AN INDEPENDENT NEWSLETTER FOR COOL SEASON TURF MANAGERS

Turf Grass TRENDS

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Late summer leaf spots and leaf blights

by Dr. Eric B. Nelson

Leaf Spots on Kentucky Bluegrass. Up close the first sign of leaf spots and blights is usually a change in color from a healthy green to purple or purplish-gray. Soon leaves turn tan to brown and sheathes turn from brown to black.

DURING THE WARM, HUMID MONTHS of late summer, many fungi are capable of causing various leaf-spotting, leaf-streaking, and leaf-blighting symptoms on turfgrasses. Literally dozens of causal fungi have been identified as problems on lawn and golf course turf under these conditions. All of these fungal pathogens are characterized by a need for warm temperatures and excessive moisture. This article covers the more commonly-observed late summer foliar diseases that occur on residential, commercial and golf course turf—with descriptions of their symptoms, biology and, where possible, recommendations for cultural or chemical controls.

Brown Patch

DISEASES ON COOL-SEASON GRASSES falling under the descriptive term "Brown Patch'"can be caused by a number of Rhizoctonia species: *R. solani*, *R. oryzae*, and *R. zeae*. All three pathogens can be quite damaging under conditions of high moisture and high relative humidity. Diseases caused by *R. solani* are most damaging when nighttime temperatures are greater than 65–70°F (18–21°C). Diseases caused by *R. oryzae* and *R. zeae* are most damaging when daytime temperatures are between 85 and 95°F (29–35°C).

Visual symptoms arising from *Rhizoctonia* infections may differ—depending on turfgrass species, cutting height, the degree of fertilization, irrigation, and other maintenance procedures. Despite these different visual manifestations, these symptoms are always found on the leaf blades and leaf sheathes. Although it can occur, little is known about root infections by species of Rhizoctonia.

R. solani biology and symptoms

ON CLOSELY MOWED, wet cool-season grasses, infection by *R. solani*, the most commonly observed of the three species, results in large patches of blighted grass that rapidly appear following prolonged periods of rainfall or high humidity, above 50%, and high nighttime temperatures, above 65°F (18°C). *R. soloni* infestations can occur over a wide range of air temperatures, generally from 60–90°F (15–32°C).

During the initial phase of the infection, the blighted leaf blades and leaf sheathes may take on a purple to purplish-gray color. As the leaf blight progresses, the leaves rapidly turn to a color range from tan to brown. Sheath blights turn to a color range from brown to black.

Often—in the morning dew, following periods of high nighttime temperatures and high humidities—a dark purplish to gray-brown border may appear around *R. solani*-blighted areas. This patch margin is frequently referred to as a "smoke ring." It is a distinctive visual symptom. It occurs when the pathogen is actively growing and infecting leaf blades—in a widening pattern from the original site of infection. This synchronous infection of leaf blades around the periphery of the patch results in a uniform wilting of these marginal plants. Occasionally, during periods of heavy dew, an abundant fluffy mycelium may be evident around the periphery of these patches.

On cool-season grasses that are cut at a two-inch height or higher (i.e., perennial ryegrass, Kentucky bluegrass, and tall fescue), the large patches will develop more slowly. They can range in size

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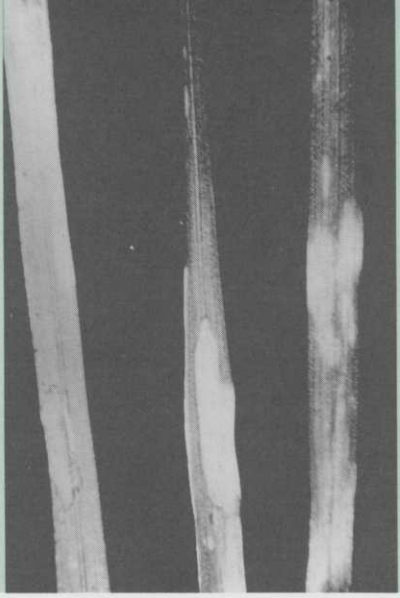
Brown Patch

Brown patch on tall fescue. Brown Patch on a tall fescue lawn may be caused by one of several varieties of Rhizoctonia. Symptoms may appear following a prolonged period of rainfall or high humidity. Later in the disease process large areas of blighted turf appear.



Rhizocronia on Kentucky Bluegrass. Rhizocronia on Kentucky Bluegrass produces lesions that are generally tan and irregular in shape with a dark brown border. On tall-cut turf, these lesions can be diagnostic. The large size of the lesions produce completely destroyed leaves on short-cut turf, so there isn't enough leaf area for their diagnostic appearance.

from several inches to several feet in diameter. Generally, no smoke ring is evident around the periphery of the patch. Patches will often appear sunken, as the leaf blades wilt and collapse to the soil surface.

Tall-cut turf can exhibit the same leaf and sheath blighting seen on short-cut turf, as well as individual lesions, which are evident on leaf blades and sheathes. Lesions are generally tan and irregular in shape, with a dark brown border. These individual lesions are particularly symptomatic on tall fescues, where the lesions can be quite diagnostic. On tall-cut turf, this individual lesion symptomology may be more numerous—over larger areas of turf than the full-scale blighted areas. Seen on short-cut turf, and, if observed early in the infection cycle, they may give the turfgrass manager more lead time to take corrective actions.

R. zeae biology and symptoms

SYMPTOMS CAUSED BY INFECTIONS from *R. zeae* are less distinct than those caused by *R. solani* infections. *R. zeae* infections are most prominent at air temperatures over 90°F (32°C). On close-cut creeping bentgrass, symptoms from *R. zeae* infection may consist of gray-brown or yellow arcs or circles of blighted turf. The characteristic "smoke ring" is usually not evident.

