# ACHILLES HEEL

*Perennial ryegrass is struck by gray leaf spot.*

**by PAUL VERMEULEN**

*As evident in the foreground, gray leaf spot is extremely virulent and can cause turf losses of up to 90%. To protect the perennial ryegrass in the background, a fungicide treatment was made in late July and again in mid-August.*

IN CELEBRATION of Achilles' birth, the Greek gods on Mount Olympus decreed that he would one day become a great warrior. This destiny came to fruition during the Trojan War when Achilles led his army to victory at the city of Troy. To ensure that he would always be invincible, his mother Thetis dipped him into the River Styx when he was a child, making his skin immortal. Tragically, she was later to discover that by holding her son's foot during his anointment he would be killed by a single arrow that struck his heel.

Much like the hero Achilles, perennial ryegrass exhibits many inherent strengths on the battlefields known to superintendents as fairways and rough. Among these strengths are its low establishment cost, excellent seedling vigor, good heat and drought tolerance, excellent wear tolerance, and superior playing characteristics over a wide range of cutting heights. Unfortunately, perennial ryegrass also has one true weakness that has caused superintendents to question its rightful position among the elite cool-season turf species.

Ever since improved varieties were first developed for golf course applications in the early 1970s, susceptibility to fungal attack has been considered the Achilles heel of perennial ryegrass. The primary concern has been *Pythium*, which can produce stand losses of 50 percent or more during periods of high heat and humidity.

In 1995 concern shifted away from *Pythium* and onto gray leaf spot. Known as *Pyricularia grisea* to the scientific community, this previously underestimated pathogen clearly demonstrated that it could slaughter perennial ryegrass with unimaginable efficiency. As made evident during recent epidemics, it can destroy 90 percent or more of a mature fairway or rough area if left unprotected by fungicide treatment.

## History Lesson

The ancestral roots of gray leaf spot are found in the Southeast, where it has infected St. Augustinegrass and to a lesser extent bermudagrass for decades. These warm-season grasses, however, were not easy victims for the disease, as it was unable to cause extensive losses on anything other then newly sprigged, juvenile stands. Being an unsuccessful predator on warm-season grasses, it turned its attention to cool-season species. An early victim in this category was annual ryegrass when, in 1971, several thousand acres of pasture-land were damaged in Louisiana and Mississippi.

Perennial ryegrass then became the next victim to fall prey to gray leaf spot in a growing chain of events. This evolutionary step was diagnosed by Dr. Peter Dernoeden of the University of Maryland in 1986, and it was later confirmed by Dr. Peter Landshoot of the Pennsylvania State University in 1991. Since it was first diagnosed, gray leaf spot has been responsible for two major epidemics. The first epidemic occurred in 1995 in the Mid-Atlantic and North-Central Regions, whereas in 1998 the epidemic occurred all across the Mid-Atlantic, North-Central, Northeast, and Mid-Continent Regions.

As of this writing, the growing list of susceptible victims includes tall fescue, creeping bentgrass, and Kentucky bluegrass. Of these three, only tall fescue has proven to be susceptible under normal field conditions, as made evident by a sole epidemic centered in North Carolina. The latter two (creeping bentgrass and Kentucky bluegrass) have only fallen prey under laboratory conditions where plants were subjected to unnatural climatic stress.

Since the first diagnosis of gray leaf spot in the Mid-Atlantic Region in 1986, the disease has seemingly moved westward at a phenomenal pace. By the end of the 1998 season, outbreaks had been diagnosed in 18 states stretching from the Atlantic coast to the eastern Colorado state line. The apparent migration of the disease is a subject of ongoing debate. Some of the prominent hypotheses include more accurate laboratory diagnosis, growing recognition among turfgrass pathologists of *Pyricularia grisea* as a primary pathogen, increased use of perennial ryegrass in the transition zone, and the birth and transport of new virulent races of *Pyricularia grisea* across the country. Whatever the reason, the disease seems to be capable of devastating new regions without much effort.

## Symptom Development

The visual symptoms of gray leaf spot on perennial ryegrass begin as small black specks on the foliage resulting from the initial infection. Next, oblong lesions begin to develop along the margins of the leaf blades. These lesions have a grayish, reddish-brown boundary and in a limited number of cases can be surrounded by a yellow halo. The ⅛-inch or smaller lesions also can be accompanied by small masses of grayish fruiting bodies called conidiospores that can give the appearance of a velvety covering. As the lesions

*Golfers in the Mid-Continent Region got their first serious look at gray leaf spot during 1998. This new disease is extremely virulent and can cause devastating losses on perennial ryegrass fairways and rough.*

expand, they can cause the tips of the leaf blades to turn brown and twist or curl.

