Pythium-Induced Root Dysfunction of Creeping Bentgrass on High Sand Content Greens

by **CLINTON F. HODGES,** Professor of Horticulture and Plant Pathology, Department of Horticulture, Iowa State University, Ames, Iowa

A PYTHIUM DISEASE of creeping bentgrass has been recognized that attacks the roots of plants growing in high sand content greens. The disease occurs primarily on old golf courses where the greens have been rebuilt with high sand content mixes. It is found rarely on newly constructed golf courses with sand-base greens. Creeping bentgrass established on the renovated greens in the fall of the growing season grows well and establishes a good cover by winter. The grass continues to grow well during the mild periods of spring and early summer of the following year. With the arrival of hot, humid weather, the turf begins to die in a pattern typical of *Pythium*-induced "cottony blight" or "foliar blight" *(Figures 1, 2, and 3).* Entire greens die within seven to 14 days. Close examination of diseased plants, however, fails to show any *Pythium* infection of above ground protions of the plants.

Examination of root systems of diseased plants reveals white, normal appearing healthy roots. No lesions or rot are present on the roots. When such roots are incubated under laboratory conditions, *Pythium* species grow from root tissues within six to 12 hours. Case histories of greens that have been attacked show that the disease may reoccur and severely damage the greens up to three growing seasons after the first outbreak of the problem. After three years, the disease may cease to be a problem or may occur at a much reduced level of activity.

Between 1977 and 1983, three *Pythium* species were found associated with roots of creeping bentgrass afflicted with the disease. The three species have been identified as *P. arrhenomanes, P. aristosporum,* and *P. vanterpoolii.* They were acquired from greens in midwestern and eastern states, and from Ontario, Canada. *P. vanterpoolii* has been implicated in foliar blights for many years and is commonly associated with turf. *P. arrhenomanes* and *P. aristosporum* are not commonly associated with turf culture. *P. arrhenomanes,* however, is widely distributed in North America and is well established as a root pathogen of cereals, corn, and sugarcane. It is also associated with species of fescue, quackgrass, and smooth bromegrass. *P. aristosporum* is primarily found in the cooler regions of North America and Japan and is the cause of snow rot of cereals. Of the diseased plants examined, *P. aristosporum* has been isolated only one time; *P. arrhenomanes* has been the most commonly isolated species.

CONTROLLED inoculations of secondary roots of creeping bentgrass with the various *Pythium* species has established *P. arrhenomanes* and *P. aristosporum* as the primary pathogens. *P. vanterpoolii* was not pathogenic to the roots of creeping bentgrass in our studies. Growth of creeping bentgrass in sand is severely reduced by roots infected by *P. arrhenomanes* or *P. aristosporum (Figure 4).* Total weights of root-infected plants are markedly reduced when plants are grown in sand; both roots and shoots show a decrease in dry weight *(Figure 5).* Inoculated roots of plants grown in a 50:50 sand-soil mix show less damage; it should be noted, however, that this disease has not been found on greens with a high soil content.

Figure 1.

Figure 2.

Figure 1. Early symptoms of Pythium-*induced root dysfunction may be characterized by a chlorotic strip of turf at the interface of the new high sand content mix and the original collar apron soil of the renovated green.*

Figure 2. Within a few days creeping bentgrass shows irregular patches of chlorotic and necrotic turf that expand very rapidly. The rate of disease spread and general appearance is typical of Pythium *blight, but without any foliar infection.*

Roots inoculated with, or naturally infected by, *P. aristosporum* or *P. arrhenomanes* may be white to slightly buff-colored and do not show lesions or rot. Roots collected two to four weeks after inoculation and incubated in culture chambers show mycelial development in root hairs *(Figure 6A)*. Roots collected four to eight weeks after inoculation, and roots collected from naturally infected plants in the field, show bulbous root tips *(Figure 6B)* as well as disorganized and devitalized tips *(Figure 6C)*. Diseased root tips incubated 12 hours in culture chambers show extensive mycelial growth from intact cortical tissue in the region or elongation *(Figure 6B)*.