On higher-cut tall fescue turf, leaf blade and leaf sheath symptoms may appear similar, if not identical with *R. solani* induced symptoms. However, those arising from *R. zeae* infections will occur at the higher air temperatures, often over 90°F (32°C). Occasionally, during high temperature periods, a cream-colored mycelium of *R. zeae* may be observed growing from infected leaf blades or sheathes.

High nitrogen fertility is less of a problem than thought

RHIZOCTONIA DISEASES HAVE GENERALLY been considered to be more severe under high nitrogen fertility conditions. Traditionally, this has been attributed to the increased succulence of the foliar tissues, under high nitrogen fertility, making them more susceptible to infection; however, recent research results show that excessive rates of nitrogen may not lead to increased Brown Patch severity. In some cases, nitrogen applications may actually suppress Brown Patch diseases.

Changing management practices can help

SINCE PROLONGED PERIODS OF FREE WATER on the surface of the leaf are required for the most severe outbreaks of Brown Patch, any management strategy that will reduce the leaf wetness period will reduce the damage from Rhizoctonia species. These practices would include:

1. MAINTENANCE OF GOOD SURFACE and subsurface drainage to remove excess water after rainfall or irrigations.
2) WATERING EARLY IN THE DAY to allow the leaf canopy sufficient time to dry.
3) REMOVING DEW from the turfgrass foliage can be particularly important on short-cut turf.
4) INCREASING THE AIR FLOW around disease-prone sites by selective removal of trees, shrubs, etc.
5) THE USE OF WETTING AGENTS to reduce water accumulation on leaf blades and to ease the movement of water down through the soil profile.

A new cultural practice that is proving helpful in reducing damage from Rhizoctonia infections is the application of compost-amended topdressings to increase microbial activity antagonistic to Rhizoctonia. This strategy may be helpful in reducing the concentrations of other pathogenic fungi. Research has shown that these compost-amended topdressings can reduce the occurrence of Red Thread and Pythium Root Rot diseases.

Nearly all cool-season turfgrasses are susceptible to infection by Rhizoctonia species; however, some varieties of fine fescue, tall fescue and perennial ryegrass are particularly susceptible. In areas of the country where Rhizoctonia species cause considerable damage, a local recommendation should be obtained for the varieties best adapted to your area.

As a last resort strategy for the control of Brown Patch, fungicides may be required to reduce or eliminate the progression of the disease. Many fungicides are labelled for

Brown Patch control. However, due to the extreme variability in the sensitivity of Rhizoctonia species to these various fungicides, no single fungicide may be effective in controlling Brown Patch under all conditions, at all locations and for prolonged periods. Trial and error may be the best approach in choosing a group of successful Brown Patch fungicides. Tank mixing contact and systemic fungicides with their different modes of action may provide the broadest and most successful means of controlling these diseases.

Cochliobolus Diseases

THE COSMOPOLITAN, SEED-BORNE PATHOGEN, *Cochliobolus sativus* (= *Bipolaris sorokiniana*), causes a wide range of disease symptoms on essentially all cool-season grasses, ranging from seedling blights to leaf spots, blights and root and crown rots on established turf. The most conspicuous symptoms are the leaf spots and leaf blights *(see photo page 1)*. These diseases were formerly lumped under the category of "Helminthosporium leaf spots and blights."

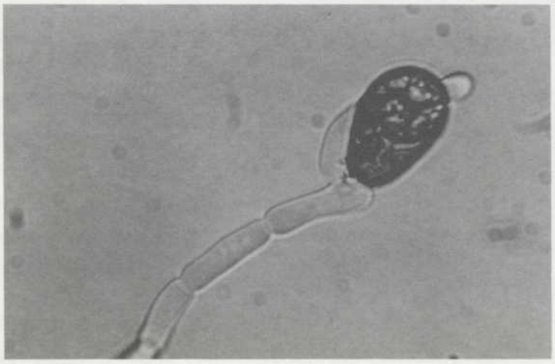
C. sativus biology and symptoms

ON MATURE KENTUCKY BLUEGRASS PLANTS, leaf spots resulting from *C. sativus* infections are quite noticeable, appearing as small, tan circular spots with dark brown or purple borders. As the lesions increase in size and number, leaf blades begin to turn yellow and the blades become extensively blighted. As the disease progresses, crowns and roots become invaded, resulting in a black to reddish-brown appearance on rotted tissues. Once root and crown infections occur, large areas of turf may rapidly die in a patch-like pattern.

Cochliobolus sativus can produce abundant dark-brown multicellular spores called conidia on diseased tissues, particularly at temperatures of 80–85°F (27–29°C). Once formed, conidia may be dispersed by wind, water, traffic or grass clippings, the most common means of spreading the infections. Under warm and wet or humid conditions, these conidia can germinate on a susceptible grass blade within a matter of minutes and generally require as little as 10 hours to infect the plant. Germinated conidia give rise to dark-brown mycelium easily observed with a microscopic examination of the infected plant tissues.

Effects may differ with different conditions

ALTHOUGH THE FAMILIAR FOLIAR INFECTIONS most commonly occur in the spring under wet conditions, the air temperatures can dramatically affect the foliar symptoms that develop throughout the season. For example, at temperatures of 70°F (21°C) or less, only slight leaf spotting and no leaf blighting are observed. At temperatures of 75–80°F (24–27°C), considerable leaf spotting and some leaf blighting can be observed. As temperatures rise to around 85–90°F (29–32°C), little or no leaf spotting can be observed, however, severe leaf blighting may prevail. At this stage, root and crown rots may become evident. At temperatures of 95°F (35°C) or greater, severe leaf blighting and severe crown and root rotting can occur resulting in the extensive destruction of established turfgrass stands. If left uncontrolled, the disease will increase in severity during successive seasons.



Bipolaris spore germinating. Given the right conditions, the abundant spores of *C. sativus* can germinate rapidly and spread infection to new areas. The most common ways the infection is spread include the wind, water, traffic, and grass clippings.