As the disease progresses, symptoms of gray leaf spot can be seen without close examination of individual leaf blades. From shoulder level, grayish or reddish-brown patches 3 to 5 inches in diameter develop rapidly. Over time, the patches tend to coalesce and they no longer have distinct boundaries. The symptoms of large infected areas can also mirror ordinary afternoon wilting under the right weather conditions. Unlike drought stress, though, the infected turf does not respond to short irrigation cycles and in the span of a few days will perish.

On seedling perennial ryegrass the symptoms are less obvious in the earlier stages of disease development, primarily because the leaf blades are very slender and the lesions are not easily seen with the naked eye. A distinct twisting of the leaf tip is probably the easiest way to identify seedlings infected with gray leaf spot. This twisting can cause individual plants to look like small fishhooks. Suffice it to say, the later stages of gray leaf spot on seedling perennial ryegrass are usually identified as complete crop failure.

The symptoms of gray leaf spot can be easily confused with brown patch or pythium on mature turf and damping-off on seedlings, even though they develop with an absence of conspicuous mycelium. When there is any doubt, the diagnosis should be *immediately* confirmed by sending a small turf sample to an experienced turfgrass pathologist. *Immediately* is the operative word, as the disease has the capacity to cause catastrophic damage to seedling turf in 48 to 72 hours and to mature fairways and rough in 3 to 5 days.

The rapid spread of gray leaf spot is attributed to its ability to produce an enormous number of spores in a short period of time. Once produced, these spores are easily transported from infected foliage to healthy host plants via air currents, water-splash, and equipment traffic. Once present on the leaf of a new host and given adequate moisture, the spores quickly germinate. Emerging fungal hyphae then penetrate the leaf blade and sheath of the new host and the spore production cycle rapidly continues.

Weather conditions that prompt the development of gray leaf spot occur during the summer months. In general, daytime temperatures above 85°F and nighttime temperatures above 70°F for prolonged periods of time can trigger an epidemic. During the summer of 1998, for example, a stretch of warm temperatures from late July through mid-September resulted in extensive losses of perennial ryegrass fairways in the Mid-Continent Region. During this particular epidemic the disease was said to be in a logarithmic phase whereby it reproduced and infected new plants at a horrifying pace.

*Lesions caused by gray leaf spot can be accompanied by masses of grayish fruiting bodies that can give the appearance of a velvety covering.*

Humidity seems to be less of a factor in the development of gray leaf spot, as the prevailing weather conditions during the 1995 and 1998 epidemics were punctuated by dry conditions in many areas. The moisture required for fungal development was likely supplied by irrigation. During prolonged periods of high temperatures and low rainfall, perennial ryegrass often requires both nightly irrigation and afternoon syringing to sustain high visual quality.

Once an outbreak of gray leaf spot occurs during warm summer weather, it will most likely continue to affect the perennial ryegrass stand until after the first two or three hard frosts in the fall. This means that the window of gray leaf spot activity can literally remain open from mid-June through late November in some regions of the country. The majority of severe infections, however, have actually occurred between mid-August and mid-October when the disease is capable of logarithmic reproduction under ideal weather conditions.

**Controlling Outbreaks**

Controlling the activity of gray leaf spot with fungicide applications is a mix of good and bad news. The good news is that the fungus can be effectively controlled with several fungicides available for use in the United States. According to trials conducted by Dr. Paul Vincelli of the University of Kentucky, azoxystrobin (Heritage), thiophanate methyl (Cleary's 3336), propiconazole (Banner MAXX), mancozeb (Fore), and chlorothalonil (Daconil Ultrex) show good activity on gray leaf spot. The efficacy of each product can vary depending on the rate and frequency of application. (Editor's note: As of this writing, only azoxystrobin, thiophanate methyl, propiconazole, and chlorothalonil are labeled for gray leaf spot control.)

The list of fungicidal controls will likely expand with the registration of new compounds. One example is the impending registration of trifloxystrobin (Compass). Furthermore, various combinations of fungicide treatments will be evaluated continually with the possibility of discovering synergistic responses.

When gray leaf spot initially infects turf and it becomes necessary to control it on a curative basis, events in the Mid-Atlantic Region indicate that both contact and systemic fugicides should be included in the spray solution for

best results. Contact fungicides produce rapid results by disrupting the disease's ability to produce large numbers of spores on the surface of the leaf blades. Systemic fungicides generally produce slower responses but provide protection for two to three times as long.

After the first documented infection on a course, the optimal approach for controlling gray leaf spot during subsequent growing seasons is to apply preventive fungicide applications when prevailing weather conditions are conducive to fungal development. A preventive posture, even when early summertime temperatures are slightly below normal, can prove to be very advantageous by the end of the season because present knowledge is insufficient in predicting whether or not the logarithmic phase will occur during the latter half of the summer. A curative posture can lead to substantial losses, as rapid symptom development will leave superintendents precious few opportunities to treat large acreage.

