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Gray Leaf Spot of Perennial Ryegrass Turf: An Emerging Problem for the Turfgrass Industry

Research is unraveling the mysteries of this serious disease of ryegrass fairways and roughs.

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Perennial ryegrass (*Lolium perenne* L.) is a cool-season grass originating from open areas and forest fringes of southern Europe and western Asia. It is widely used in the turf industry, especially on golf course fairways, due to its agronomic attributes such as turf color, upright and bunch growth habit, rapid germination and coverage, tolerance to close mowing and soil compaction, and absence of thatch. Additionally, tolerance to cold weather has led to the use of perennial ryegrass for overseeding dormant bermudagrass golf tees and fairways during the fall in the southern United States.

Gray leaf spot, or blast, caused by the fungal pathogen *Magnaporthe grisea* (Hebert) or *Pyricularia grisea* (Cooke) Sacc, is a newly emerging disease of perennial ryegrass in several regions of the United States. The name of the fungal pathogen changes depending on the stage of the disease life cycle.

In recent years, severe outbreaks of gray leaf spot resulted in extensive damage to perennial ryegrass golf course fairways and athletic fields, particularly in the midwestern and northeastern United States. Under favorable condi-

Gray leaf spot disease causes turfgrass stands to develop an off-color, wilted appearance followed by the development of pocketed areas or irregularly-shaped patches. Inset: Photomicrograph of conidia that cause gray leaf spot disease.

tions, the disease develops rapidly, and entire ryegrass swards can be killed within a few days, leaving only annual bluegrass and other grassy weeds that are not affected by the disease.

Turfgrass managers are now considering replacing perennial ryegrass with other turfgrass species such as creeping bentgrass and Kentucky bluegrass due to the extensive and unpredictable damage caused by gray leaf spot. However, replacement of perennial ryegrass with these turfgrass species does not provide the best solution because of the excellent agronomic characteristics of perennial ryegrass in contrast to the rapid thatch buildup and patch disease problems in other turfgrass species.

HOSTS

Magnaporthe grisea is pathogenic to more than 50 grass hosts, including small grains, forage, and turfgrasses.[1,2,5] The fungus is probably best known for the devastating losses it can cause on rice (*Oryza sativa* L.). It may infect at any growth stage of the rice plant, causing rapid blighting that is referred to as blast.

Gray leaf spot is a common foliar disease of St. Augustinegrass in the southeastern United States[4,10]; however, it does not cause damage to the extent reported in perennial ryegrass. In 1991, Landschoot and Hoyland[3] reported gray leaf spot on perennial ryegrass turf in Pennsylvania golf course fairways. The epidemic was confined to the southeastern region of Pennsylvania, where extensive damage was reported. Since this first report, outbreaks of gray leaf spot have occurred sporadically, resulting in serious loss of turf in 1995, 1998, and 2000 in the Mid-Atlantic region. The disease has recently been reported in the Midwest, New England, and the western United States.

SYMPTOMS

Gray leaf spot develops on perennial ryegrass leaf blades as small, water-soaked lesions that subsequently turn into dark-colored, 1-3mm-diameter necrotic spots. The spots expand rapidly and become gray, grayish-brown, or light brown, circular to oblong lesions with purple to dark brown borders that often are surrounded by a yellow halo. The necrotic lesions coalesce, become irregular in shape and cause partial blighting (tip blighting) or complete blighting of the leaves. Blighted leaf blades also may exhibit twisting or

Initial signs of gray leaf spot on perennial ryegrass leaf blades are the appearance of small, water-soaked lesions that subsequently turn into dark-colored necrotic spots.

flagging. Complete leaf necrosis results in the death of the entire plant. There is no evidence of infection of crown tissue by the pathogen. Blighted leaf blades may appear grayish-white to tan and have a dusty or velvety texture when conidia are produced profusely. Aerial mycelium is usually not evident on necrotic leaves under humid conditions.

Diseased turfgrass stands develop an off-color, diffuse blighted or wilted appearance followed by the development of sunken or pocketed areas or irregularly shaped large patches. In a severe case, the entire ryegrass stand may be killed, leaving annual bluegrass and other grassy weeds in the fairways. The disease may be distributed along low-lying or drainage areas where high relative humidity and prolonged leaf wetness periods occur in the turf canopy.

