Control of Spring Dead Spot of Bermudagrass with Fungicides in North Carolina

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ABSTRACT

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Spring dead spot (SDS) of bermudagrass was controlled with five monthly applications of benomyl, PCNB, or a combination of fungicides during July–November in 1973 and 1974. Applications of chloroneb, nabam, maneb, or carboxin did not control the disease. The severity of SDS increased in plots without fungicides that received extra nitrogen in August and September. SDS was controlled in the spring of 1976 and 1977 with three monthly applications of benomyl at 145 g a.i./93 m^2 in the fall (October, November, and December) and with single applications in October or November of 1975.

Spring dead spot (SDS) of bermudagrass (*Cynodon dactylon* (L.) Pers.) was first described in Oklahoma in 1960 (2,11). The disease occurs in the northern range of adaptation of bermudagrass across the southern United States where winter weather is cold enough for periods of winter dormancy to develop (10). Symptoms of SDS are circular dead areas 0.2–1 m in diameter that appear in the spring as bermudagrass resumes growth from dormancy. The dead spots often appear in the same places and may enlarge for several years (11; *unpublished*). Bermudagrass slowly grows over the spots during the summer, which suggests the presence of a pathogen or toxin in the soil (3,11).

Several fungi have been isolated from bermudagrass in affected areas (4,7,10), but attempts to reproduce typical symptoms of the disease by inoculation with these fungi have failed in the United States. Smith (7) isolated *Ophiobolus herpotrichus* (Fr.) Sacc. from SDS-affected bermudagrass in New South Wales, Australia, and demonstrated that this fungus could cause root and stolon rot in the greenhouse. Later *Leptosphaeria narmari* (Walker and Smith) was described and shown to cause root rot and spring dead spot-like symptoms in inoculated turf (8). The disease cannot be identified as the same disease in the United States and Australia until a causal agent is identified in the United States.

Some fungicides have been evaluated for the control of SDS in the United States and Australia. Nabam applied four times at monthly intervals beginning 6 wk before the first killing frost in the fall was reported to control SDS in Missouri (3). Smith (9) reported control of SDS in Australia with nabam or thiram applied every 4 wk from the last month of summer until early spring. Many fungicides tested at rates recommended for control of other turf diseases were not effective in Georgia (3).

Several fungicides with activity against certain types of fungi were evaluated at different rates and times of the year for the control of SDS in the research reported here. Preliminary results have been reported (5).

MATERIALS AND METHODS

Experiments were conducted on 4- to 6-yr-old 'Tifton 419' bermudagrass on golf course fairways near Goldsboro and Raleigh, NC, where SDS had been severe in the spring. Treatments were replicated four times in a randomized complete block design with 3.05 × 3.05 m plots in all experiments. Fungicides were applied (rates and times are indicated in the tables) as a drench in 3.8 L of water per 9.3 m^2 except when otherwise indicated. The fungicides were not washed into the soil with irrigation after application.

Benomyl, PCNB, chlorothalonil, chloroneb, maneb, and nabam were applied to plots near Goldsboro once a month for 5 mo beginning in July of 1973 and 1974 (Table 1). The proper amounts of fungicides were mixed in 3.8 L of water and applied evenly with a sprinkler can to 9.3 m^2 plots. Methyl bromide was applied in one treatment at 454 g/9.3 m^2 to undisturbed turf with SDS under a polyethylene cover to determine if the disease could be eliminated by killing the grass and sterilizing the soil. Two weeks after treatment, healthy Tifton 419 bermudagrass plugs (5.7 cm in diam) were transplanted into the methyl bromide-treated area on 0.3 m centers. Extra ammonium nitrate was applied in August and September at the rate of 454 g of N per 93 m^2 in one treatment because the use of high rates of nitrogen fertilizer

Table 1. Effect of five monthly applications of selected fungicides in 1973 and 1974 on spring dead spot (SDS) development in the spring of 1974 and 1975 at Goldsboro, North Carolina

Treatment (g a.i./93 m^2)[a]	No. of SDS/plot[b]			Turf quality[c]		% SDS[d]
	13 July 1973	16 May 1974	2 May 1975	16 May 1974	2 May 1975	2 May 1975
Benomyl (145)	5.0	2.5*[e]	0*	8.8*	8.8*	0*
PCNB (284)	6.3	5.3	0*	7.0*	7.3*	0*
Chlorothalonil (210)	8.5	6.8	1.3*	4.8	6.8*	7*
Chloroneb (180)	7.8	7.3	3.5	3.3	5.5	15
Combination of above (half rates)	7.0	1.8*	0*	8.8*	8.8*	0*
Maneb (220)	7.8	6.0	4.0	6.0*	5.3	27
Nabam (230)	9.0	7.3	6.5*	5.5	4.0	33
Check (0)	7.3	6.8	4.3	3.5	4.5	25
Extra N (907 g of N)[f]	7.0	6.8	6.3*	5.0	2.5*	64*
LSD (0.05)	NS[g]	2.8	1.8	2.5	1.7	18

[a] Fungicides applied as a drench to 9.3 m^2 plots at the rate of 38 L of water/93 m^2 once a month in July through November in 1973 and 1974 to Tifton 419 bermudagrass that had SDS in the spring of 1973.

