Preventative and Curative Control of Downy Mildew of St. Augustinegrass by Metalaxyl

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ABSTRACT

Bruton, B. D., Toler, R. W., and Grisham, M. P. 1986. Preventative and curative control of downy mildew of St. Augustinegrass by metalaxyl. Plant Disease 70:413-415.

Metalaxyl applied at 14.2, 28.4, 56.7, and 85.1 g a.i./93 m^2 as foliar sprays provided both protective and systemic activity against *Sclerophthora macrospora* on St. Augustinegrass. All rates of metalaxyl reduced the percentage of diseased leaf blades from greater than 90% on the day of application to 0% 28 days later. Histological examination of *S. macrospora*-infected leaf blades 7 days after application of metalaxyl showed that the fungicide can eradicate the fungus. Both spring and fall/spring applications of metalaxyl in the field controlled downy mildew. Fenaminosulf demonstrated little or no control of St. Augustinegrass downy mildew.

Additional key words: histopathology, *Stenotaphrum secundatum*, turfgrass

Downy mildew of St. Augustinegrass was reported simultaneously in Florida and Texas by Jones and Amador (4) in 1969. Bruton et al (1,2) subsequently identified the pathogen as *Sclerophthora macrospora* (Sacc.) Thirum., Shaw, & Naras. *S. macrospora* colonizes the plant, causing white, raised, linear streaks parallel to the leaf midvein. Severe symptoms include leaf yellowing and premature necrosis and reduction of internode length.

Available fungicides have generally failed to maintain effective control of downy mildew of St. Augustinegrass. The systemic fungicide metalaxyl, which reportedly controls other downy mildew diseases of gramineous hosts (3,5–8,10), may be effective against this disease. The purpose of this study was to evaluate the protective and curative properties of metalaxyl in the greenhouse and field for control of downy mildew in St. Augustinegrass. In vivo effects of the fungicide on sporangium production and zoospore release were investigated. Histological examination of host tissues was used to determine effects of the fungicide on hyphal colonization.

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Accepted for publication 12 November 1985 (submitted for electronic processing).

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MATERIALS AND METHODS

Two fungicides active against oomycete fungi were tested: metalaxyl (Subdue 2EC) at 14.2, 28.4, 56.7, and 85.1 g a.i./42.25 L/93 m^2 and fenaminosulf (Lesan 35W) at 53.1 g a.i./42.25 L/93 m^2, the recommended rate of application. The fungicides were applied as foliar sprays with 0.25% Tween 20 added as a surfactant in each fungicide treatment as well as in the water control.

Effect of fungicide on disease development. Naturally infected Scott 1081, a highly susceptible cultivar of St. Augustinegrass (9), was transplanted to 15-cm-diameter plastic pots and placed in the greenhouse at 25–40 C. Six one-pot replicates of each fungicide treatment were used. A minimum of 300 leaves per replicate was examined to determine the percentage of diseased leaves 7, 14, 21, and 28 days after fungicide application. Visual phytotoxic effects were assessed on a scale of 1–5, where 1 = no visual effects and 5 = extensive necrosis of entire leaf blades 7 days after fungicide application.

Histology after fungicide application. Histological examinations of *S. macrospora*-infected Floratam and Scott 1081 St. Augustinegrass leaf blades were made 7, 14, 21, and 28 days after fungicide application. All plant material was fixed in FAA solution immediately after collection, dehydrated in tertiary-butyl alcohol series, and embedded in paraffin. Sections (8–12 μm) of tissue were made with a rotary microtome and stained with safranin-fast green.

Effects of fungicides on sporangium and zoospore production. Five *S. macrospora*-infected leaf blades of Scott 1081 taken from each fungicide and control treatment were used to inoculate the bioassay host, grain sorghum (inbred Tx2536, highly susceptible to *S. macrospora*). Grain sorghum plants 3–4 cm high were inoculated by flooding the plants with water, then floating or submersing the five *S. macrospora*-infected leaves above the plants. Plants remained flooded in a dark environmental chamber for 24 hr at 20 C. Plants were then placed in the greenhouse for 28 days and rated for percentage of diseased plants.

