FEATURE ARTICLE

Pythium-Induced Root Dysfunction of Creeping Bentgrass Greens

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Pythium species are associated with all turfgrasses and cause seed decay, postemergence damping-off, foliar blight, root and crown rot, and snow blight. **Foliar blight is known as Pythium blight, cottony blight, grease spot, and spot blight. This disease is most destructive during hot and humid periods. The initial symptoms of *Pythium* blight appear as small, circular spots or patches.** On creeping bentgrass (*Agrostis stolonifera*) greens, infected patches turn orange or brown and gray "smoke rings" may appear at the periphery of infected patches. Infected leaves appear slimy and matted, and eventually turn brown when dry. During prolonged periods of high humidity, fluffy grayish-white masses of mycelium may appear on collapsing leaves. Large areas of turf may die within hours due to the coalescence of numerous patches. Six Pythium species (i.e., *Pythium aphanidermatum; P. graminicola; P. myriotylum; P. torulosum; P. ultimum* var. *ultimum;* and *P. vanterpoolii*) are causal agents of *Pythium* blight. *Pythium aphanidermatum* was isolated as early as 1926 from diseased creeping bentgrass in Rossly, Virginia by Dr. John Monteith, and is the most common incitant of foliar blight in the United States during periods of high temperature and humidity.

Unlike foliar blight, ***Pythium* root and crown rot may occur throughout the entire growing season. It primarily develops during cool and wet periods of spring, causing a general decline of the turfgrass stand.** The symptoms of this decline are very difficult to describe and a **positive diagnosis requires a laboratory analysis.** In the northeastern United States, nearly all cool-season turfgrasses may be affected by *Pythium*-incited root diseases during prolonged periods of wetness, regardless of temperature. Annual bluegrass (*Poa annua*) and creeping bentgrass grown on greens, however, are the primary turfgrasses affected.

Pythium species are common inhabitants in the roots of creeping bentgrass and other grasses. The name Pythium root rot was probably first used by Dr. Robert Endo in 1961 to describe damping-off of turfgrass seedlings as well as a root rot of more mature plants in California. Hodges and Coleman (1985) described a secondary root Pythium disease of turfgrasses, which they named ***Pythium*-induced root dysfunction.** The occurrence of root dysfunction on secondary roots of creeping bentgrass was associated with renovated golf greens grown on high–sand content mixes in Iowa. They found that secondary roots of plants infected with *Pythium aristosporum* and *P. arrhenomanes* were not killed, and root lesions or rotting were not observed, although plant growth was reduced extensively. Spore-bearing sporangia and the thick-walled, resistant oospores were rarely found in infected roots by Hodges and Coleman (1985). These observations suggested that *P. aristosporum* and *P. arrhenomanes* were not virulent pathogens of creeping bentgrass. According to Hodges and Coleman (1985), the level of injury inflicted by these root infecting *Pythium* species depends on plant growing conditions and high temperature stress.

In recent years, the pathogenicity of *Pythium* species that infect turfgrass roots has received more study. In 1991, Nelson and Craft reported *Pythium* root rot in New York State and found *P. graminicola, P. aphanidermatum, P. aristosporum, P. torulosum,* and *P. vanterpoolii* were pathogenic to creeping bentgrass seedling roots maintained under both cool 55°F (13°C) and warm 82°F (28°C) temperatures. Based on recovery frequency and virulence studies, Nelson and Craft (1991) concluded that *P. graminicola* was the principal species associated with turfgrass root rot in New York State. In North Carolina, Abad et al. (1994) obtained 237 *Pythium* isolates from creeping bentgrass. They reported that 29 of 33 *Pythium* spp. isolated from turfgrasses were pathogenic to primary roots of creeping bentgrass seedlings. Among these species, *P. arrhenomanes, P. aristosporum, P. aphanidermatum, P. graminicola, P. myriotylum, P. tardicrescens, P. vanterpoolii,* and *P. volutum* were highly aggressive. Sixteen of the 29 species were only weakly or nonpathogenic. They concluded that *P. arrhenomanes* was the most important pathogen causing root and crown rot of creeping bentgrass in North Carolina. Both Nelson and Craft (1991) and Abad et al. (1994) found that *P. torulosum* was the most frequently recovered species from turfgrasses exhibiting symptoms of root and crown rot. *Pythium torulosum* also was reported to be commonly isolated from the roots of cool-season grasses in California (Endo, 1961). Several researchers, however, reported that *P. torulosum* was weakly pathogenic or nonpathogenic.

