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PURPOSE

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The Efficacy of Spring Fungicide Applications Plus Organic Fertilizer for Controlling Spring Dead Spot of Bermudagrass

Maria Tomaso-Peterson

SUMMARY

Scientists at Mississippi State University investigated the use of fungicide and fertilizer applications to control spring dead spot of bermudagrass. Results include:

- Rubigan (fenarimol) applied in the spring, fall, or combination of both, and Banner MAXX (propiconazole) applied in the fall were effective for controlling spring dead spot.
- Neither fertilizer source (organic/inorganic) nor fertilizer source by fungicide interaction had significant effects on SDS severity or percent SDS symptoms in this study.
- Similar to SDS results, neither the fertilizer source nor the interaction of fungicide and fertilizer source had an effect on spring green-up or turfgrass quality.
- All Rubigan treatments were significantly effective in controlling SDS. The spring only (March, April, May) application was equally effective based on SDS severity compared to fall-only applications of Rubigan, Banner MAXX, Eagle (myclobutanil), and Heritage (azoxystrobin). An advantage of a spring fungicide application is that only areas where the disease is active and exhibiting SDS symptoms are treated.

Spring dead spot (SDS) is a serious root-rot disease of bermudagrass (*Cynodon dactylon* L.) and is the most important disease of hybrid bermudagrass (*C. dactylon* × *C. transvaalensis* Burt-Davy) managed as putting green and fairway turf. Necrotic patches ranging from a few inches to several feet in diameter are evident in the spring and early summer in bermudagrass swards that experience a dormant period. The number of healthy roots and rhizomes in the affected turf may be reduced and exhibit light tan to dark brown lesions but overall appear black and rotted.

Three fungal species in the genus

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Ophiosphaerella: *O. korrae* (J.C. Walker and A.M. Smith) Shoemaker and Babcock, *O. herpotricha* (Fr:Fr) J.C. Walker, and *O. narmari* (J.C. Walker and A.M. Smith) Wetzel, Hulbert, and Tisserat have been identified as causal agents of SDS in the United States (8). In Mississippi, *O. korrae* has been reported as the predominant causal agent of SDS (2, 4). In a previous study conducted on a 'Tifway' bermudagrass fairway by researchers at Mississippi State University, isolation of *O. korrae* from naturally infested roots was significantly higher in the winter and spring and lowest in the fall (4). Traditionally, fungicides are applied in the fall when soil temperatures range between 65 to 75° F. Currently, a limited number of penetrant fungicides provide adequate to good control of SDS in 'Tifway' bermudagrass fairways (6).

The effect of fertilizer source on SDS has been studied extensively. Fertilizer timing, rates, sources, and the interaction with soil pH have been reported to influence SDS severity in bermudagrass (1, 3, 7). Tredway et al. (5)



A visible reduction of roots and rhizomes underlying a necrotic spring dead spot patch can be observed (right half of turf sample). Light tan to dark brown lesions and black, rotted roots and rhizomes are symptoms of spring dead spot.

observed distinct responses to fertilizer by *Ophiosphaerella* spp. Research from North Carolina State University demonstrated SDS severity incited by *O. korrae* was reduced when bermudagrass was fertilized with calcium nitrate, while *O. herpotricha*-induced SDS responded favorably to acidifying fertilizers.

The concept of this fairway study was

based on the observation that *O. korrae* can be isolated with greater frequency from bermudagrass roots in the winter and spring than in the summer and fall (4). As a result of *O. korrae* activity associated with bermudagrass roots during dormancy and spring transition in Mississippi, spring fungicide applications and organic fertilizer were evaluated for SDS control.

Treatment (fl oz product/1,000 sq. ft)	Application Timing*	Soil Temperature**
Rubigan AS (4.0)	March	60
	April	62
	September	75
	October	65
Rubigan AS (4.0)	March	60
	April	62
	May	70
Rubigan AS (4.0)	April	62
	September	75
	October	65
Rubigan AS (4.0)	September	75
	October	65
Rubigan AS (4.0) + Clearys 3336 F (4.0)	September	75
Heritage TL (2.0)	October	65
Banner MAXX (4.0)	October	65
Eagle 20EW (1.2)	November	60
Control (water)	-----	-----
*Application dates: March 17, April 14, May 19, September 24, October 20, November 3, 2008; March 18, April 14, May 18, September 30, October 21, and November 4, 2009. ** At a 1.5-inch depth; values (F) are means of eight replications combined for 2008 and 2009.		