Fungicide as protectant. Healthy Scott 1081 St. Augustinegrass was inoculated as described previously with 10 *S. macrospora*-infected St. Augustinegrass leaves per pot, six pots per treatment, 7, 14, 21, and 28 days after fungicide application. The percentage of diseased leaves of new growth was recorded 28 days after inoculation.

Field fungicide trial. Metalaxyl and fenaminosulf were evaluated for downy mildew control on naturally infected Scott 1081 St. Augustinegrass at a Bay City, TX, sod farm. The effect of application time on disease development was also evaluated. A factorial design arranged in a completely randomized block with four replicates was used. Plots were 23 m^2. Foliar applications were made in the fall of 1978 (2 December), spring of 1979 (30 March), and combination of fall and spring (2 December 1977 and 30 March) of 1978. On 27 April (146 days after fall application and 30 days after spring application), the

percentage of diseased leaves per square meter was determined for each plot by a random quadrant method. In Texas, the most severe symptom expression occurs during the spring.

Efficacy of metalaxyl for the control of downy mildew was further evaluated on naturally infected Texas Common St. Augustinegrass at College Station, TX. Metalaxyl at 14.2 and 28.4 g a.i./93 m^2 was applied as a foliar spray in the fall of 1981 (5 October), in the spring of 1982 (12 April), and in a fall 1981 and spring 1982 combination (5 October and 12 April). The plots were 2.2 m^2, replicated four times in a completely randomized block design. The percentage of diseased leaves was determined for each treatment on 10 May 1982 (216 days after the fall application and 28 days after the spring application). Three 100-cm^2 samples were counted from each plot.

RESULTS

Effects of fungicide treatments on disease development. All rates of metalaxyl effectively reduced downy mildew symptoms in Scott 1081 St. Augustinegrass. More than 90% of the leaves showed symptoms on the day of application; however, after 28 days, all new growth was free of symptoms (Table 1). Metalaxyl-treated plants remained free of downy mildew symptoms for more than 90 days. New growth of control and fenaminosulf-treated plants showed typical downy mildew symptoms. There was no difference between the fenaminosulf treatment and the control in percentage of diseased leaves.

Phytotoxicity ratings for metalaxyl ranged from a mean of 1.3 (slight chlorosis of leaf tips) at the lowest dosage to 3.3 (necrosis of tips of leaf blades) at the highest application rate (Table 1). No phytotoxicity was noted on grass treated with fenaminosulf.

Histology after fungicide application. Histological examination of *S. macrospora*-infected St. Augustinegrass leaves made 7, 14, 21, and 28 days after fungicide application revealed mycelium of *S. macrospora* in the fenaminosulf treatment and untreated controls. In contrast, no fungal mycelium was observed in metalaxyl-treated leaves (Fig. 1). Intercellular spaces, similiar to those containing fungal mycelia in the control and fenaminosulf treatments, were completely void, leaving large hollow cavities within the leaf tissue. No histological abnormalities were found in leaves treated with any rate of metalaxyl.

Effects of fungicide on sporangium and zoospore production. No infection occurred on bioassay plants inoculated with metalaxyl-treated St. Augustinegrass leaves, indicating metalaxyl inhibited sporangium and zoospore production at each rate tested (Fig. 2). Optimum sporangium production occurs on mature, fully expanded leaf blades (*unpublished*); therefore, sporangium production and subsequent infection were greatly reduced in the fenaminosulf and control treatments at 21 and 28 days because immature leaf blades were used.

