Bermudagrass surviving in the center of spring deadspot areas forming the ring-shaped spots that develop after the disease has occurred in the same spot for several years.

Spring Deadspot of Bermudagrass

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SPRING DEADSPOT (SDS) is the most serious disease of bermudagrass throughout the north range of adaptation of bermudagrass in the United States. Recently, a workshop was held on SDS, and information was gathered to determine the distribution of this disease. The northern limit of SDS corresponds with the northern range of adaptation of bermudagrass. The southern range of SDS appears to be related to the regular occurrence of freezing temperatures where bermudagrass goes dormant during the winter. The area in this zone includes portions of Maryland, Virginia, North Carolina, South Carolina, Georgia, Kentucky, Tennessee, Alabama, Mississippi, Louisiana, Arkansas, Illinois, Missouri, Kansas, Oklahoma, Texas, New Mexico, Arizona, and California. Published reports and personal communications indicate that the disease has been observed on bermudagrass in all of the above states except New Mexico and Arizona. The disease is not known to occur in Florida and has not been observed in the southern portion of other Gulf Coast states.

The symptoms of SDS were first described in a publication from Oklahoma in 1960, although information indicates that the disease was present in Oklahoma as early as 1936. Symptoms on pure stands of bermudagrass are circular dead areas in the spring as the grass resumes growth from winter dormancy. The spots may vary in size from a few inches to several feet in diameter. Weeds often invade the affected spots and inhibit the growth of bermudagrass into the affected spots during the summer. Even with a good weed-control program, the growth of bermudagrass over the spots is slow, indicating the presence of a pathogen or toxin in the soil.

The bermudagrass usually grows over the SDS areas by the end of the summer in North Carolina; however, reports from drier areas of the country indicate that the spots may remain bare for several years. The affected spots can be seen in fall and winter on taller cut

grass in roughs and on some fairways as areas with shorter grass that remain green later into the fall than the nearby healthy grass. Spots can sometimes be detected on highly maintained shorter cut grass on fairways and greens during the fall and winter as areas with thin turf or depressed areas with very little thatch. Symptoms on overseeded bermudagrass greens often resemble brown patch in the spring. In this case, the dead circular areas of bermudagrass show through the overseeded grass after the surrounding bermudagrass has turned green, giving the healthy turf a darker color.

The cool season grasses will often remain in the SDS areas longer into the summer, and bentgrass used in some overseeding mixtures has been observed in affected spots for several years. Many of the spots occur in the same location for several years and develop into ring or doughnut shaped spots. The spots develop the ring shape as bermudagrass begins surviving in the center of the affected areas.

THE DEVELOPMENT of SDS has been followed over a period of three years at several locations in North Carolina. In one place, 80 percent of the spots occurred in the same place the following year with an average increase in diameter of the spots of about 15 percent. After about three to four years, bermudagrass begins surviving in the center of the spots. Usually, the symptoms of SDS disappear in North Carolina one or two years after the ring-shaped symptoms develop.

SDS was recognized as a problem in North Carolina in the late 1960s. The disease probably was present earlier, but it was not so evident until good winter weed-control programs came into use. The spots are clearly evident on bermudagrass fairways where *Poa annua* and other weeds have been controlled and not in areas with weeds. Many golf course fairways were planted to improved bermudagrass varieties a few years before this time and received high rates of nitrogen fertilizer. The higher level of management and thatch accumulations are factors that have been associated with the development of SDS.

Since the cause of SDS was not known and a good chemical control was not available in the United States, studies were initiated in North Carolina using high rates of several new fungicides in 1973. In these experiments, fungicides were applied once a month for six times in late summer and fall, based on information developed by W. A. Small, of Mallinckrodt Chemical Company, to bermudagrass that had severe SDS the previous spring. Control of SDS was obtained with heavy rates of fungicides containing benomyl, thiophanatemethyl or PCNB but not with several other fungicides the following spring.

Additional experiments were conducted using fewer applications and lower rates of fungicides in which fall applications gave the best control (Table 1). Control of SDS has been obtained in more recent experiments with one application of benomyl at eight ounces per 1,000 square feet in October or November on larger areas on fairways. Additional experiments are in progress to evaluate other fungicides and to obtain information needed to apply for a label to use these fungicides to control SDS.