Table 1. Conventional fungicides, rates, and timing used in this study and average soil temperatures (F, 1.5-inch depth) associated with application timing, 2008 and 2009.



Fungicides were applied using a six-nozzle (11004 VS flat fan), CO₂-powered, dual wheel sprayer at 40 psi in water equivalent to 2.5 gal per 1,000 ft² while dew was present. Fungicide applications were immediately followed by 0.25 inches of irrigation.

Bermudagrass Fairway Study

A study was initiated on a ‘Tifway’ bermudagrass fairway at a golf course in West Point, MS in the spring of 2007. The soil consisted of a fine-loamy, siliceous, semiactive, thermic Typic Fragidults that ranges from extremely acid to strongly acid. The fairway was limed in 2003 at 100 lb per 1,000 sq ft per year resulting in a pH of 7.0 in April 2004 and 6.1 at the initiation of the study in 2007. To maintain a pH of > 6.0 in the study area, pelletized lime applications were made at 33 lbs per 1,000 ft² in May, August, and October of 2007 through 2009. The fairway was mowed twice weekly at 0.5 inches with clippings returned.

The plots (10 ft wide × 15 ft long) were established within a ‘Tifway’ sward expressing symptoms of SDS and arranged in a split-plot randomized complete block design replicated four times. Fungicide treatments were the main plot

and fertilizer source was the sub-plot factor (10 ft wide × 7.5 ft long). Treatments on individual plots remained the same throughout the study. One Watchdog data logger (Spectrum, Plainfield, IL) was buried 1.5 inches deep in each control plot to record soil temperature.

Commercial fungicides labeled for SDS including Rubigan AS® (fenarimol, Gowan Co., Yuma, AZ), Banner MAXX® (propiconazole, Syngenta, Greensboro, NC), Eagle® (myclobutanil, Dow AgroScience, LLC, Indianapolis, IN) Heritage TL® (azoxystrobin, Syngenta, Greensboro, NC), and Cleary 3336 F® (thiophanate-methyl, Cleary Chemical Corp., Dayton, NJ) were applied according to labels in the fall, and label rates were also applied in the spring (Table 1). Fungicides were applied using a six-nozzle (11004 VS flat fan), CO₂-powered, dual-wheel sprayer at 40 psi in water equivalent to 2.5 gal per 1,000 ft² while dew was present.

Fungicide applications were immediately followed with 0.25 inches of irrigation.

The organic fertilizer used was Roots® (Novozymes, Salem, VA) 12-2-12. The breakdown of Roots, based on the label, included 0.2% ammoniacal N, 6.0% water-insoluble N, 2.3% urea N, 0.5% water-soluble organic N, and 3.0% slowly available water-soluble N. Bone, blood, and feather meals formed the basis of balanced fertility for turf nutrition.

Amino acids, vitamins, humic acids, and sea kelp extract are also contained in the Roots fertilizer, as well as a beneficial microbial package that includes five *Bacillus* spp. plus a *Paenibacillus* spp. These beneficial bacteria may increase the release of nutrients in the soil and enhance nutrient uptake for the turf. A blended inorganic 12-2-12 included ammonium sulfate (21-0-0), triple super phosphate (0-46-0), and muriate of potash (0-0-60). Each fertilizer was applied at 1.0 lb N per 1,000 ft² per month (May through October). The fairway was treated in February of each year with oxadiazon (Ronstar G®, Bayer environmental Science, Research Triangle, NC) to avoid the inhibition of root development and promote lateral stolon growth and root penetration in the necrotic SDS patches.

Spring dead spot severity (1 to 9; 9 = no disease) and percent plot area exhibiting SDS symptoms were determined visually the first week of April 2009 and 2010. Visual ratings of spring green-up (1 to 9; 1 = straw brown and 9 = completely green) were assessed the last week of March each year, and turfgrass quality (1 to 9; 9 = ideal and 6 = acceptable) was rated each month (April through September) throughout 2008 and 2009. Soil pH was determined in the spring and fall of each growing season.