Randomly collected 1.5-cm pieces of older roots from inoculated plants, and from naturally infected plants from the field, incubated in culture show mycelial growth from the vascular cylinder at the cut ends of the roots within six hours *(Figure 6D)*. Some of the initial growth from the cut ends of the roots seems to develop from the interface of the cortex and vascular cylinder *(Figure 6E)*. Within 12 hours, extensive mycelial growth develops from all root tissue at the cut ends *(Figure 6F)*. Within 12 hours, mycelial growth occurs directly from cortical tissues over the entire length of infected roots. *(Figure 6G)*.

There is no immediate explanation for the source of the pathogens in the renovated greens or for why the disease has been observed only in high sand content media. The pathogens may be introduced with the sand or peat, or they may be present in the collar-apron soil that is commonly left during renovation to the sand medium. The severity of the disease in sand media may be related to the microbiology of sand. The microbiology of sand may be different from that of soil, or the microbial population may be poorly established. In either instance, the ability of the *Pythium* species to function in sand may be related to inadequate competition from other microbes. There is evidence that *P. aristosporum* and *P. arrhenomanes* are more destructive on cereals, grasses, tomatoes, and beans on light and sandy soils. The observation that the severity of the disease decreases over a three-year period may relate to a more competitive microflora becoming established in the sand.

THE ROOT DISEASE induced by *P. aristosporum* and *P. arrhenomanes* has been termed "*Pythium*-induced root dysfunction." Both *Pythium* species thoroughly colonize infected roots, but both fail to produce a root rot. The decrease in growth of plants infected by either pathogen is extensive *(Figure 4)*, but infected plants in controlled studies were not killed. This suggests that, under optimal growing conditions, the roots may become extensively infected, and the host and pathogen may co-exist without evidence of the disease. This may explain why the infected plants are killed very rapidly during periods of high temperature. Rapid death of the root-infected plants in the absence of rotting suggests that under stress, infected roots dysfunction relative to water uptake and translocation. Both *Pythium* species become associated with the vascular cylinder *(Figure 6D and 6E)* and with the root tip *(Figure 6B and 6C)*. There is no evidence of physical blockage of vascular tissue; however, the water content of wheat seedlings is reduced when roots are infected by *P. arrhenomanes*, and filtrates of *P. arrhenomanes* also inhibit water uptake by wheat seedlings.

The asexual (sporangia) and sexual (oospores) reproductive structures of *P. aristosporum* or *P. arrhenomanes* are rarely found in creeping bentgrass roots. Transferring either pathogen to Bacto-ager (3% v/v) or cornmeal agar results in abundant production of lobate sporangia and oospores on the respective media. Inoculation of orchardgrass roots with either pathogen also results in production of sporangia and oospores in cortical and vascular tissues. These responses suggest that creeping bentgrass may not be an ideal host for either pathogen. These developmental characteristics also may relate to the three-year persistence of the disease. If the *Pythium* species survive primarily in a vegetative state within creeping bentgrass roots, they could be vulnerable to the potential development of microbial competitors in the sand.

CONTROL OF *Pythium*-induced root dysfunction is not promising with present technology. Contact and systemic fungicides specific for *Pythium* species are not effective for control of root dysfunction. The primary problem is that there is no effective means of getting the fungicides to the root zone, and there also is some question of their effectiveness in the root zone. At present, intense aerification with application of the fungicides into the aerifier holes may slow the disease, but not stop it. Wetting agents in conjunction with the fungicides have been useful sometimes. Unfortunately, our experience indicates that most efforts to control the disease chemically are futile, and on most diseased greens, the turf must be reestablished after the stressful period of the growing season.