Several factors may alter the susceptibility of turfgrasses to infection by *C. sativus*. Elevated nitrogen levels, excessive nighttime irrigation, inappropriate mowing height, thatch accumulation, and the use of some herbicides and fungicides may increase disease development in Kentucky bluegrass turf. Periods of drought stress will also enhance disease severity. Drying and wetting cycles appear to increase the germination of *C. sativus* conidia and increase the chances of plant infection. Day length has also been shown to affect the severity of foliar symptoms. Generally, as day-length shortens, symptoms on infected leaves become more severe with lesions enlarging and becoming joined by yellow streaks or entire leaf blades becoming blighted.

Planting resistant varieties is effective

NEARLY ALL COOL-SEASON GRASSES can be affected by *C. sativus* diseases to some extent, but some species, and varieties within a species, are more vulnerable than others. Many cultivars of Kentucky bluegrass and quite a few of the ryegrasses have been bred for and exhibit good to excellent resistance to *C. sativus* diseases. However turfgrass managers should double check with local experts when selecting *C. sativus* resistant species and varieties because this resistance can vary from one region to another.

Although the use of resistant varieties can greatly reduce the severity and frequency of *C. sativus* disease

Generally, as day-length shortens, symptoms on infected leaves become more severe with lesions enlarging and becoming joined by yellow streaks, or entire leaf blades becoming blighted.

infestations, under adverse weather conditions and when the turf is under stress from other problems *C. sativus* infestations can be very opportunistic. Under these conditions, especially when the turf is under stress from any of the root damaging diseases, *C. sativus* infestations can be very difficult to control.

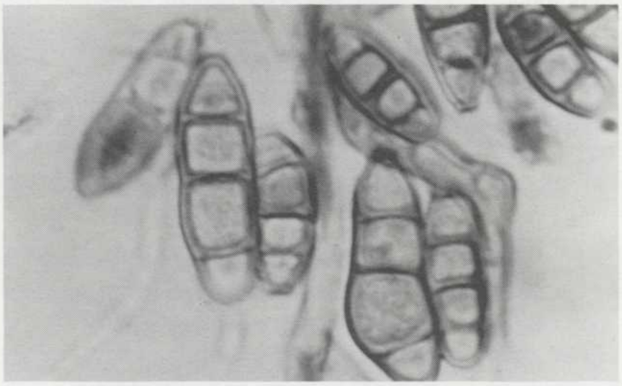
Recommended strategies for controlling *C. sativus* diseases

THE FOLLOWING ARE RECOMMENDED control strategies for Cochliobolus leaf spots and leaf blights:

1. USE DISEASE-RESISTANT VARIETIES adapted to your area.
2. AVOID THE EXCESSIVE USE OF QUICK-RELEASE nitrogenous fertilizers, particularly in the spring.
3. RAISE MOWING HEIGHTS to at least two inches and maintain the sharpness of mower blades.
4. WHERE POSSIBLE, REMOVE CLIPPINGS since these are a major source of inoculum.
5. REDUCE THATCH ACCUMULATION through periodic topdressing applications or by mechanical dethatching techniques.
6. AS A LAST RESORT, APPLY FUNGICIDES such as anilizine, chlorothalonil, iprodione, mancozeb, thiram, or vinclozolin. Check label instructions for rates and application frequencies.
7. AVOID THE USE OF STEROL-INHIBITING triazole fungicides, since these will predispose the plant to infection.

Curvularia Blights

MANY SPECIES OF CURVULARIA cause leaf spots and leaf blights on cool-season turfgrasses. The most common species are *C. geniculata, C. intermedia, C. inaequalis, C. lunata, C. protuberata,* and *C. trifolii*. All cause diseases on Kentucky bluegrasses, creeping red fescues, and creeping bentgrasses. *C. intermedia* is also pathogenic to perennial



Curvivaria spores. Curvularia species produce distinctive three and four-celled conidia, which can germinate rapidly on dead tissue. On mature turf, look for die-back and progressive yellowing from the tip of infected blades.

. . . tips appear to die back from the tip with a progressive yellowing down the leaf blade. The affected portions of the leaf blade shrivel and die, turning a brown to gray color.

ryegrasses. Symptoms from Curvularia infections range from seed rots and seedling blights to root and crown rots as well as extensive leaf blights on mature turfgrass stands. These pathogens closely resemble *C. sativus* in their host preference, disease habit, and microscopic appearance, but they are generally less damaging.

Curvularia biology and symptoms

ON MATURE TURFGRASSES, symptoms appear as a general decline of the turfgrass stand. Upon closer examination of grass blades, tips appear to die back from the tip with a progressive yellowing down the leaf blade. The affected portions of the leaf blade shrivel and die, turning a brown to gray color. Sometimes on Kentucky bluegrasses and creeping red fescues, a reddish-brown border delimits the diseased portion of the leaf blade from the healthy portion.

Curvularia species are most damaging at temperatures greater than 85°F (29°C), higher than the temperature optimum for Cochliobolus diseases. Also, Curvularia diseases generally require a host compromised from other stresses to cause significant levels of damage. Since Curvularia species are ubiquitous in turfgrass thatch, this is the main source of inoculum for foliar and crown infections. Many species may be carried with the seed.

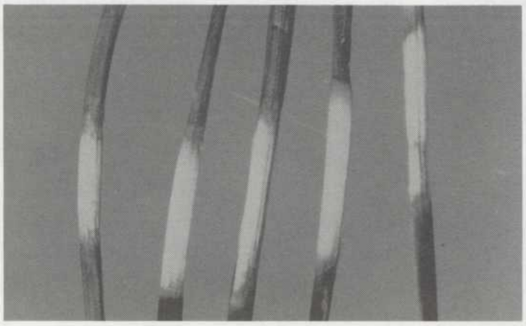
Curvularia species produce very characteristic three to four celled conidia that are curved with an enlarged cell in the middle. Both conidia and mycelium are dark brown in color and are easily recognized under the microscope. Conidia are produced in abundance on dead tissue and can quickly germinate to reinfect susceptible leaf and sheath tissues.

