ^z	19.0	1.8
Compass 50W	1.0 oz	14	157.9	19.8	4.3
Compass 50W	2.0 oz	14	162.0	21.2	3.0
Banner Maxx	5 fl oz	21	149.0	20.1	2.1
Eagle 40W	8.0 oz	14	156.0	21.4	1.6
Heritage 50W	8.0 oz	14	153.0	19.2	1.4
Unsprayed control	--	--	133.1	14.8	12.0
LSD (<i>P</i> =0.05)			14.6	2.0	1.1

^xGrowth index = height + width + width /3.

^yIncidence of powdery mildew was evaluated using a 1 to 12 Horsfall and Barratt rating system where 1 = no disease, 2 = 0 to 3%, 3 = 3 to 6%, 4 = 6 to 12%, 5 = 12 to 25%, 6 = 25 to 50%, 7 = 50 to 75%, 8 = 75 to 87%, 9 = 87 to 94%, 10 = 94 to 97%, 11 = 97 to 100%, and 12 = 100% of the leaves colonized by the powdery mildew fungus.

^zMean separation within columns was tested according to Fisher's Protected Least Significance (LSD) test (*P* = 0.05).

In 2001, Compass 50W, when applied over a range of labeled application rates and treatment intervals, significantly reduced the incidence of powdery mildew on 'Cloud 9' flowering dogwood, as compared with the unsprayed control (Table 3). Signs and/or symptoms of powdery mildew were noted on nearly 50% of the leaves of the unsprayed trees. At the 1.0 and 2.0 oz/100 gallon rates, Compass 50W gave significantly better disease control when applied on a 1 and 2 week schedule than when applied every 4 weeks. The levels of leaf colonization noted on the trees treated with the two lower rates of Compass 50W at 1 and 2 week intervals were similar. The incidence of powdery mildew on flowering dogwood treated with the highest rate of Compass 50W at 1, 2, and 4-week intervals did not significantly differ. With the exception of the 1.0 and 2.0 oz/100 gallon rates applied monthly, Compass 50W proved equally as effective in controlling powdery mildew on flowering dogwood as the fungicide standard Eagle 40W.

Table 3. Influence of application rate and interval on the efficacy of Compass 50W for the control of powdery mildew on 'Cloud 9' flowering dogwood.

Treatment	Rate per 100 gal	Spray Interval wk	Growth Index ^x cm	Powdery Mildew Incidence ^y
Compass 50W	1 oz	1	105 ^z	2.2
Compass 50W	1 oz	2	97	2.5
Compass 50W	1 oz	4	104	4.8
Compass 50W	2 oz	1	104	1.7
Compass 50W	2 oz	2	95	2.0
Compass 50W	2 oz	4	103	4.2
Compass 50W	4 oz	1	100	1.5
Compass 50W	4 oz	2	108	2.5
Compass 50W	4 oz	4	96	2.8
Eagle 40W	8 oz	2	92	1.8
Unsprayed control	--	--	106	6.7
LSD (P=0.05)			NS	1.5

^xGrowth index = height + width + width /3.

^yIncidence of powdery mildew was evaluated using a 1 to 12 Horsfall and Barratt rating system where 1 = no disease, 2 = 0 to 3%, 3 = 3 to 6%, 4 = 6 to 12%, 5 = 12 to 25%, 6 = 25 to 50%, 7 = 50 to 75%, 8 = 75 to 87%, 9 = 87 to 94%, 10 = 94 to 97%, 11 = 97 to 100%, and 12 = 100% of the leaves colonized by the powdery mildew fungus.

^zMean separation within columns was tested according to Fisher's Protected Least Significance (LSD) test (P = 0.05).

Tree Growth: In the 1999 study, severe powdery mildew development on the unsprayed controls had an adverse affect on tree growth. The growth index (GI) and trunk caliper logged for the unsprayed flowering dogwoods were significantly below those recorded for nearly all of the fungicide-treated trees (Table 2). Although the low rate of Compass 50W gave excellent disease control, the GI for these trees did not differ significantly from that recorded for the unsprayed controls. In contrast, the GI for flowering dogwoods treated with the 1.0 and 2.0 oz/100 gallon rate of Compass 50W were higher than those for the lowest rate of this same fungicide. Trunk caliper for the flowering dogwood sprayed with the highest rate of Compass 50W was significantly higher than the trunk caliper recorded for trees treated with the lowest rate of the same fungicide. The trees treated with the 1.0 oz/100 gal rate of Compass 50W had a similar trunk caliper as those flowering dogwood treated with the 0.5 oz/100 gal rate of the same fungicide. Generally, the GI and trunk caliper for trees treated with Banner Maxx, Eagle 40W, and Heritage 50W were similar to the results recorded for the two highest rates of Compass 50W.