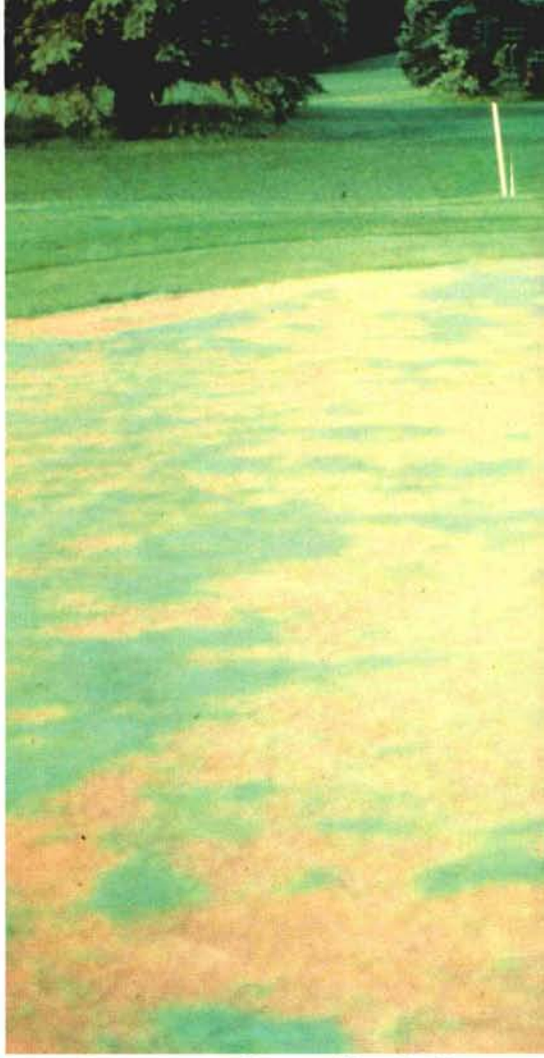

Figure 3. Appearance of greens afflicted with Pythium-*induced root dysfunction seven to 10 days after the disease is first noticed.*

Acknowledgement

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Figure 3.

Figure 4. Growth of creeping bentgrass after eight weeks in response to inoculation of roots with Pythium *isolates. A) Control plant. B) Canadian isolate of* P. arrhenomanes. *C) Iowa isolate of* P arrhenomanes. *D)* P. aristosporum.
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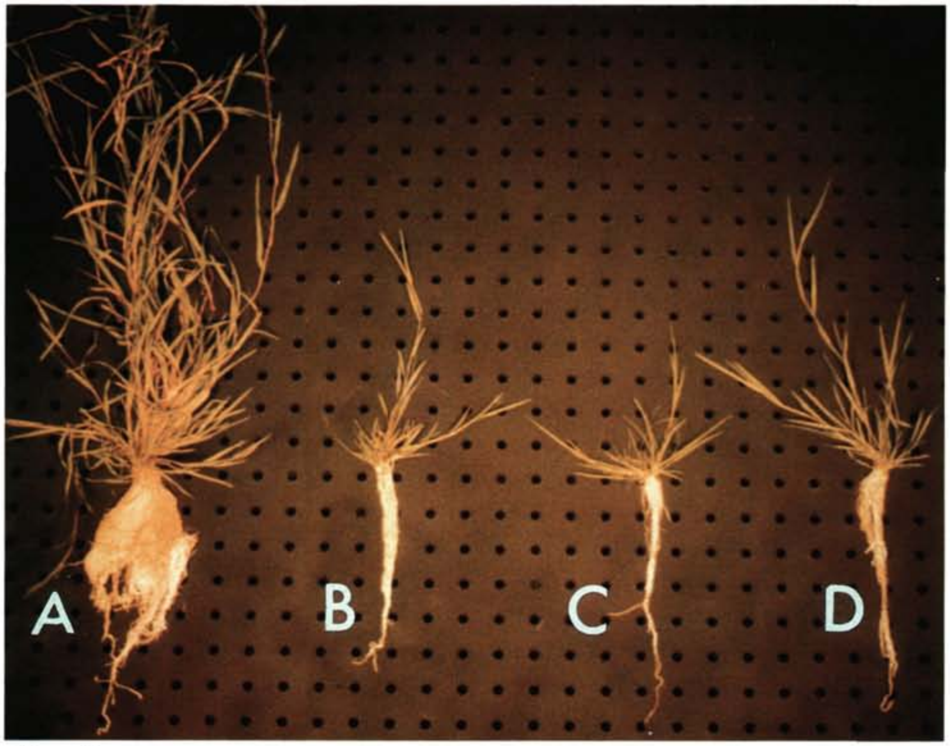

Figure 4.