One of the most significant results of these experiments was the increase in severity of SDS following heavy applications of nitrogen in late August and September to turf that was affected with SDS the previous spring. Extra nitrogen has not caused the disease to develop after three years in areas that have not had the disease. The control of SDS with benomyl may indicate the involvement of certain types of fungi in the disease. *Helminthosporium* species that are not generally sensitive to benomyl are not indicated as primary pathogens in SDS, although these fungi have been associated with the disease. Phycomycetes such as *Pythium* species were not indicated, since these fungi usually are not sensitive to benomyl and the disease was not controlled with a fungicide containing chloroneb.

THE SURVIVAL of bermudagrass in SDS-affected areas was followed during three winters in North Carolina. The bermudagrass in SDS areas and nearby healthy areas regrew equally well when plugs were collected in December and placed in a warm greenhouse for one month. However, when samples were collected in late January or February and placed in the greenhouse, the number of shoots from SDS affected turf was 64 percent less than from nearby healthy turf.

The survival of bermudagrass in SDS-affected turf that had been treated with benomyl in November was the same in January and February as for healthy turf.

Throughout these experiments, lower weights of roots were associated with SDS-affected turf. This information indicates that the bermudagrass in SDS areas is probably killed by cold weather

TABLE 1
Effect of Time of Application of Benomyl on Control of Spring Deadspot in 1976 Experiment at Raleigh, North Carolina

Treatment[1]	Turf Quality[2] 5-11-77	% SDS[3] 5-11-77
Oct., Nov., Dec.	6.3*	7*
Oct.	5.8*	9*
Nov.	5.5*	9*
Dec.	4.8	15
Check	3.5	21
LSD (.05)	1.4	10

[1]Benomyl applied at 10 oz. of formulated product per 1000 ft² once a month for the months indicated in 1976 to an area that had severe spring deadspot in the spring of 1976.

[2]Turf quality ratings were 1-9 with 9 being a good uniform turf and 1 indicating all turf was dead.

[3]Percent of area in a plot dead from spring deadspot in May following fall applications.

in January. The benomyl may be controlling a fungus on the bermudagrass or it may be increasing the winter hardiness of the SDS-affected turf.

This fungicide has some growth regulator properties that could affect the winter survival of bermudagrass. Additional research is in progress to determine how the fungicide protects the grass during the winter.

Efforts have been made to associate a pathogen with SDS in North Carolina. The fungus, *Leptosphaeria narmaria*, that has been associated with SDS in Australia has not been isolated in North Carolina. Other fungi have been isolated from bermudagrass but have not been shown to cause SDS.

In North Carolina, several different mushroom-type fungi were associated with some SDS-affected areas. Several of these fungi were used to inoculate soil in the greenhouse and affected top and root growth of bermudagrass in greenhouse experiments. These normally saprophytic fungi that decompose organic matter and thatch may be involved in the disease and could produce the small fairy-ring-type symptoms that develop after several years.

At present, a theory for SDS development involves the predisposition of bermudagrass to damage by cold weather in small areas by some type of fungus. Bermudagrass that remains green later into the fall and has a poor root system, as in SDS-affected turf, would be more susceptible to damage by cold weather. Also, the zone in which the disease occurs indicates the involvement of cold weather in disease development.

RECOMMENDATIONS FOR the prevention of SDS include the use of lower levels of nitrogen and good management practices to avoid excess thatch accumulations. Once SDS is present, a good aerification and weed-control program will encourage bermudagrass to grow over affected spots. Heavy verticutting during the summer once the bermudagrass begins to grow over the spots should not be used since it removes the stolons that are growing over the spots and reduces the rate of cover. Reduced levels of nitrogen fertilizer, particularly in late summer, has reduced the severity of SDS the following year in North Carolina. Also, adequate amounts of potassium are recommended where the disease is a problem and should improve the winter hardiness of the turf. Fungicides are not yet approved for control of SDS, but they should be economical to use on tees, greens and small areas in fairways in the fall where SDS was a problem the previous spring.

Spring deadspot was controlled in plot No. 1 on the right treated with benomyl the previous fall. Other treatments ineffective.