Conditions favoring Curvularia diseases include prolonged periods of leaf wetness and high air and soil temperatures; high relative humidities; excessively low mowing heights; excessive fertilization; excessive thatch accumulation; and the use of some herbicides and fungicides.

Control strategies are the same as *C. sativus* diseases

CONTROL STRATEGIES for Curvularia diseases are generally the same as for Cochliobolus diseases. Because this disease infects turfgrass stands under a narrow set of conditions, chemical control is often not necessary, particularly for the occasional infestation. If the site has shown a history of Curvularia disease problems, then the institution of the non-chemical control strategies should be sufficient. In the case of persistent infections of Curvularia, turfgrass managers should make a concerted effort to ensure that other stress factors, such as low-level, chronic Pythium or Necrotic Ring Spot infestations, are controlled.

Nigrospora Blight



Nigrospora lesions on Kentucky Bluegrass. The lesions produced by Nigrospora Blight on Kentucky Bluegrass can be distinguished from Dollar Spot by the absence of the hour-glass shape of the lesions produced by Dollar Spot. As the infection progresses, the color of infected leaves, which is tan in contrast to the off-white color of plants infected with Dollar Spot, provides another diagnostic clue.

NIGROSPORA BLIGHT, caused by *Nigrospora sphaerica*, is an uncommon disease in most parts of the country, but it can be found frequently in warmer locations along the eastern seaboard and the eastern sections of the Transition Zone. The disease is a problem on perennial ryegrasses and Kentucky bluegrasses often occurring on installed sod. It occurs during the hot humid months of midsummer, and is frequently mistaken for Dollar Spot or Pythium Blight.

Nigrospora biology and symptoms

IN THE INITIAL PHASE OF THE INFECTION, lesions form on leaf blades that appear very much like Dollar Spot lesions. The lesions appear near the middle of the leaf half way down from the tip. The lesion spreads across the blade width similar to Dollar Spot lesions, but it does not appear to have the pinched hour-glass shape so diagnostic for Dollar Spot. The upper and lower margins of the lesion may have a brown to dark purple border. As the infection progresses, the top portion above the lesion can take on a distinct dark purple color. This color will fade and the blighted leaf takes on a light tan color unlike blighted Dollar Spot leaves that have a decidedly off-white appearance.

As more leaves become infected small spots three to five inches in diameter appear. In the turf, these small spots are generally twice the size of initial Dollar Spot symptoms. The spots rapidly expand to 6–10 in., and may coalesce into large areas of blighted turf. In the most advanced stages of Nigrospora infections, the affected area appears as an uniformly blighted area of turf with sections where the blades have collapsed.

Under very warm, humid conditions, abundant white foliar mycelium may be visible on grass blades—where new infections can then occur wherever the mycelium contacts uninfected grass blades. Besides the conspicuous mycelium associated with blighted patches of turf, Nigrospora produces shiny black conidia that are observable under a microscope. The white mycelium can be incorrectly identified as Pythium infestations.

Periods of warm humid weather accompanied by nighttime temperatures between 70–75°F (21–24°C) and free water on the surface of the foliage may result in severe outbreaks of Nigrospora blight. This disease is also a particular problem on turf growing in very dry or infertile soils. Turfgrasses are generally not affected by *N. sphaerica*, if they are not weakened by other stresses. Increasingly, it is a problem on Bluegrass sod installed over poorly prepared subsoils.

Strategies for controlling Nigrospora Blight

The following are recommended control strategies for Nigrospora Blight:

1) MAINTAIN ADEQUATE AMOUNTS OF BALANCED fertilizers.
2) AVOID MOISTURE STRESS BY CONSIST IRRIGATING thoroughly and infrequently.
3) AVOID NIGHTTIME WATERING.
4) DO NOT MOW WHEN THE GRASS IS WET.
5) AVOID AS MUCH PHYSICAL OR CHEMICAL STRESS TO the turf as possible.
6) IDENTIFY AND CONTROL OTHER STRESS producing conditions that reduce the turf's general health.
7) THE USE OF FUNGICIDES designed to control other diseases such as Dollar Spot at labeled curative rates may reduce the severity of Nigrospora Blight *(Note: no fungicides are specifically labelled for Nigrospora Blight.)*

Pythium Blight

PYTHIUM BLIGHT, also known as spot blight, grease spot, cottony blight, and foliar Pythium, is caused by several different species of Pythium. At least six species have been

Pythium turf damage. At least six different Pythiums may be the culprit behind this kind of extensive damage. Like other leaf blights, warm and wet conditions that produce prolonged leaf wetness provide ideal conditions for Pythium outbreaks. This photograph shows typical damage spread by the movement of water.

There is a difference

Nigrospora on turf. Often mistaken for Dollar Spot and Pythium Blight, Nigrospora Blight is a less common disease. It is, however, becoming more of a problem in the warmer parts of the East Coast—especially on bluegrass sod installed over poorly prepared subsoils.

Pythium mycelium on turf. At first glance, the mycelium of Pythiums and Nigrospora look similiar; however, a closer look reveals that the *Pythium is growing from the bottom up,* while the Nigrospora grows from the top down. Also, by the time the mycelium is present, damage from Pythiums can be much more massive than damage from Nigrospora.

implicated in this disease. They include *P. aphanidermatum, P. graminicola, P. torulosum, P. vanterpoolii, P. arrhenomanes*, and *P. ultimum*. Under high temperatures of late summer, *P. aphanidermatum*—and possibly *P. arrhenomanes* and *P. graminicola*—are the predominant causes of Pythium Blight. The other species, except for *P. myriotylum*, are involved in a cool season Pythium Blight that occurs in some locations.