Analysis of variance using GLM procedure of SAS (version 9.2, SAS Institute Inc., Cary, NC) was used to evaluate fungicide and N source effects on SDS, turfgrass quality, and spring green-up. Percent SDS severity is reported following arcsine square-root transformation. Treatment means were separated using Fisher's protected least significant difference test at P = 0.05.

Response of Spring Dead Spot to Fungicides and Fertilizer Source

This study was initiated in the spring of 2007 on a 'Tifway' bermudagrass fairway at Old Waverly Golf Club, West Point, MS. The study was established over an area symptomatic for SDS resulting in an average of 33 necrotic patches per main plot. At the onset of the study in 2007, only an April fungicide application was made. However, subsequent results reported by Perry et al. (4) indicated frequency of *O. korrae* in bermudagrass roots was greatest in spring transition (April and May). Spring fungicide treatments were added to include March and May in 2008 (Table 1). Therefore, only SDS observations made in the spring of 2009 and 2010 are included.

Neither fertilizer source (organic/inorganic) nor fertilizer source by fungicide interaction had significant effects on SDS severity or percent SDS symptoms in this study. Therefore, fertilizer source was pooled within the main effect of fungicide. The effect of fungicide treatments on SDS severity and percent SDS symptoms within main plots were combined across years as there was no fungicide by year interaction for either parameter.

Moderate SDS severity was observed in April 2009 despite persistent cold temperatures in late winter and early spring. Necrotic patches ranged in size from 4 to 15 inches in diameter. Spring dead spot symptoms were not observed in plots treated with Rubigan in March, April, September, October, or September followed by October. The remaining Rubigan, Banner MAXX, and Eagle treatments reduced SDS with ratings of > 8.5. Heritage and the untreated control had similar SDS ratings (7.9 and 7.5, respectively). Rubigan treatments applied in the spring or fall only, spring followed by fall, and the Banner MAXX treatment had less than 1.3% SDS symptoms, while the untreated control averaged 12% SDS symptoms.

Spring and fall fungicide applications were applied in 2009. However, an unprecedented amount of precipitation (16 inches) was received on the fairway beginning the second week of September, totaling 72 inches of precipi-

Active Ingredient (fl oz/1,000 sq ft)	Application Timing	SDS Severity ^Z	% SDS ^Y	Turfgrass Quality ^X
Rubigan AS (4.0)	Mar, Apr, Sept, Oct	9.0 a ^W	0.0 c	6.0 a
Rubigan AS (4.0)	Mar, Apr, May	8.9 ab	1.0 c	6.0 a
Rubigan AS (4.0)	Apr, Sept, Oct	8.8 ab	3.0 bc	6.1 a
Rubigan AS (4.0)	Sept, Oct	9.0 a	0.0 c	6.0 a
Rubigan AS (6.0) + Cleary 3336 (4.0)	Sept	8.8 ab	3.0 bc	6.0 a
Heritage TL (2.0)	Oct	8.4 ab	4.0 bc	5.8 a
Banner MAXX (4.0)	Oct	8.9 ab	1.0 c	6.0 a
Eagle (1.2)	Nov	8.2 b	9.0 b	6.0 a
Control (water)	----	6.8 c	18.0 a	5.7 a

^Z Spring dead spot severity based on a visual rating scale of 1 to 9 where 9 = no disease. Values represent the combined average (n=16) of SDS ratings for spring 2009 and 2010.

^Y Percent area of plot expressing spring dead spot symptoms. Values represent the combined average (n=16) of % SDS for spring 2009 and 2010.

^X Turfgrass quality based on a visual rating scale of 1 to 9; 9 = ideal and 6 = acceptable with components that include color, density, uniformity, texture, and disease. Values represent the combined average (n=80) of turfgrass quality ratings for 2008 and 2009.

^W Means within column followed by the same letter are not significantly different at P = 0.05 according to Fisher's protected least significant difference test.