Feng (1998) found eight species of *Pythium* (i.e., *P. aristosporium, P. aphanidermatum, P. catenulatum, P. graminicola, P. torulosum, P. vanterpoolii, P. ultimum* var. *ultimum,* and *P. volutum*) associated with the roots of creeping bentgrass greens in Maryland and adjacent states. *Pythium torulosum* was the most common species isolated.

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Although most *P. torulosum* isolates had low virulence or were nonpathogenic it appeared that this species must be able to cause root dysfunction when found in high populations. *Pythium aristosporium* was the most common and virulent species isolated from Maryland putting greens. ***Pythium*-induced root dysfunction was primarily found during mid to late spring (May and June) on new golf courses or older greens recently renovated with methyl bromide.** The most destructive cases appeared just after seeding in October and November or in the spring following an autumn seeding. As noted below, *Pythium*-induced root dysfunction and not root rot was the primary problem found on Maryland greens. Clearly, more research information is needed to help diagnosticians distinguish between Pythium root rot and root dysfunction. *Pythium*-induced root dysfunction, however, appears to be more commonly associated with new golf courses or methyl bromide–renovated greens.

Symptoms. The symptoms of *Pythium*-induced root dysfunction are nonspecific, making it one of the most difficult diseases to diagnose. In immature bentgrass greens, the leaves of infected plants are yellow, stunted, and tend to be narrower than leaves of healthy plants. In most situations, there are dark green, perfectly healthy looking plants dispersed throughout pockets of chlorotic and diminutive plants. **Mixed within chlorotic areas, small patches turn brown and die. Death of plants generally first appears at the outer periphery of the greens.** This is due to two reasons. First, the *Pythium*'s likely ingress at the point where the mineral soil and greens' mix meet. Death of plants, however, is due to a combination of mechanical injury from mowing stressed plants with dysfunctional root systems. More mechanical injury occurs at the point where the greens mower enters a curved area, where the mower must turn. The turning action twists and grinds infected leaves and stems, placing a lethal stress on infected plants. **Eventually, large areas throughout the entire putting surface may die. The disease is generally more severe on shaded or pocketed greens.**

In mature creeping bentgrass, leaves of infected plants may be chlorotic or they may develop a reddish-brown color and the turf exhibits a loss of density. These symptoms mimic basal rot anthracnose. For annual bluegrasses (*Poa annua*), the leaves appear yellow-brown or reddish-brown in color before plants die. Disease develops primarily in pockets and often is most pronounced in low areas or follows the drainage pattern. Some injury, however, may be observed throughout the putting surface even in higher, well-drained areas. *Pythium*-induced root dysfunction, however, was seldom observed in greens older than 3 years in the Maryland and Iowa studies.

Washing soil from infected plants and observing roots for symptoms often provides no useful clues. Infected roots may have lesions or a generalized light-tan to brownish discoloration, which can only be seen with a microscope. In North Carolina, researchers sometimes observed brown colored and twisted root tips (Abad et al., 1994). Discoloration or rotting of crowns and roots of infected plants was observed by researchers in New York and North Carolina (Abad et al., 1994; Nelson and Craft, 1991). Hodges and Coleman (1985), however, found no rotting or discoloration of the root system from bentgrass greens in Iowa. Similarly, in Maryland we also have found a general lack of any pronounced discoloration or lesion development on bentgrass roots, including roots containing huge numbers of oospores.

Disease Management. The disease must be aggressively managed by a combination of cultural and chemical means. *Pythiums* grow and reproduce rapidly in wet soils, so **drying the soil is essential.** This is obviously difficult, because the root systems of infected plants are unable to absorb and translocate sufficient amounts of water and nutrients. Irrigation from sprinkler heads must be replaced by **frequent hand syringing on an as-needed basis. Affected greens should only be mowed when dry and with a lightweight, walk-behind greensmower.** Never mow affected greens on rainy days or when the surface is excessively wet. Mowing height should be increased (i.e., >5/32″) and frequency of mowing reduced to 4 or 5 times weekly. Remove grooved rollers from mowers and replace them with solid rollers. Avoid other potential mechanical stresses by delaying topdressing, brushing, vertical cutting, and both core and water injection cultivation until the disease has been controlled.