DISEASE DEVELOPMENT

Magnaporthe grisea overwinters as dormant mycelium in dead leaves. Conidia produced from the leaf debris apparently serve as the primary inoculum for leaf infections early in the growing season, although details of this early infection process need to be determined.

It also is possible that at least some infection foci are established via long-distance dispersal of conidia. Based on field observations, we hypothesize that gray leaf spot develops at visually undetectable levels in early to mid-summer. Conidia produced on infected leaves during this period eventually trigger a series of secondary infections that contribute to the buildup of inoculum during the late summer periods.

Gray leaf spot is often observed first in turf in golf course rough maintained at higher mowing heights. These areas may be partially shaded and have extended leaf wetness periods and high humidity that are more conducive for infection. The disease may be detected in roughs several days before extensive damage of turf in fairways becomes evident.

Dispersal of inoculum is by wind, wind-blown rain, water-splash from sprinkler irrigation, movement by ground maintenance equipment, and other golfing activities. Dispersal of conidia by mowers, spray rigs, spreaders, core aerifiers, and golf carts is important in the spread of the disease in golf courses.

Gray leaf spot normally develops from early August to mid-October. Environmental conditions prevailing during this late summer period and availability of inoculum are major determinants in the development of gray leaf spot epidemics. Efforts to quantitatively describe the relationships between environmental factors and gray leaf spot showed that temperatures between 79°F and 84°F (26°C and 29°C) were optimal for disease development.

Leaf wetness duration also is important in disease development. Uddin et al.[6] reported that the disease incidence and severity increased with increased leaf wetness duration at all temperatures. Shorter leaf wetness duration was required for disease development under warmer temperatures.

In addition to leaf wetness duration, relative humidity influences gray leaf spot development. Although expansion of necrotic lesions is rapid under prolonged leaf wetness periods, conidia are not produced when excessive free moisture is present on the left tissue. Removal of free moisture from the infected leaf blades under high humidity is necessary for production of conidia. Therefore, warm day and night temperatures, subsequent wetting and drying of leaf blades, and high humidity regimes are major factors in the development of gray leaf spot epidemics and perpetuation of the disease.

DISEASE MANAGEMENT STRATEGIES

Cultural management practices often do not provide adequate control of gray leaf spot due to rapid development of the disease and high susceptibility of currently available cultivars. An integrated approach that entails various cultural management practices and a sound fungicide program provides effective control.

FUNGICIDAL CONTROL

Among currently labeled fungicides, the most effective materials for gray leaf spot control are azoxystrobin, trifloxystrobin, and thiophanate methyl. Azoxystrobin is labeled for gray leaf spot as Heritage 50WG at the rates of 0.2-0.4 oz. per 1,000 sq. ft. (0.61-1.22 kg. of formulated product per ha.) at 14- to 28-day intervals. While the 0.2 oz. per 1,000 sq. ft. (0.61 kg. per ha.) rate of Heritage 50WG has proven very effective in some tests, biweekly applications of the 0.2 oz. per 1,000 sq. ft. (0.61 kg. per ha.) rate sometimes have resulted in small, but significant, amounts of foliar blighting.

In contrast, application of Heritage 50WG at the 0.4 oz. per 1,000 sq. ft. (1.22 kg. per ha.) rate typically has provided excellent disease control for at least three weeks under high disease. The performance of trifloxystrobin (Compass 50WG) in field tests typically has been very satisfactory. In some studies, there was no statistical difference between Compass used at labeled rates at two-week intervals and the top-performing treatment in the test. However, in several tests, use of the compound according to label directions provided slightly lower disease control than the top treatment in the test. The product has not always provided acceptable disease control when used at labeled intervals exceeding two weeks, even at the highest labeled rate.


One unique characteristic of gray leaf spot is a distinct twisting of the leaf tip, often resembling a fishhook shape.

Thiophanate methyl (Clearys 3336 50WP) and similar products typically have provided excellent control under high disease pressure when used at a minimum of 3 oz. active ingredient per 1,000 sq. ft. (9.15 kg. per ha.) at 14-day intervals. Rates as low as 2 oz. per 1,000 sq. ft. (6.1 kg. per ha.) have been effective under low to moderate disease pressure. In one test, thiophanate methyl applied biweekly at 3 oz. per 1,000 sq. ft. (9.15 kg. per ha.) provided excellent control for most of the season, but diminished somewhat at the end of the epidemic, suggesting that under the highest disease pressure, the 4 oz. per 1,000 sq. ft. (12.2 kg. per ha.) rate may be necessary.