Table 1. Downy mildew development in Scott 1081 St. Augustinegrass after fungicide application in the greenhouse

Treatment	Rate (g a.i./93 m^2)	Days after application	Leaves infected[a] (%)	Phytotoxicity[b]
Control	...	7	95	1.0
		14	91	
		21	90	
		28	93	1.0
Fenaminosulf	53.1	7	97	
		14	99	
		21	95	
		28	96	1.3
Metalaxyl	14.2	7	70	
		14	44	
		21	15	
		28	0	1.8
	28.4	7	85	
		14	39	
		21	5	
		28	0	2.8
	56.7	7	70	
		14	40	
		21	10	
		28	0	3.3
	85.1	7	85	
		14	50	
		21	25	
		28	0	

[a] Six replicates; average of 300 leaves per replicate.
[b] Phytotoxicity noted as leaf burn rating from 1 (no visual effects) to 5 (extensive necrosis of leaf blades).

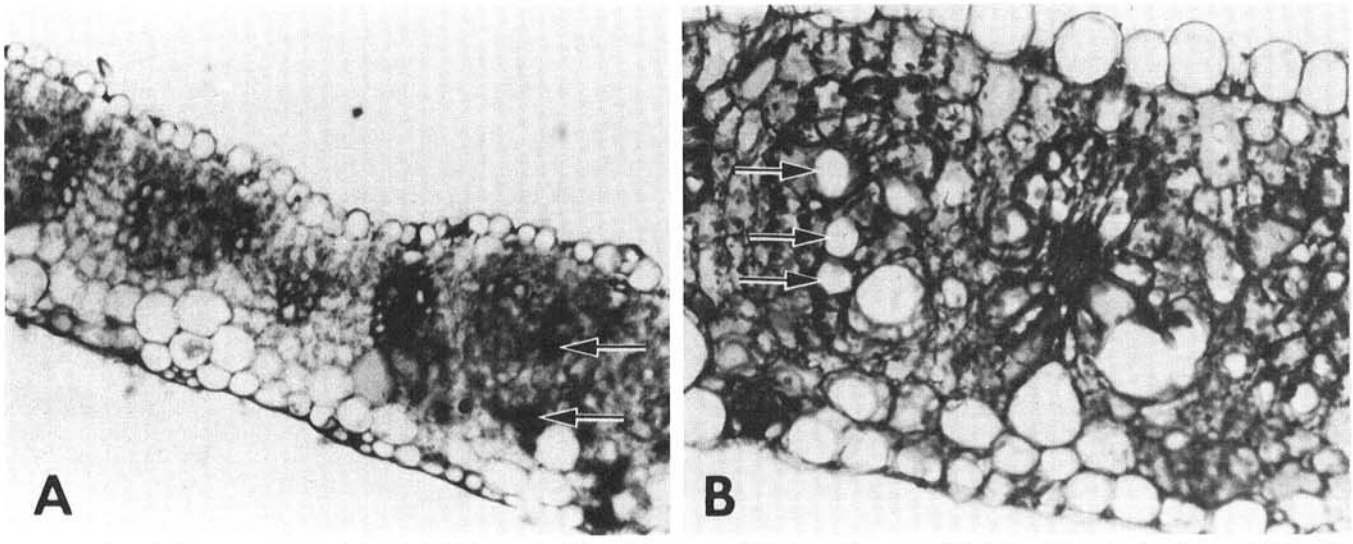

Fig. 1. *Sclerophthora macrospora*-infected leaf tissue of cultivar Floratam of St. Augustinegrass. **(A)** Intercellular hyphae (arrows) (×6). **(B)** Intercellular spaces (arrows) similar to those containing fungal mycelia in the control and fenaminosulf treatments (×25).

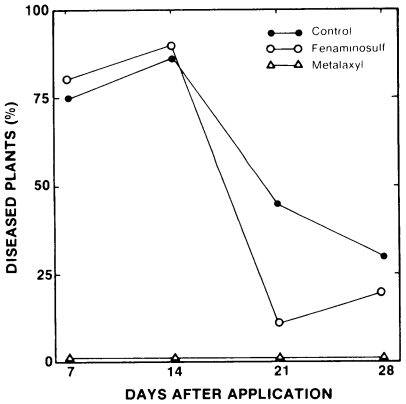

Fig. 2. Effects of four rates of metalaxyl (14.2, 28.4, 56.7, and 85.2 g a.i./42.25 L/93 m^2 and one rate of fenaminosulf (53.1 g a.i./42.25 L/93 m^2) on sporangium and zoospore production from *Sclerophthora macrospora*-infected turfgrass leaves determined by percentage of diseased plants on sorghum bioassay host (Tx2536). Treated diseased leaves of St. Augustinegrass were harvested 7, 14, 21, and 28 days after fungicide application as source of inoculum.