Figure 5.

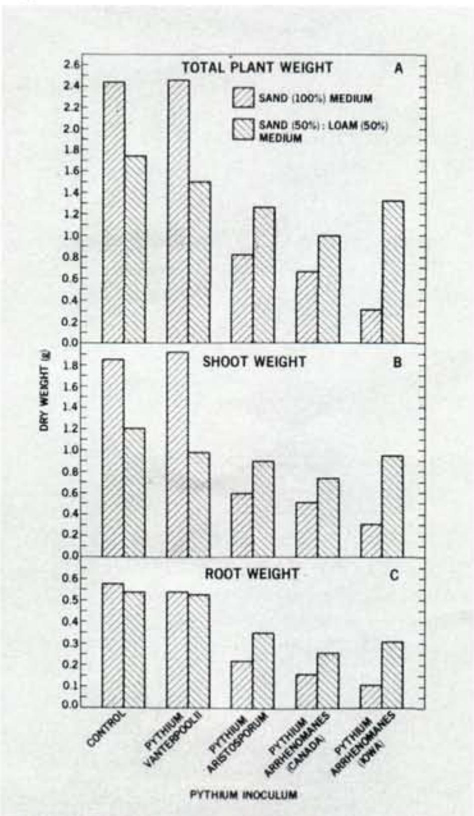

Figure 6.

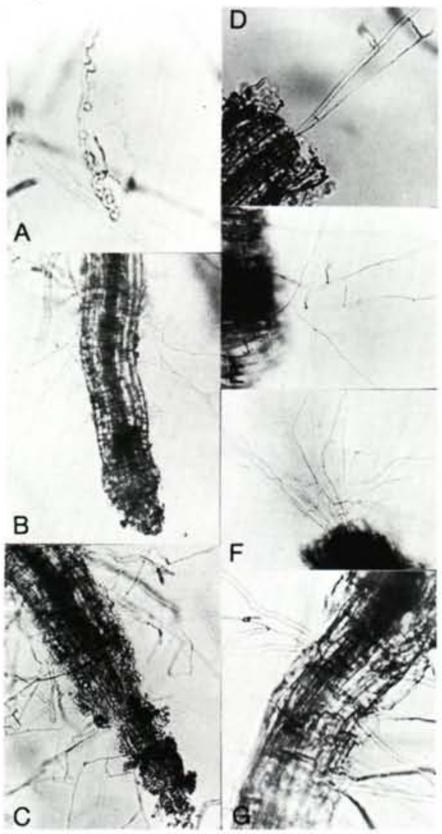

Figure 5. Growth of creeping bentgrass in sand (100%) and sand-loam (50/50%) media eight weeks after innoculation of roots with Pythium aristosporum, P. arrhenomanes, *or* P. vanterpoolii. *Differences between* Pythium *isolates (a/) and growing media (/a) followed by the same letter are not significantly different. Least significant difference (LSD), P = 0.05.*
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Figure 6. Symptomatology and histopathology of creeping bentgrass infected by Pythium aristosporum *or* P. arrhenomanes. *A) Mycelium in root hair two to four weeks after inoculation. B) Bulbous root tip and growth of mycelium from region of elongation. C) Devitalized root tip. D) Growth of mycelium from vascular cylinder within six hours after incubation. E) Growth of mycelium from the interface of the cortex and vascular cylinder. F) Massive growth of mycelium from all root tissue after 12 hours of incubation. G) Direct growth of mycelium from cortical tissue of root. Note absence of rotted tissue or lesions.*
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