There are no published studies that have investigated the performance of fungicides against *Pythium*-incited root diseases. In most cases, a battery of fungicide applications is recommended. This may involve an application of fosetyl-aluminum + mancozeb (Aliette® + Fore®), followed in 5 to 7 days with an ethradiazol (Koban®) or chloroneb (Terraneb SP®) drench. Thereafter, alternating metalaxyl (Subdue MAXX®) and propamocarb (Banol®) applications on a 10 to 14 day interval is suggested. **Experience has shown that some fungicides ameliorate the condition and some do not. This is due to the many different species of *Pythium* that can be involved, and it is likely that various *Pythium* species will be affected differently by fungicides having varying modes of action.** Of the aforementioned, only Aliette® + Fore® is not watered-in. The others should be watered-in to a depth of 0.5 to 1.0 in. (1.0–2.5 cm). A syringe cycle from the irrigation system usually provides sufficient water to move fungicides into the effective zone immediately following a fungicide application. Among these five fungicides, most superintendents find one or two products that perform best. In extreme cases, a fungicide application may be required on a 7 to 10 day interval throughout much of the growing season, particularly in wet years. Applications of biostimulants and micronutrients are proposed along with fungicides, but their overall impact on the condition is unknown. The disease in young bentgrass greens can recur for 2 to 3 years following an autumn seeding. Mature bentgrass greens appear to be less susceptible to injury. Conversely, annual bluegrass on greens in more northern climates may be more chronically affected.

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Turfax Projections

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- Central Garden and Pet acquired Pennington Seed, Inc. and Seeds West, Inc. (formerly Farmers Marketing).
- The Toro Company acquired James Hardie Irrigation, Exmark Manufacturing, and Dingo™ Digging Systems.
- J.R. Simplot Company acquired Jacklin Seed.
- The Monsanto Company and American Home Products recently have announced plans to merge, which includes the Crop, Turf, and Ornamental Section of American Cyanamid.

A key driver in these acquisitions is the **rapid biotechnology developments** toward transgenic turfgrass cultivars and the progress being made in biological control agents for pests of turfgrasses.

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Putting green construction with **a high-sand root mix and a perched hydration zone will continue to increase** worldwide, on greens subject to intensive play.

The next 5 years will see **a major emphasis on the conversion of putting greens** composed of creeping bentgrass (*Agrostis stolonifera*) or dwarf hybrid bermudagrass (*Cynodon dactylon* x *C. transvaalensis*) to the newer cultivars that can sustain high shoot densities at cutting heights below 4 mm.

Emphasis on **use of slow-release nitrogen and potassium carriers** as a key part of turfgrass fertilization strategy.

Increased use of a fertilization strategy for putting greens involving **macro applications of granular fertilizer combined with micro applications of foliarly applied nutrients** at light rates to make short-term, minor adjustments in turfgrass responses as needed.

Increasing use of **intensive sand topdressing on poorly drained, clayey fairways.**

The use of **three-dimensional, interlocking mesh in root zone stabilization** of turfed sport fields, race tracks, and golf course tees and cart paths will increase worldwide.

A very desirable trend which is not yet at a significant level would be **the use of composted, living organic matter sources** in the original construction of root zones and in subsequent topdressing mixes.

The trend is to a smaller total area devoted to fairway turf on many golf courses, but with a higher intensity of culture and with an increased area of intermediate rough.

Genetic transformation will provide for cultivars that better resist pests and tolerate herbicides. Some genetically improved germplasm will be delayed entering the market due to legal and patent problems.

Some relatively effective biological agents will be marketed in the next several years. Because of environmental factors, consistently efficacious biological agents may never be developed that will match the performance of the chemical pesticides.

Many new effective pesticides will be developed from chemicals produced naturally by plants and microorganisms.

Rough bluegrass (*Poa trivialis*) is rapidly surpassing annual bluegrass (*Poa annua*) as one of the most difficult-to-manage weeds on golf courses where cool-season turfgrasses are grown. Currently, there are no herbicides that selectively control rough bluegrass in cool-season grasses. It must be spot-treated with a nonselective herbicide or physically removed.

Moss problems will increase rapidly on closely mowed putting greens, with **more effective moss control methods being developed.** A warning on moss control programs you may read about in the press: **any product used to control moss is technically illegal unless moss control is stated on the label.** Any product used to mitigate a pest problem is considered a pesticide by the U.S. EPA, and thus must be labeled for that use.

Look for a trend of **even greater restrictions regarding setbacks from wetlands and aquatic ecosystems.** Policy-makers continue to ask more questions about the fate of nutrients and pesticides applied to golf courses.