EXECUTIVE SUMMARY

Project Title: The Biology and Management of Spring Dead Spot in Bermudagrass

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Project Summary:

Golf course superintendents managing bermudagrass in the middle United States commonly observe severe injury in spring as a result of spring dead spot disease (SDS). Currently, three root-rot fungi (*Ophiosphaerella herpotricha, O. korrae, and Leptosphaeria narmari*) cause SDS in North America. One of these pathogens (*L. narmari*) was only identified in the U.S. within the last three years. Although some progress has been made in screening bermudagrass selections for SDS susceptibility and identifying cultural practices that predispose turf to injury, little headway has been made in developing an effective fungicide or IPM control program. This is partly because the biology of the fungi associated with SDS is poorly understood. As a result, SDS is one of the few diseases that largely remains unmanageable by the golf course superintendent. Our objectives are to determine the distribution and abundance (frequency) of three pathogens that cause SDS in the U.S.; to develop reliable technique for screening bermudagrass selections for SDS resistance; and to develop an integrated approach to managing susceptible bermudagrass.

To date we have determined that *O. herpotricha* is the most common cause of SDS in Oklahoma and Kansas whereas *O. korrae* is primarily associated with the disease in Mississippi, Alabama, North Carolina, Georgia, Tennessee and Virginia. Both pathogens are present in Kentucky. The population of *O. korrae* isolates from southern states also appears to be distinct from those collected in more northern regions. *O. narmari* is rarely detected from SDS patches in the United States. In inoculation trials, isolates of *O. herpotricha* caused larger dead spots than either *O. korrae* or *O. narmari.* Seeded and vegetative selections of bermudagrass in the Oklahoma State University breeding program and the National Turfgrass Evaluation Program (NTEP) trials have been inoculated with isolates of the three SDS pathogens. Several seeded and vegetative bermudagrass selections have been identified with increased resistance to SDS. Cultural practices for SDS suppression were evaluated. In 1999, bermudagrass treated with the fungicide azoxystrobin plus the growth regulator trinexapac-ethyl had less SDS damage than turf in other treatments. Turf receiving trinexapac-ethyl in combination with one or more cultural practices generally had better spring quality than turf that did not.

The Biology and Management of Spring Dead Spot of Bermudagrass

Objective 1. Distribution of Spring Dead Spot Pathogens

The distribution of three *Ophiosphaerella* species that cause spring dead spot of bermudagrass was studied by systematically sampling two golf courses in Oklahoma and one in Kansas. *O. herpotricha* was the most abundant, and at Jenks, Oklahoma, the only SDS pathogen isolated. *O. korrae* was isolated from Afton, Oklahoma and Independence Kansas whereas *O. narmari* was only detected in samples from Afton. This is the first report of all three *Ophiosphaerella* species on bermudagrass at the same location. It is also the first report of *O. narmari* in North America. In 1999 and 2000, bermudagrass samples were collected from golf courses in Alabama, Kentucky Mississippi, North Carolina, Tennessee, and Virginia (Table 1). *O. korrae* was the only pathogen detected in the deep South and was the most common pathogen in Virginia and Tennessee. Both *O. herpotricha* and *O. korrae* were detected in samples from Kentucky. Our results indicate that *O. korrae* is the primary SDS pathogen in the southeastern United States whereas *O. herpotricha* is more common in the Great Plains and the northern transition regions of the southcentral United States.

To date, we have been unable to acquire spring dead spot samples from Texas or western regions (New Mexico, California). Therefore the distribution of SDS pathogens in these regions remains unclear. We will attempt to contact golf course superintendents and collect samples from these areas in spring 2001.