Formulations of two demethylation inhibitor (DMI) fungicides, propiconazole and triadimefon, are labeled for gray leaf spot. These DMI fungicides, when used alone following label directions, have usually provided poor control under high disease pressure. Chlorothalonil and mancozeb, both contact fungicides that act as non-specific enzyme inhibitors, are also labeled for this disease. Although some studies have shown good results with these materials, chlorothalonil and mancozeb have not consistently provided acceptable control under high disease pressure. Tank-mixes of a DMI fungicide and chlorothalonil at labeled rates can often provide excellent control, but control is sometimes not complete under high disease pressure.

Some turf managers will initiate a spray program a week or two before the time of year when epidemics historically have begun in the area; others will begin spraying when the disease is first reported in the region. Both approaches carry risks. The frequency and longevity of a spray program often depend on a combination of the past history of the disease at the site and in the region, and the weather conditions favorable to disease development.

In the Midwest and Northeast, the window where fungicide protection is needed is usually from early August to early September and often beyond. In seasons with low disease pressure, no fungicide protection may be needed beyond early September, whereas under high disease pressure, fungicides are needed into October.

TURFGRASS HEIGHT AND GRASS CLIPPING MANAGEMENT

Results from experiments on the effects of mowing height on gray leaf spot severity have been contradictory. A study conducted in the northeastern region of the U.S. indicated gray leaf spot was more severe at a mowing height of 3.5 inches (8.9 cm.) compared to 0.5 inch (1.27 cm.)[9]. In Kentucky, Williams et al.[11] found no differences in disease severity on perennial ryegrass mowed at 0.75 inch (1.9 cm.) and 2.5 inches (6.4 cm.). This discrepancy may have been due to various cultural and environmental factors influencing disease development.

Turf managers in the northeastern and mid-Atlantic states are generally advised to avoid raising mowing heights, particularly during the periods of gray leaf spot epidemics. Grass clipping management is important, as the removal of clippings can reduce disease incidence substantially under low disease intensity; however, under high disease intensity the effect of clipping removal is not significant. Although clipping removal effectively reduces disease intensity under low to moderate disease intensity, collecting the clippings from large fairways and disposing of them is impractical in the operation of most golf courses.

FERTILITY

Increasing the amount of nitrogen increases gray leaf spot severity. The source of nitrogen also influences gray leaf spot development. A recent study has shown that gray leaf spot severity was lower when controlled-release forms of nitrogen such as isobutylidene diurea (IBDU) and sewage sludge-based Milorganite were applied compared to quick-release forms such as ammonium nitrate and urea.[8]