Table 2. Effect of spring and/or fall fungicide applications on spring dead spot and turfgrass quality in a 'Tifway' bermudagrass fairway, 2008-09 and 2009-10.

tation in 2009 (18 inches above normal). In April 2010, SDS symptoms appeared throughout the fairway, but within the study area, SDS symptoms were only observed in the March/April/May Rubigan and Eagle treatments, and the untreated control. The remaining fungicide treatments rated 9.0 with 0.0% SDS symptoms. Percent SDS was high in the Eagle (24%) and untreated control (41%) plots. The soil was saturated at the time of the Eagle application on November 4, 2009, and the fungicide may not have been adequately absorbed by the bermudagrass roots or diluted rendering it ineffective for SDS control.

A trend in fungicide efficacy was observed throughout this study. Based on SDS severity ratings, all treatments performed significantly better than the untreated control (Table 2). Rubigan treatments applied in March/April/September/October and September/October had SDS ratings of 9.0.

The spring-only Rubigan treatment resulted in an SDS rating of 8.9, identical to the Banner MAXX treatment. The April/September/October Rubigan treatment and Rubigan tank-mixed with Cleary 3336 resulted in the same SDS rating of

8.8. When percent SDS symptoms were considered, the untreated control had the greatest level of SDS at 18% (Table 2). Symptoms of SDS observed in Eagle and Heritage treatments were 9% and 4%, respectively. All Rubigan and Banner MAXX treatments resulted in 3.0% or less area of SDS symptoms (Table 2).

Spring Green-up, Turfgrass Quality and pH

Similar to SDS results, neither the fertilizer source nor the interaction of fungicide and fertilizer source had an effect on spring green-up or turfgrass quality. Spring green-up, rated in late March of 2009 and 2010, was similar for all treatments with overall ratings of 6.7 and 5.2, respectively. The fairway was treated in February of each year with oxadiazon (Ronstar®G, Bayer Environmental Science, Research Triangle, NC) to avoid the inhibition of root development and promote lateral stolon growth and root penetration into the necrotic SDS patches. The necrotic SDS patches present within the study were filled in with healthy bermudagrass by mid-June of each year.

Turfgrass quality was similar for all fungicide treatments each month and fungicide by year interaction was not significant. Turfgrass quality was combined across 2008 and 2009 for each treatment. Although not significant, seven of the nine treatments had acceptable turfgrass quality (> 6.0) throughout the study with Heritage and the untreated control having ratings of 5.8 and 5.7, respectively (Table 2).

Fertilizer source had a significant effect on soil pH, and there was no fertilizer source by year interaction, therefore pH was combined for the growing seasons of 2008 and 2009. The pH was significantly higher in sub-plots treated with the organic fertilizer compared to the inorganic fertilizer source, even though there was only a 0.4 difference in pH. Soil pH from organic fertilizer was 5.9 and 5.5 from the inorganic fertilizer that contained ammonium sulfate and served as the acidifying component.

Previous reports indicate soil pH at 5.0 to 5.5 may suppress SDS (1, 7). However, in the report by Perry et al. (4), soil pH less than 5.5 did not influence SDS, but did reduce spring green-up and turfgrass quality early in the growing season due annual applications of elemental sulfur. Recently, Tredway et al. (5) demonstrated *O. korrae* was not influenced by acidifying fertilizers, but did respond favorably to calcium nitrate resulting in reduced SDS. Further research is needed to clarify the role of soil pH in SDS severity.

Conclusions

Based on the results of this study, Rubigan applied in the spring, fall, or combination of both and Banner MAXX applied in the fall were effective for controlling spring dead spot. Soil temperature may be a key factor in determining fungicide timing for spring dead spot control. In Mississippi, the spring (March, April, May) soil temperatures reflect those during the fall (September, October, November) which are within the range of optimum fungicide application timing for spring dead spot based on the Rubigan

label. The fungicide should also be applied when the foliar tissue is wet and immediately watered into the top 1.0 to 1.5 inches of rootzone. This ensures the fungicide does not dry on the foliar tissue and become mobilized acropetally via the xylem at the point of absorption, completely missing the rootzone.

In this and other studies conducted at Mississippi State University, we have incorporated cultural practices, fertility, and fungicide treatments to develop an effective SDS management program. One factor that cannot be manipulated in a bermudagrass fairway is the soil temperature and its influence on infected roots. Future research efforts should focus on the influence and interaction of environmental factors such as soil type, soil temperature, soil moisture, and microbial activity associated with bermudagrass roots to better understand SDS, which may, in turn, lead to a more reliable and consistent SDS control programs.

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