Objective 2. Aggressiveness of SDS Pathogens

Bermudagrass plots at two locations in Kansas and one location in Oklahoma (cooperation with D. L. Martin, Oklahoma State University) were inoculated in 1997 with isolates of *O. herpotricha*, *O. korrae*, and *O. narmari*. In Kansas, necrotic patches first developed in the spring of 1999. Dead spots associated with *O. herpotricha* were significantly larger than those caused by *O. korrae* or *O. narmari* (Table 2). Patch diameters in *O. herpotricha*-inoculated plots continued to enlarge in spring 2000 whereas those inoculated with the other *Ophiosphaerella* species did not. Similar results were reported for inoculations in Oklahoma.

Bermudagrass plots were inoculated in September 2000 with various isolates of *O.*

korrae, O. herpotricha and *O. narmari* to determine the relative aggressiveness of individual isolates.. This information should help ascertain which fungi need to be used in screening for SDS resistance in new bermudagrass selections.

Amplified fragment length polymorphism (AFLP) marker analysis was used to investigate inter- and intra-specific genetic diversity of *Ophiosphaerella* isolates from North America and Australia. A majority of the *O. herpotricha* and *O. narmari* isolates from Afton Oklahoma were distinct haplotypes, suggesting that sexual recombination was occurring within the population. Conversely, the presence of multiple isolates of *O. herpotricha* and *O. narmari* with the same haplotype indicated that asexual propagation, most likely from movement of fungal mycelium on bermudagrass sprigs, was also occurring. The genetic diversity among *O. herpotricha* isolates from Afton was not distinctly different from isolates collected throughout the southern United States. In contrast, *O. narmari* isolates from Afton were distinct from those collected in Australia. The genetic diversity in *O. korrae* was markedly different than the other *Ophiosphaerella* spp. The population at Afton was dominated by just a few haplotypes, and these were nearly identical to isolates collected from bermudagrass and Kentucky bluegrass throughout western, central, and northern North America. However, *O. korrae* isolates collected in the southeastern United States were only distantly similar to other North American isolates (Table 1). These southern isolates had higher growth rates on potato dextrose agar at temperatures ranging from 15-30 C. It is not known whether these southern isolates represent a more aggressive population. We are in the process of evaluating the aggressiveness of northern vs. southern *O. korrae* isolates to bermudagrass in growth chamber experiments

Objective 3. Screening Bermudagrass for Disease Resistance

Bermudagrass resistance ratings to SDS are being collected on a yearly basis. The seeded bermudagrass selection OKS 91-11 had smaller SDS patches than those found on 'Mirage' and 'Jackpot'. Several interspecific hybrid bermudagrasses (*Cynodon dactylon* [L.] Pers. X *C. transvaalensis* Burtt-Davy) were also inoculated to determine their visual quality and resistance to SDS. SDS was more severe on Tifway, OKC 39-3, OKC 19-9 and OKC 7-2 than on OKC 3-3, OKC 46-8 and Midlawn. Of the experimental grasses that provided improved dead spot resistance, selections OKC 46-8 and OKC 3-3 generally had quality equal to Midlawn.

We are attempting to develop a more rapid, laboratory-based procedure for screening bermudagrass selections for resistance to SDS. Inoculated bermudagrass is first inoculated and incubated in the greenhouse for approximately three months. The plants are then cold acclimated and roots are exposed to freezing temperatures. Selections that survive the inoculations and cold temperature treatment will be selected for further testing.

Objective 4. Integrated Management for Control of Spring Dead Spot

Cultural practices for SDS suppression were evaluated at Manhattan, Kansas in 1998 and 1999. Treatments were arranged in a split-plot design with four replicates. Cultivation (aerifying followed by verticutting) was the main plot, and factorial combinations of ammonium sulfate, trinexapac-ethyl (Primo, a growth regulator), and azoxystrobin (Heritage, a fungicide) were the sub-plots. Cultivation treatments were imposed in June and July. Ammonium sulfate (49 kg ha^{-1}) and trinexapac-ethyl (0.36 kg ha^{-1}) were applied in June, July, and August. Azoxystrobin (0.6 kg ha^{-1}) was applied in September. Data were collected on SDS incidence (% plot area affected) and turf quality (0 to 9 scale, 9 = best).