HERBICIDES

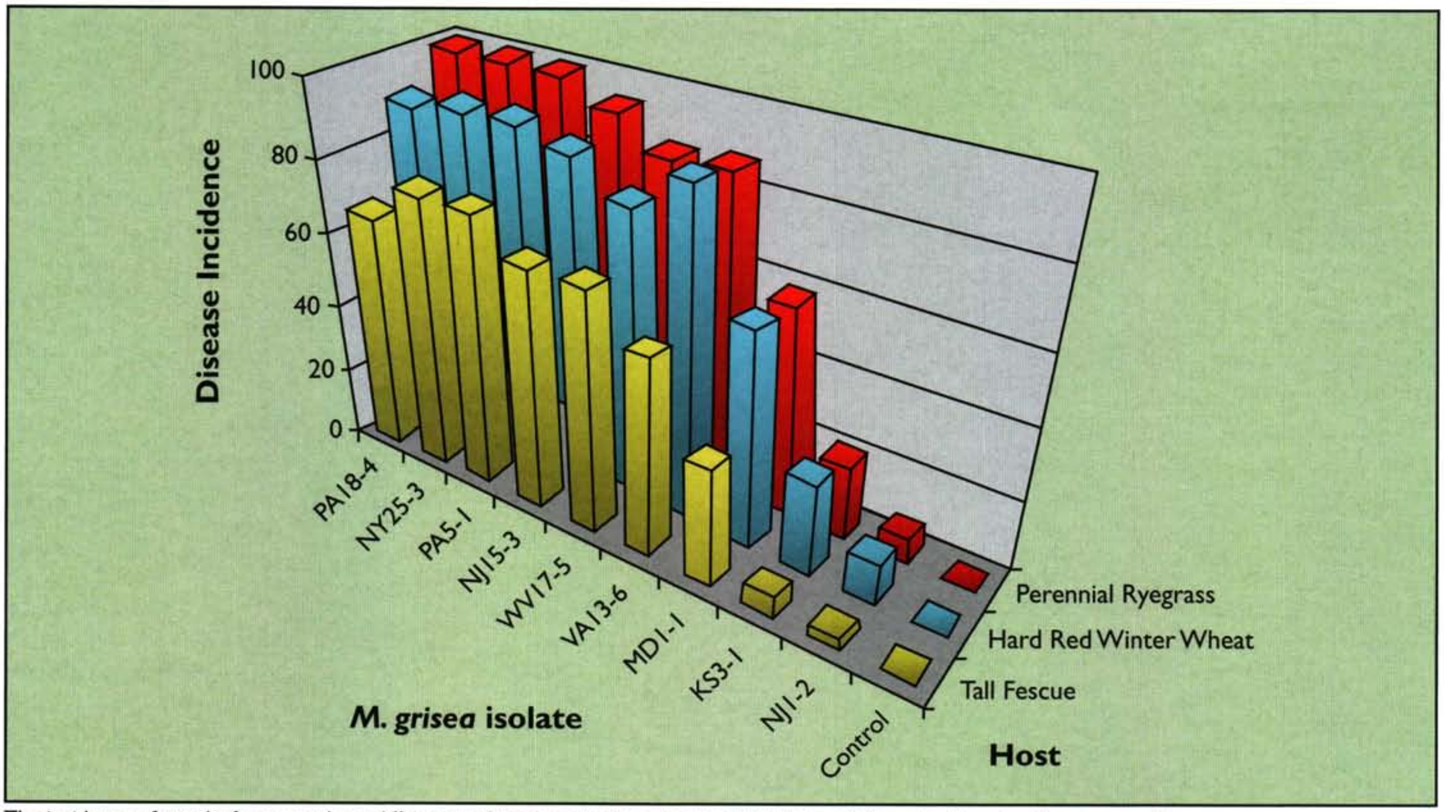
The herbicide ethofumesate (Prograss) is widely used to control annual bluegrass in perennial ryegrass fairways. Its use in the spring has been associated with increased severity of gray leaf spot. This effect was not evident when the herbicide was applied during the fall. The mechanism for the increase in severity of gray leaf spot is unclear. The herbicide interferes with fatty acid biosynthesis in plants and causes aggregation of the epicuticular wax on leaves. More efficient penetration of host plant surfaces at the thinning areas of leaf tissue by *M. grisea* may have resulted in higher gray leaf spot severity. A more rigorous fungicide spray program for gray leaf spot may be required in areas where ethofumesate is applied in spring for annual bluegrass seedhead suppression.

BREEDING FOR RESISTANCE

Cultivars of perennial ryegrass that are resistant to gray leaf spot pathogen are not currently available. Polygenic resistance appears to be present in perennial ryegrass. A number of field studies to identify novel sources of resistance in a worldwide collection of perennial ryegrass cultivars and lines are currently underway. Thus far, some progress in identifying resistant germplasm has been made, and several improved lines and cultivars have been identified.

CURRENT STATUS AND FUTURE OUTLOOK

Development of a weather-based model for predicting gray leaf spot epidemics has been a focus of our research, and currently a model based on temperature and leaf wetness duration is available.[6] Efforts to quantitatively describe the relationship between the relative humidity and gray leaf spot development are currently underway. A major breakthrough in research on gray leaf spot management is the development of effective fungicide programs for the disease. While intensive use of fungicides is not a desirable long-term disease control strategy, spray programs can be used to prevent epidemics until more sustainable management options are available.



The incidence of gray leaf spot on three different turfgrass species inoculated with isolates of *Magnaporthe grisea* from perennial ryegrass.

While significant advances have been made in understanding gray leaf spot, some major challenges still exist. One of the most serious challenges is the identification of resistant germplasm and development of resistant cultivars. Additionally, very little is known about the life cycle of the gray leaf spot pathogen. Further understanding of the life cycle and its significance to the epidemic development in ryegrass fairways in late summer periods will require major efforts in gray leaf spot research.

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EDITOR'S NOTE

An expanded version of this paper, including fungicide resistance, biological control, and cultivar genetic improvement, is available on the USGA's *Turfgrass and Environmental Research Online* (http://usgatero.msu.edu), June 1, 2003, issue (Vol. 2 No. 11).

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