Pythium species symptoms

ALL OF THESE PYTHIUMS can cause nearly identical symptoms on infected turfgrasses, and the exact identity of the causal agent can only be determined by microscopic examination of infected tissues. Currently, all cool-season turfgrasses are susceptible to infection by Pythium species.

On close-cut turf, symptoms first appear as small circular to irregularly-shaped patches of water-soaked, dark-colored plants. Individual leaf blades generally become slimy in appearance. Patches may range from less than one inch to greater than five inches in diameter. Under high temperatures and abundant moisture, these patches quickly fade to a light brown or reddish brown, as the leaves wilt and die. Because of the tremendously disruptive manner that Pythiums attack turf, these small patches can rapidly coalesce to form large areas of dead or dying turf. In the early morning hours, when temperatures are warm and relative humidities are high, abundant mycelium can be found associated with the patches. During intense Pythium Blight epidemics, root and crown infections can also occur, resulting in the rapid destruction of a turfgrass stand.

Temperature and moisture are critical in Pythium infections

AIR AND SOIL TEMPERATURES and moisture levels are the primary deciding factors of the severity of Pythium blight epidemics. Most severe Pythium blight outbreaks are associated with hot, rainy weather and high nighttime temperatures that ensure prolonged leaf wetness periods.

Generally, the appearance of Pythium Blight follows a period of hot days, and is preceded by a period of wet, warm and humid nights. Specifically, studies have shown that Pythium Blight outbreaks may be predicted by monitoring selected temperature and relative humidity levels. These include a maximum daily temperature of greater than 86°F (30°C) followed by a 14-hour period where the relative humidity exceeds 90% and the temperature does not fall below 70°F (21°C). This set of conditions is often met when a hot day, or days, is followed by a prolonged nighttime rainfall.

Aside from temperature and moisture effects on Pythium Blight incidence, other stress factors, such as unbalanced fertility, may also affect disease severity. Generally, excessive quick release nitrogen fertilization will markedly increase the severity of Pythium Blight. Calcium deficiencies may also increase the susceptibility of turfgrasses to Pythium Blight damage. Both conditions can have detrimental effects on turf root growth or regeneration.

Pythium species biology

PYTHIUMS SURVIVE PRIMARILY as perennial infections in turfgrass roots, but they also survive in thatch layers. Pythiums produce abundant oospores in infected tissues that allow it to survive in turfgrass roots and thatch. A unique characteristic of Pythium species is that they produce spores that can swim in free water. These swimming spores are released from sporangia produced in the leaf crown and root tissues. The presence of these swimming spores, coupled with the abundance of foliar mycelium typically associated with diseased patches, ensures easy spread of this disease from one location to another. As a result, Pythium Blight has the distinction of being perhaps the fastest developing, and the most devastating, of all fungal diseases of turfgrasses.

Control strategies for Pythium infections

AS WITH RHIZOCTONIA DISEASES OF TURFGRASSES, water management is one of the keys to effective control of Pythium Blight. This should be accompanied by practices that minimize plant stress, such as reducing thatch, improving surface drainage with wetting agents, the use of sand-based

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How to improve short-term drought stress tolerance

by Christopher Sann

AS MANAGEMENT of our nation's water resources becomes an increasing priority, turfgrass managers will need to pay more attention to strategies and materials designed to improve the ability of turf to survive short-term drought stress. By improving the turf's ability to survive short periods of drought, lasting up to six weeks, turfgrass managers can reduce their reliance on supplemental or increased irrigation. Increasing a turf's ability to survive and reducing the reliance on supplemental irrigation can also help reduce the number and frequency of root and leaf damaging diseases.

As turf grass management practices have become more sophisticated, a group of management strategies and specific applied materials has been identified as helping to maintain or improve root mass and, thereby, improving drought stress survivability. These various approaches can be classified into two groups: those that improve the soil and root environment—to allow the turf to respond to the more favorable growing conditions—and those materials that either reduce the turf's need for water or stimulate root growth.

Management strategies that have shown to improve drought stress tolerance by improving the soil environment are

- CORRECTING SOIL NUTRIENT IMBALANCES,
- INCRASING SOIL AVAILABLE CALCIUM LEVELS,
- REDUCING EXISTING COMPACTION,
- REDUCING THATCH LEVELS,
- AVOIDING COMPACTION DEVELOPMENT,
- AND IMPROVING SOIL STRUCTURE.

Materials that have shown an ability to improve drought tolerance by reducing the turfs' water needs are

- SOIL WETTING AGENTS,
- FUNGICIDES THAT REDUCE root damaging diseases,
- INSECTICIDES THAT CONTROL root damaging insects,
- SUPPLEMENTAL IRON APPLICATIONS,
- SUPPLEMENTAL PHOSPHORUS APPLICATIONS,
- AND HIGH POTASSIUM FERTILIZATION.

Materials that stimulate root growth include products such as Roots® and Roots with Iron® and fungicides such as Bayleton® and Banner®.

How to get started?

THE FIRST STEP to solving a turf stand's drought stress problem is to identify the condition or conditions that are contributing to the turf's inability to tolerate short periods of drought *(see page 9 for Drought Stress Identification Form)*. The reason or reasons that a particular stand of turf is having problems will vary from one site to another and may vary within a specific site *(see table on this page)*.

Contributing conditions affect the root mass in different ways

ROOT DAMAGING DISEASES AND INSECTS can cause a massive loss in the number of roots and root hairs. When the total root biomass falls below a critical level and the turf is drought stressed, the root structure is no longer able

CONDITIONS THAT CAN CONTRIBUTE TO SHORT-TERM DROUGHT STRESS

The following is a partial list of conditions that—in combination with reduced rainfall, excessive heat or both—can contribute to short-term drought stress.