SDS occurred in 1999, but not 2000. Bermudagrass that was aerified and verticut had less ($P<0.10$) SDS damage than that which was not (Table 3). Bermudagrass treated with Heritage + Primo had less SDS damage than turf in other treatments. Turf receiving Primo in combination with one or more other cultural practices generally had better spring quality than turf that did not.

Table 1. Identification of *Ophiosphaerella* species isolated from bermudagrass cores collected in various states in 1999 and 2000.

Location	Number of isolates	Fungal identification	Population type[x] (tentative)
Alabama	13	*O. korrae*	southern
Arkansas	6	*O. korrae*	southern
Georgia	2	*O. korrae*	southern
Mississippi	18	*O. korrae*	southern
Kansas	71	*O. herpotricha*	-
	9	*O. korrae*	northern
	1	*O. narmari*	-
Kentucky site 1	4	*O. korrae*	southern
Kentucky site 2	10	*O. korrae*	northern
Kentucky site 3	14	*O. herpotricha*	-
	1	*O. korrae*	?
Kentucky site 4	11	*O. korrae*	?
Oklahoma	374	*O. herpotricha*	-
	28	*O. korrae*	northern
	21	*O. narmari*	-
Tennessee	17	*O. korrae*	southern
Virginia site 1	4	*O. korrae*	southern
	2	*O. herpotricha*	-
Virginia site 2	20	*O. korrae*	southern
U.S.A., Canada, and Australia (bluegrass isolates)	66	*O. korrae*	northern

[x]Population type refers to the relative genotypic similarity of isolates based on amplified fragment length polymorphism (AFLP) analysis. In general, *O. korrae* isolates either exhibit a 'northern' (common to isolates in the Great Plains or other northern regions) or 'southern' (common to isolates from the southern United States) AFLP pattern.

Table 2. Development of spring dead spot on 'Midlawn' bermudagrass following inoculation with *Ophiosphaerella herpotricha*, *O. korrae*, and *O. narmari* in Wichita, Kansas.

Fungal species	1999		2000	
	Number of inoculation sites with dead spots[x]	Patch area (cm^2)[y]	Number of inoculation sites with dead spots	Patch area (cm^2)
Ophiosphaerella herpotricha	14	374.1	14	1120.0
Ophiosphaerella korrae	10	77.9	7	263.5
Ophiosphaerella narmari	1	45.6	1	78.5
sterile oats	0	0.0	0	0.0

[x]Number of 14 inoculation sites for each species in which spring dead spot symptoms developed. Plots were inoculated in September 1997 with three isolates of each species and were rated in May of 1999 and 2000.

[y]Average patch area for those inoculation sites in which spring dead spot symptoms developed.

Table 3. Effect of aerification, nitrogen source, and fungicide on development of spring dead spot on 'Midlawn' bermudagrass in 1999.

Treatment	rate/1000 ft^2	Plot area damaged 1999 (%)	Turf quality April 1999	Turf quality April 2000
Main plots				
Aerify	-	26.9 a	-	6.2 a
Non aerify		31.4 b	-	4.0 b
subplots				
untreated	-	33.7 bc	4.0 d	4.9 bc
Heritage 50 DG	0.4 oz	31.9 bc	4.0 d	4.8 c
Primo EC	0.25 fl oz	27.5 abc	4.8 abc	5.8 a
ammonium sulfate	3 lb	38.8 c	4.1 cd	4.9 bc
Heritage + ammonium sulfate	0.4 oz + 3 lb	35.0 bc	4.3 bcd	4.8 c
Heritage + Primo	0.4 oz + 0.25 fl oz	20.6 a	5.3 a	5.1 bc
Primo + ammonium sulfate	0.25 fl oz + 3 lb	24.4 ab	4.8 abc	5.1 bc
Heritage + Primo + ammonium sulfate	0.4 oz + 0.25 fl oz + 3lb	21.9 ab	4.9 ab	5.4 ab

Abstracts and Papers resulting from funding of this project:

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