In contrast to the 1999 study, the GI for the fungicide-treated 'Cloud 9' flowering dogwood did not differ significantly in 2001 from those recorded for unsprayed trees (Table 3). Also, application rate and treatment interval for Compass 50W had no detrimental impact on tree growth. As was previously noted, the GI for the Eagle 40W treated trees was not significantly different from that recorded for all three rates of Compass 50W.

Discussion

Of the registered fungicides evaluated in 1997 and 2001, Banner Maxx provided the most consistent and effective control of powdery mildew on flowering dogwood. Mmbaga (5) and Windham *et al* (7) also obtained excellent control of powdery mildew on flowering dogwood with Banner Maxx. Eagle 40W and Phyton 27 proved slightly less efficacious in controlling powdery mildew in 2001 than in 1997. In a recent Tennessee study (7), Eagle 40W (Systhane 40W) demonstrated good activity against powdery mildew on 'Rubra' flowering dogwood. The activity of Domain 50W and 3336 4.5F, which both contain the active ingredient thiophanate-methyl, as well as Bayleton T/O against powdery mildew was marginal when compared with that of Banner Maxx. Immunox and Heritage 50W, which were screened only in 2001, were as effective as Banner Maxx in controlling powdery mildew on flowering dogwood. SunSpray Ultrafine Oil, which also gave moderately effective disease control, would be an organic alternative to synthetic fungicides.

Compass 50W demonstrated excellent activity against powdery mildew on flowering dogwood over a range of application rates and treatment intervals, especially in the 2001 study. At the labeled 1 and 2 oz/100-gallon rates, the level of disease control obtained with Compass 50W was comparable to the fungicide standard Eagle 40W in 2001 but not in the 1999 study. In addition, the above rates of Compass 50W were less effective when applied every 4 weeks than at 1 and 2 week intervals. In contrast, the 4-oz/100 gallon rate was equally efficacious against powdery mildew in 2001 when applied at 1, 2, and 4-week intervals. Windham *et al* (7) also observed excellent control of powdery mildew with the 2 and 4 oz/100 gallon rates of Compass 50W.

Historically, the impact of powdery mildew diseases on woody landscape plants has been considered largely cosmetic. Few, if any, published reports have correlated reduced shoot elongation or slowed plant growth with severe outbreaks of powdery mildew diseases. However, in the 1999 Compass 50W study, the GI of the untreated powdery mildew-susceptible cultivar 'First Lady' (2) were significantly below those recorded for all but one fungicide treatment. In a recent Tennessee study (6), similar powdery mildew-related reductions in the growth of flowering dogwood have also been observed. In 2001, on the moderately disease resistant cultivar 'Cloud 9' (2), the Bayleton T/O-treated flowering dogwood also had a higher GI than did the unsprayed controls. The failure of the remaining fungicide treatments to boost tree growth in that and a second 2001 study may be linked to a lower level of powdery mildew pressure than was noted in 1999 or to the moderate disease resistance of the 'Cloud 9' flowering dogwood.

In summary, Banner Maxx, Heritage 50W, and Eagle 40W proved to be highly effective in controlling powdery mildew on flowering dogwood over the two-year test period. Systemic Fungicide (ferti-lome) contains the same active ingredient (propiconazole) as Banner Maxx and is marketed at garden centers and other retail outlets for the homeowner market. Other fungicides targeted at the homeowner market that gave acceptable control of powdery mildew are Immunox (Spectracide) and SunSpray Ultrafine Oil. Eagle 40W and Immunox also contain the same active ingredient myclobutanil, but the formulations are different. In addition, the new strobilurin fungicide Compass 50W (trifloxystrobin) provided effective control of powdery mildew over a range of rates and treatment intervals, particularly in the 2001 study. Bayleton T/O, Triforine EC, and to a lesser extent 3336 4.5F and Domain 50W, which both gave either inconsistent or less efficacious disease control, are not the fungicides of choice for managing powdery mildew on flowering dogwood.

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