- **Root damaging diseases**
- **Root damaging insects**
- **Soil layering**
- **Thatch depth greater than 1/2 inch**
- **Soil compaction**
- **Poor soil construction**
- **Nutrient imbalances in soil chemistry**
- **Poor soil particle structure**
- **Shallow topsoil mass**
- **Poor water percolation**
- **Poor species or variety choices**
- **Light frequent irrigation**

All these conditions have a detrimental effect on a turf stand's root biomass.

to provide sufficient water to the crown and foliar sections of the plant, causing it to wilt and, if prolonged, to die.

Poor soil chemistry—with its nutrient imbalances and restricted nutrient availability—causes poor general plant health. At this reduced level of health, the turf does not "repair" itself well. When up to 80% of the root biomass of turf is replaced each year, this inability to replace all of the previous year's lost root structure leaves the turf vulnerable to short-term drought stress. Poor soil chemistry, if allowed to continue, will not only adversely affect the turf, but will lead to a deterioration of the soil structure. As the highly soluble available calcium levels drop, the soil particle flocculation and granulation, that occurs under high calcium and humic acid levels, deteriorates, causing the soil pore spaces to fill with smaller soil particles—severely restricting the growth of turf roots. Under severe conditions a layer of these finer particles, called a pan, can form, causing an impenetrable subsoil layer—with all of the accompanying water percolation and root damaging disease problems.

Poor soil construction, either native soils that are simple aggregates with no soil particle flocculation, poor soil pore structure and reduced nutrient holding capacity or poor site preparation, caused by using large soil compacting earth-moving machinery, can produce a hostile growing medium leading to poor plant health and drought stress vulnerability.

Soil layering, either naturally occurring, as a developed pan, or man-made, if it occurs in the top 3–4 in., is frequently a problem for which there are no good answers. Layering in the root zone—with its dramatically restricted root biomass—often makes the turf highly vulnerable to short-term drought stress.

Soil compaction—caused by either excessive traffic or the chemical formation of a pan—is known for the detrimental effects that the reduced pore spaces have on the growth of a root structure. Mechanical cultivation, where appropriate—in combination with gypsum and wetting agent applications—can help reduce the drought stress vulnerability.

Poor species choices, such as the use of fine fescues in normally wet areas, can leave the turf highly vulnerable to both short-term and long-term drought stress. Frequent or daily waterings can lead to chronic low level root-damaging disease infestations that are not severe enough to be symptomatic, but can dramatically reduce the root biomass, making the turf drought stress vulnerable.

Is the condition correctable?

ONCE THE TURF GRASS MANAGER has identified the contributing conditions, it is important to decide if the conditions are correctable and, if so, how is that accomplished?

There are some circumstances that, for all practical purposes, are not correctable. It may be possible to reduce some adverse effects of these conditions, but often the only solution to these problems is to adjust the irrigation patterns, where supplemental irrigation is available—or to periodically reseed, with the most drought resistant species available, where supplemental irrigation is not practical.

Soil layering, with underlying impermeable layers of clay or stone and a shallow soil mass, are prime examples of conditions that are difficult to correct.

Soil layering, with underlying impermeable layers of clay or stone and a shallow soil mass is a prime example of a condition that is difficult to correct. In the case of deeper impermeable layering (4–6 in. down), wetting agents and root protecting fungicide applications supplemented with periodic applications of root growth stimulating compounds may help limit drought stress damage, but often reconstruction of the site is the only proper solution. In the case of shallow impermeable layering (down to 4 in.) and shallow soil mass (less than two inches) these techniques will only help for short periods and reconstruction is the best solution.

Other conditions that may be difficult to correct or require a long-term management strategy are poor soil construction, with its reduced soil pore spaces, poor soil particle distribution, such as that which occurs in high sand soils or in the case of a developing pan, and poor soil moisture percolation, which occurs in areas with poor or restricted subsoil water flow patterns. In these cases, identifying the problems for each site and the severity of its effects on the turfgrass stand should provide the clues to whether the problem can be managed, corrected or ignored.

Correctable or partially correctable conditions include inappropriate species, frequent watering, high thatch levels, poor soil chemistry, poor soil construction, soil compaction, poor water percolation and root damaging diseases and insects.

Root damaging disease

ROOT-DAMAGING DISEASES CAN BE DIFFICULT to deal with, particularly because it is not uncommon to have one or more active diseases present—often with no gross visible symptoms. The occurrence of a transient root-damaging disease infestation, the severity of that infestation and its duration can be difficult to predict, because it often depends on adverse weather conditions. Transient infestations may only become a drought problem if they occur on turf that is already under stress from other sources. All of the root damaging diseases that affect cool season turf are candidates for this type of transient infestation, and the decision whether to control the infestation should be made after checking the weather forecast and deciding how much damage is acceptable at that site.

Chronic root-damaging disease infestations are often the byproduct of other long-term drought stress conditions such as layering, poor soil pore space structure, poor soil percola-

– continued on page 10

DROUGHT STRESS IDENTIFICATION

____

COMPANY NAME

NAME OF SITE ______________________________ APPROXIMATE AREA: ________ ft. x ________ ft.