Fenaminosulf caused no difference in sporangium production and subsequent infection of the bioassay host compared with the control 7 and 14 days after fungicide application. At 21 and 28 days, under reduced inoculum pressure, fewer diseased bioassay plants were produced in the fenaminosulf treatment than in the control.

Fungicide application as a protectant. Metalaxyl protected healthy St. Augustinegrass from infection by the downy mildew fungus for 28 days at all rates of application. In contrast, St. Augustinegrass in the control and fenaminosulf treatments were 82 and 90% infected, respectively, 28 days after fungicide application.

Field fungicide trial. With the fall application alone, the lower rates of metalaxyl (14.2 and 28.4 g a.i./93 m^2) were not as effective as the higher rates (Table 2). At the lower rates, however, there were significantly ($P = 0.05$) fewer diseased leaves than in the control and fenaminosulf treatments. The higher rates (56.7 and 85.1 g a.i./93 m^2) resulted in 4 and 2% of the leaves diseased, respectively. Both the spring and fall/spring applications resulted in 7% diseased leaves at each rate of metalaxyl. No effect was noted in the fenaminosulf treatment compared with the control.

No downy mildew symptoms were observed in the spring of fall/spring metalaxyl-treated plots at College Station (Table 3). No phytotoxic effect was observed.

Table 2. Effect of fungicide application time for control of downy mildew on Scott 1081 St. Augustinegrass at Bay City, TX

Treatment	Rate (g a.i./93 m^2)	Leaves infected (%)[w] Fall application[x]	Spring application[y]	Fall and spring application
Control	···	86 a[z]	92 a	87 a
Fenaminosulf	53.1	89 a	90 a	93 a
Metalaxyl	14.2	54 b	3 b	4 b
	28.2	30 b	3 b	3 b
	56.7	4 c	6 b	2 b
	85.1	2 c	3 b	2 b

[w] Mean percentage of infected leaf blades noted on 27 April.
[x] Applied on 2 December.
[y] Applied on 30 March.
[z] Values within a column followed by the same letter are not significantly different ($P = 0.05$) according to Duncan's multiple range test.

Table 3. Effect of metalaxyl on downy mildew of Texas Common St. Augustinegrass at College Station, TX

Treatment	Rate (g a.i./93 m^2)	Leaves infected (%)[a] Fall application[b]	Spring application[c]	Fall and spring application
Control	···	16	26	15
Metalaxyl	14.2	9	0*[d]	0*
	28.1	5*	0*	0*

[a] Mean percentage of infected leaf blades noted on 10 May.
[b] Applied on 5 October.
[c] Applied on 12 April.
[d] * = Significantly less than control at $P = 0.01$.

DISCUSSION

Preventive and curative activity by metalaxyl was demonstrated for control of downy mildew of St. Augustinegrass. Histological examination of treated, diseased tissues demonstrated metalaxyl's ability to eradicate *S. macrospora*. Because new tissues remained disease-free for up to 90 days and the bioassay indicated no effective inoculum was produced after metalaxyl treatment, we concluded that the fungus was effectively eradicated from the host tissues. The residual effect demonstrated in the greenhouse was also evident in the field. Spring applications of metalaxyl were the most effective for control of downy mildew; however, residual effects were observed from fall application at rates of 14.2 and 28.4 g a.i./93 m^2 on plants inoculated with *S. macrospora* in the spring.

Any phytotoxicity that may have occurred in the field experiments was inconspicuous, and the tip burning noted in plants treated in the greenhouse with the higher rates would be removed by mowing in the field. No systemic phytotoxic effect was observed.

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