[b] Number of spring dead spots per plot on given dates over 3 yr.

[c] Turf quality ratings were 1–9, with 9 representing good, uniform turf. Large amounts of SDS are indicated as lower turf quality ratings.

[d] Percentage of area in plot affected by SDS.

[e] * = significantly different from the check at $P = 0.05$.

[f] Extra nitrogen was added [$(NH_4)_2NO_3$] at the rate of 454 g of N/93 m^2 in August and September.

[g] NS = not significant.

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had been associated with SDS (3).

Results on the control of SDS were recorded in May and June of each year. Turf quality ratings of 1–9 (9 = good, uniform turf and 1 = all grass dead) were recorded. SDS severity ratings of 1–9 (9 = zero SDS and 1 = all turf killed by SDS) were made in 1974, but this system was replaced with percentage of area affected with SDS in 1975. The number of dead spots in each plot was counted each year.

An experiment to evaluate different times of application of benomyl was established in 1975 on another area of the same golf course that had SDS in the spring of 1974 and 1975 (Table 2). Benomyl was applied at the rate of 145 g a.i. per 93 m^2 three times in the summer (July, August, and September) or fall (October, November, and December) of 1975 or winter (January, February, and March) or spring (April, May, and June) of 1976. Plots were evaluated in May and June of 1976 and 1977.

Other experiments were started in the fall of 1976 near Goldsboro and Raleigh on turf where SDS occurred in the spring of 1976 to evaluate different rates and number of applications of benomyl and PCNB in the fall (Table 3). Benomyl was applied at rates of 145, 72.5, and 36.3 g a.i./93 m^2 in October, November, and December as a drench in 38 L of water or at 145 g a.i. in 9.5 L of water as a spray. Benomyl at 145 g a.i./93 m^2 was also applied once in October, November, or December in other treatments. Carboxin at 145 g a.i./93 m^2 was applied in one treatment. PCNB was applied at 284 g a.i./93 m^2 once a month in October, November, and December and once in October, November, or December in other treatments.

RESULTS

Turf quality was significantly better than the check in 1974 in plots that had been treated with benomyl, PCNB, maneb, and a combination of benomyl, PCNB, chlorothalonil, and chloroneb in the summer and fall of 1973. Results were similar in 1975 for benomyl, PCNB, and the fungicide combination after the second year of treatment. Treatment with chlorothalonil resulted in significantly better turf quality and less SDS in the second year but not in the first year. Maneb and nabam did not reduce the percentage of SDS or improve turf quality significantly in 1975.

The number of dead spots did not differ significantly among plots when the experiment began in 1973. Fewer spots developed in plots treated with benomyl and the combination of fungicides in 1974 after the first year of treatment. Fewer spots developed in 1975 in plots treated with benomyl, PCNB, chlorothalonil, and the combination of fungicides. The percentage of area affected with SDS was significantly lower in the above treatments in 1975 and correlated closely with the number of dead spots per plot.

Extra nitrogen in August and September of 1973 and 1974 resulted in significantly lower turf quality and larger percentage of area affected by SDS. The number of dead spots remained about the same from 1973 through 1975 in the high-N-treated plots, but the size of the spots increased, as indicated by the high percentage of area affected (Table 1).

SDS did not occur in 1974–1976 in plots treated with methyl bromide and plugged with healthy bermudagrass in 1973. Bermudagrass in plots treated with PCNB and the fungicide combination was shorter and lighter green in early fall before frost and lighter tan during the winter than turf in check plots or plots treated with other fungicides.

Benomyl applications in the summer (July, August, and September) and fall (October, November, and December) of 1975 gave significantly better turf quality in May 1976, but only fall applications lowered the percentage of SDS significantly. Spring (April, May, and June) applications in 1976 gave significantly better turf quality ratings in June 1976 than untreated plots but did not reduce the percentage of SDS (Table 3). The fall applications also controlled SDS in 1977, the second year after treatment.

Benomyl applied in October, November, and December 1976 as a drench at 145, 72.5, or 36.2 g a.i./93 m^2 or sprayed at 145 g a.i./93 m^2 resulted in significantly better turf quality in May 1977 than in the check plot at Goldsboro. Three applications in October, November, and December and single applications in October or November of benomyl at 145 g a.i./93 m^2 gave significantly better turf quality at Goldsboro and Raleigh. One application of benomyl in December did not improve turf quality or reduce the amount of SDS. Percentage of SDS was significantly less only at Raleigh but was reduced at Goldsboro in the above treatments. PCNB applied in October, November, and December or in single applications did not control SDS. Carboxin did not raise turf quality or lower the amount of SDS significantly at Goldsboro or Raleigh (Table 3).