SURVEYED BY ______________________________ DATE OF SURVEY ________ / ________ / ________

CONTRIBUTING CONDITIONS	Problem	Primary condition	Secondary condition	Recommended action(s)
SOIL	**Thatch** *Use soil probe to examine sample*	❑ Decomposed	❑ **All depths**	❑ Core/aerate, add wetting agent
		❑ Undecomposed	❑ **< 1/2 in. deep**	
			❑ With root invasion	❑ Verticut & add wetting agent
			❑ Poor roots	❑ Verticut & add wetting agent
			❑ Without root invasion	❑ Dethatch (multiple passes)
			❑ Good roots	❑ Dethatch (multiple passes)
			❑ **> 1/2 in. deep**	
			❑ With root invasion	❑ Verticut, core/aerate & add wetting agent
			❑ Poor roots	❑ Verticut, core/aerate & add wetting agent
			❑ Without root invasion	❑ Dethatch (multiple passes for multiple years)
			❑ Good roots	❑ Dethatch (multiple passes for multiple years)
	Soil Layering	❑ <4 in. deep	❑ Impenetrable	❑ Overseed & watering
			❑ Penetrable	❑ Deep core & heavy wetting agent application(s)
		❑ >4 in. deep	❑ Impenetrable	❑ Overseed & water, add root-protecting fungicide(s)
			❑ Penetrable	❑ Deep shatter aerations & heavy wetting agent application(s)
	Soil Compaction	❑ <3 in. deep	❑ Light to medium	❑ Check soil chemistry, add wetting agent(s)
			❑ Medium to heavy	❑ Coring, check soil chemistry, add wetting agent(s)
		❑ >3 in. deep	❑ < 6 in. deep	❑ Re-direct traffic, add wetting agents(s)
	Shallow Top Soil Mass	❑ < 2 in. deep		❑ Add 2-4 in. topsoil, overseed, water
		❑ > 2 in. deep	❑ < 4 in. deep	❑ Same as above & add root-stimulating compounds
	Poor Soil Construction	❑ < 3 in. deep		❑ Add soil and humus, then till to > 6 in. deep
		❑ > 3 in deep	❑ < 6 in. deep	❑ Add wetting agent(s) & do deep shatter aeration
	Poor Particle Construction or Distribution	❑ < 3 in. deep		❑ Check soil chemistry, raise calcium levels, core & add wetting agent(s)
		❑ > 3 in deep	❑ < 6 in. deep	❑ Same as above
EXTERNAL	**Root damaging Diseases**	❑ **Pythium**	❑ **Warm season**	❑ Apply fungicide(s) for prevention
			❑ Leaf & crown damage	❑ Apply fungicide(s) for prevention
			❑ **Cool season**	❑ Apply fungicide(s) & root stimulating compounds
			❑ Root rot	❑ Root rot apply fungicide(s) & root stimulating compounds
		❑ **Necrotic Ring Spot**	❑ Chronic	❑ Add wetting agent(s), fungicide(s) for prevention & root stimulating compounds
			❑ Acute	❑ Apply fungicide(s) at recommended cure rate & root stimulating compounds
		❑ **Summer Patch** ❑ **Take All Patch**	❑ Chronic	❑ Apply fungicide(s) for prevention, add wetting agent(s) & root stimulating compounds
		❑ **Other Root/ Crown Rots**	❑ Acute	❑ Apply fungicide(s) at recommended cure rate & add root stimulating compounds
	Root Damaging Insects	❑ Grubs	❑ Occasional	❑ Monitor & treat as needed
			❑ Acute	❑ Apply appropriate insecticide at recommended rate
CULTURAL	**Wrong species**	❑ Fine Fescue	❑ Site changed from shady to sunny	❑ Renovate area
			❑ Site changed from dry to wet	❑ Overseed with bluegrass or tall fescue
		❑ Blugrasses	❑ Site changed from normal to dry	❑ Overseed with tall fescue
	Watering	❑ Light, frequent irrigations		❑ Increase amount of water per irrigation
				❑ Decrease frequency of irrgations

tion or any other condition that increases the time water spends in the root zone of the turf. This type of infestation can be very detrimental to the long-term health of a turf stand as well as causing short-term drought stress vulnerability, because, as new root tissue is formed, it is damaged or destroyed by the chronic infestation. Both Necrotic Ring Spot and the Pythium species, as cool season root rot or warm season blights, have been identified as causing chronic infestations. Control of chronic infestations requires that the other contributing factors be controlled, as well as a disease management strategy that coordinates long-term preventive fungicide applications with the use of wetting agents and root growth stimulating compounds.

Root damaging insects can do considerably more damage to root biomasses in short periods of time than root damaging diseases. However, depending on the species of insect, their infestations are relatively easy to predict and, therefore, easy to prevent—with timely applications of the proper insecticide. If insect infestations have not historically posed a consistent problem, then close monitoring of populations may be all that is necessary.

High thatch levels pose multiple problems. The thatch layer is an ideal breeding area for diseases and insects, and it frequently becomes invaded with turfgrass roots. This root invasion can become a serious problem if the underlying soils are dense or have poor structure. When the largest portion of the root biomass is in the thatch layer, the turf is highly susceptible to short-term drought stress.

Correcting a root-invaded thatch problem can be difficult. First, there is the expense and time to dethatch the site. Often dethatching must be spread out over several seasons to obtain the best results. Then there is the problem of identifying the cause or causes leading to the high thatch levels.

The classic definition of a thatch accumulation—developing where excess material is not being decomposed by the available soil bacteria at a fast enough rate—begs the issue. The most appropriate question is "Why was the excess material being deposited, in the first place?" Most often the answer to that question is low level or chronic disease infestations combined with the over-use of quick release nitrogen sources.

Poor soil chemistry, poor soil particle construction and to some extent soil layering, where a pan is involved, can be corrected by an aggressive soil testing and amendment application program. Establishing and keeping a good balance of available calcium and magnesium is beneficial not only to general plant health, but also to good soil particle structure by maintaining good soil particle flocculation and granulation. Also it will benefit good soil particle distribution by preventing the deposition of smaller soil particles in established soil pore spaces and the eventual formulation of layering as a pan.

Poor water percolation through deep impermeable subsoil layers or because of poor subsoil water flow patterns can be very difficult to correct.

Keeping a high level of available calcium in relation to a lower level of exchangeable magnesium will help to keep all of the variously sized positively charged soil particles in suspension and avoid the settling-out process that loss of calcium produces. This is a particular problem with sandier soils, and should be monitored with yearly soil tests and amendment applications.

Soil compaction is the mechanical compression of the soil mass solids, which reduces the pore spaces from their nominal 25% of the soil mass down to five to 10%. This reduction in pore spaces causes a dramatic reduction in the normal growth of root structure. The best solution to soil compaction is to avoid the excessive traffic that causes the problem. The use of mechanical cultivation with core and shatter aeration, in combination with applications of wetting agents and root stimulating compounds, can reduce the effects of the compaction. Also, periodic applications of gypsum—a pH neutral source of available calcium—should be made.

Poor water percolation through deep impermeable subsoil layers or because of poor subsoil water flow patterns can be very difficult to correct. The high and prolonged root zone moisture levels that result from this problem will often cause root loss, because of suffocation from lack of oxygen or by prolonged contact with toxic waste byproducts that are flushed from the root zone with normal percolation. These effects can be reduced by the heavy and consistent use of soil wetting agents and/or, where practical, by the use of the new deep penetrating coring or shatter aeration.

Poor species or varietal selections can be identified and corrected by renovation, overseeding or management practices that favor other species in the turf stand. Light frequent watering practices often instituted to avoid short-term drought stress can often become a problem themselves by keeping the root zone soil moisture levels to high. This practice can be changed to deeper less frequent practices as the other contributing problems are corrected.

Controlling the conditions that cause short-term drought stress should be common goal

THE SUCCESS THAT EACH TURFGRASS MANAGER has in identifying and controlling short-term drought stress vulnerability will vary from site to site and condition to condition. And the amount of reduced supplemental irrigation will often depend on the cooperation of the weather, but any management strategy should be persued that can ultimately reduce the amount of time, money, and resources. ■

Leaf Blights continued from page 6

topdressing materials and improving air flow where possible, while maintaining balanced fertility. However, because of the explosive nature of this disease, fungicides are usually relied upon for effective disease management.

Fungicides are important for Pythium management

MANY FUNGICIDES ARE AVAILABLE for the control of Pythium Blight. Nearly all of these fungicides, however, are only effective against Pythium species diseases. Therefore, an accurate diagnosis is essential for effective control. Contact fungicides available for Pythium Blight control include chloroneb (various trade names), ethazole (Koban®, Terrazole®), and mancozeb (various trade names). Systemic fungicides labeled for Pythium species control include metalaxyl (Subdue®), propamocarb (Banol®), and fosetyl Al (Aliette®).

Generally, these fungicides are effective in suppressing Pythium Blight, but the level of control and the duration of that control will vary. Also, the duration of control by a particular product will vary considerably, depending on the conditions at each site. When using a long-term fungicide preventive program, their applications should always be rotated among the various available materials to avoid the development of a fungicide-resistant population of Pythium. ■

LETTERS TO THE EDITOR

Readers who wish to comment on any aspect of the articles, news items, or commentaries published in *Turf Grass Trends,* or on any issues or concerns raised by them, should do so by writing to:

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Have a question on any aspect of turf management? Send it to: Ask the Expert, Turf Grass Trends, 2070 Naamans Rd., Suite 110, Wilmington DE 19810-2644 or fax it to (302) 475-8450. If we can't answer your question, we will put it to the best available expert on the subject.

REGULATORY WATCH

Oregon fines Great Western for mislabeling seeds

THE OREGON DEPT. OF AGRICULTURE and Oregon State University have jointly brought the Great Western Seed Co. to task for mislabeling grass seed bags. The company was fined $81,000 for substituting uncertified seed for certified seed—the largest civil penalty to date for a case of its kind in Oregon. The company also was placed on one-year probation and its "approved certified warehouse" status was revoked for two years.

The case grew out of a customer complaint to the university, which handles the certification process. The company has issued a press release saying that it corrected the problems in question before the state investigation.

E.P.A. files suit against Miles

THE E.P.A. HAS FILED A CIVIL COMPLAINT AGAINST MILES, INC. for the alleged late reporting of tests that indicated that two of thier prominant pesticides might be potential human carcinogens.

In their complaint, the E.P.A. alleges that on two separate occasions Miles (formally named Mobay) failed to notify the agency, in a timely manner, when it became aware of test results that indicated that two of their products—Bayleton and Dylox—induced tumors in laboratory mice.

A section of FIFRA, the enabling legislation, requires that, if a company receives new contrary information about a product that is already registered, the company must submit the new data to the E.P.A. within 30 days. In the case of Bayleton (Triadimefon,) the E.P.A. claims that Miles failed to notify the E.P.A. for 27 months, and 10 months in the case of Dylox.

Notification act redrafted

THE NOTIFICATION CONTROL AND APPLICATION ACT OF 1991 will not be brought to the floor of Congress until next session. The redrafted U.S. Senate bill S.849 is designed to establish local registries for pesticide sensitive people and posting requirements that include homeowner-applied pesticides

The bill, that requires the states to establish registries for people who want advance notice of a neighbor's pesticide applications, would require 72 hours written notice to people on the registry. Also, the bill will expand posting requirements to include homeowners—with explanation of the posting requirements to be printed on the packaging. The posting would be required just prior to the application of the pesticide.

E.P.A. will investigate granular pesticides danger to birds

THE E.P.A. HAS SELECTED 14 OF THE 99 GRANULAR PESTICIDES, which it sees as posing the highest risk to bird populations. The 14 compounds will be tested in both corn fields and turf. They include aldicarb, bendiocarb, carbofuran, chlorpyritos,diazinon, disulfoton, ethoprop, ethyl parathion, fenamiphos, fonofos, isofensphos, methomyl, phorate and terbufos.

E.P.A. & Texas college offer hotline

THE FEDERAL ENVIRONMENTAL PROTECTION AGENCY and Texas Tech University in Lubbock, Texas, have been cooperating in offering a 24-hour, 365 day-a-year, toll-free pesticide information hotline. Last year the hotine served 40,000–50,000 callers. The majority of the calls concerned pesticide safety. Callers also can get quick answers on detecting pesticide poisionings, spill clean-up and disposal information, and what to do in the case of a pesticide poisioning. The Hotline number is **1-800-858-PEST(7378).** ■

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