DISCUSSION

Benomyl consistently controlled SDS

Table 2. Effect of time of application of benomyl on control of spring dead spot (SDS) on 'Tifton 419' bermudagrass in the spring of 1976

Treatment[a]	Turf quality[b]	% SDS[c]
July, August, September (1975)	6.3*[d]	14
October, November, December (1975)	7.5*	0*
January, February, March (1976)	5.5	18
April, May, June (1976)	5.8	18
Check	4.8	20
LSD 0.05	1.5	10

[a] Benomyl applied at the rate of 14.5 g a.i./9.3 m^2 plots as a drench in 3.8 L of water per plot once a month for the months indicated.
[b] Turf quality ratings were 1–9, with 9 representing good, uniform turf and 1 representing all grass dead May 4, 1976.
[c] Percentage of area in plot affected by SDS on May 4, 1976.
[d] * = significantly different from the check at $P = 0.05$.

Table 3. Effect of time of application and rates of benomyl and PCNB in 1976 on development of spring dead spot (SDS) at Goldsboro and Raleigh in the spring of 1977

		Turf quality[b]		% SDS[c]	
Treatment (g a.i./93 m^2)[a]	Time	Goldsboro	Raleigh	Goldsboro	Raleigh
Benomyl (145)	Oct., Nov., Dec.	8.0*[d]	6.3*	1	7*
	Oct.	7.8*	5.8*	1	9*
	Nov.	7.8*	5.5*	2	9*
	Dec.	3.5	4.8	14	15
Benomyl (72.5)	Oct., Nov., Dec.	8.0*	···	1	···
Benomyl (36.3)	Oct., Nov., Dec.	6.8*	···	5	···
Benomyl (145, spray)	Oct., Nov., Dec.	8.8*	···	0	···
PCNB (284)	Oct., Nov., Dec.	5.0	3.8	14	21
	Oct.	6.0	4.0	8	26
	Nov.	5.0	4.8	10	14
	Dec.	5.8	4.0	5	23
Carboxin (145)	Oct., Nov., Dec.	5.3	4.0	8	16
Check		4.5	3.5	11	21
LSD 0.05		2.6	1.4	NS[e]	10

[a] Fungicides applied as a drench in 3.8 L of water per 9.3 m^2, except benomyl spray applied in 0.95 L of water per 9.3 m^2 plot, to 'Tifton 419' bermudagrass that was affected with SDS in 1976.
[b] Turf quality ratings were 1–9 (9 = good, uniform turf; 1 = all turf dead) in May 1977.
[c] Percentage of area in plot affected by SDS.
[d] * = significantly different from the check at $P = 0.05$.
[e] NS = not significant.

when applied in the fall at relatively high rates to turf that had severe SDS the previous spring. PCNB significantly improved turf quality the first year when applied once a month from July through December but not when applied only in the fall. PCNB did not significantly reduce the number of dead spots the first year but eliminated them entirely the second year. The need for large amounts of PCNB and its effectiveness in the second year may be due to the low water solubility and high persistence of the chemical. The lighter green grass observed in PCNB-treated plots indicates some phytotoxicity, but the turf was not affected the following year. Applications of benomyl in the spring when symptoms of SDS were most evident did not control the disease but appeared to increase the rate of recovery of the turf in the summer.

Control of SDS with benomyl and not with chloroneb or carboxin, which are more specific for certain fungi (1,6), may indicate that certain types of fungi are involved in this disease. The results do not indicate that *Helminthosporium* species or phycomycetes cause SDS, as suggested by others (10,12), since these types of fungi are not usually sensitive to benomyl (1). Since the sensitivity of *Leptosphaeria narmari* to benomyl and the effect of benomyl on SDS in Australia have not been reported, these results cannot be used to indicate that the causal agents for SDS in Australia and the United States are similar. Results indicate that the critical time for SDS development in North Carolina is October or November, before winter dormancy of bermudagrass.

The increase in severity of SDS caused by applying extra nitrogen fertilizer as ammonium nitrate in late summer indicates that nitrogen has an effect on the disease. The development of SDS has been associated with the use of high rates of nitrogen, and lower rates of nitrogen have been suggested to prevent the development of the disease (3). These data support the use of lower rates of nitrogen and indicate that using less nitrogen on bermudagrass turf where SDS is present may help reduce the severity of the disease the following year. Problems have occurred in research programs (3) from the failure of SDS to develop in research plots from year to year. The application of ammonium nitrate throughout the SDS experimental area late in the summer may assure the development of the disease.

Since rates of benomyl two to five times higher than normally used to control most other turf diseases were needed to control SDS, the use of this fungicide may be limited to areas of high maintenance such as golf tees and greens. It should be practical to use benomyl at the rate of 145 g a.i./93 m^2 in October or November on portions of turf establishments that have large maintenance budgets. Additional data are needed to obtain registration for effective fungicides.

Fungicides that are more specific for certain types of fungi have been used in this research to obtain new information on the nature and control of SDS of bermudagrass. Future studies with benomyl and some newer fungicides may help show the cause of SDS in the United States.

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