The bad news on the issue of fungicidal treatment is that gray leaf spot control can be very expensive. The primary variables that determine the cost of control most often are (1) the seasonal duration of conducive weather conditions, (2) the number of treated acres, and (3) product pricing. Taking these variables into account, the cost of treating 50 acres of perennial ryegrass fairways and rough during an extended summer when the window of disease activity remains open for 120-plus days can exceed $60,000. This cost does not include fungicide treatments for other diseases that also may be problematic or the cost of manpower or equipment depreciation.

Controlling gray leaf spot using cultural management strategies is a topic of great interest. Unfortunately, the disease's rare occurrence on golf courses prior to the mid-1990s has provided few opportunities for the scientific community to conduct investigative studies. This aside, there are a few actions that warrant consideration based on limited evidence.

As gray leaf spot is known to be triggered by high temperatures and extended periods of wet foliage, improving cross ventilation throughout an entire course and irrigating during the daytime, when possible, may help prevent mild infections from worsening. Additionally, as the disease's spores are produced on the surface of the leaf blades, collecting the clippings during routine mowing and disposing of them into a managed composting facility can help prevent the spread of isolated infections.

To reduce perennial ryegrass's susceptibility to gray leaf spot, excessive nitrogen applications and the use of growth regulators during the heat of summer should be avoided on areas unprotected by fungicide treatment. Excessive summer growth resulting from high nitrogen applications will cause the foliage to become succulent and thus an easy target for the fungal hyphae that penetrate the leaf's surface during infection. Similarly, avoiding over-regulation of perennial ryegrass with growth-retarding compounds will improve recuperative potential if the turf is left unprotected by fungicidal treatments. During the fall, frequent nitrogen applications with urea at a dosage between 0.1 and 0.2 lbs./1,000 sq. ft. can help promote the recovery of damaged foliage.

Exploiting inherent resistance to gray leaf spot by planting select perennial ryegrass varieties is also a prudent cultural practice. While inherent resistance alone cannot eliminate the need for fungicidal treatments, choosing better varieties can result in faster recovery of blighted areas because the crown portion of semi-resistant plants is not as severely damaged. The National Turfgrass Evaluation Program (NTEP) publishes susceptibility ratings for many of the commercially available varieties on the World Wide Web at the following address: http://hort.unl.edu/netep.

The final cultural strategy available to superintendents is to decrease the cutting height. In studies conducted by Dr. Bruce Clarke, of Rutgers University, gray leaf spot infections became more severe as the cutting height was increased from 1 to 3 inches. This discovery is intriguing, as most diseases become more severe as cutting heights are lowered and the turf is placed under greater physiological stress.

### The Need For More Research

Better management of courses infected with gray leaf spot will require additional research. Perhaps a good starting point is to develop a more in-depth understanding of the gray leaf spot organism. This information is needed to provide answers to some of the following questions:

- Will gray leaf spot continue to spread into new regions, such as the Southeast and Southwest, where perennial ryegrass is used extensively for winter overseeding?
- Does gray leaf spot have the capacity to further mutate and become a destructive pathogen on other economically important turfgrass species?
- Can other cultural management strategies be discovered that will reduce or partially eliminate the present need for fungicidal treatments?
- Can a better prediction model be developed to aid in scouting and reduce the number of treated acres?

In addition to continuing basic research, funding must also be sought to intensify the hunt for resistant genes. Dr. Andy Hamblin, of the University of Illinois, is currently screening the perennial ryegrass gene pool for inherent resistance. If this initial investigation fails to make a significant discovery, then researching the gene pools of closely related species should be undertaken. Once a resistant gene is discovered, the probability of importing it into the genetic coding of popular perennial ryegrass varieties using existing technology is thought to be very good.

### Alternative Turfgrasses

Based on the enormous cost of protecting vulnerable areas of perennial ryegrass, it comes as no surprise that a growing number of course officials are beginning to ask whether or not it is worth maintaining in the long run. Depending on a number of mitigating factors, there are various responses to this inquiry. First, total acreage and historical performance must be considered. If a course has a small number of acres of perennial ryegrass and turf performance has not be problematic, then throwing the baby out with the bath water would not make a great deal of sense. If a course has a large number of acres and has experienced unacceptable losses that can only be prevented in the future with costly fungicide applications, then establishing an alternative turfgrass would be advisable.

Second, a course must consider the total cost of maintaining alternative species. Calculating this cost should include an assessment of the equipment inventory and irrigation system. Perennial ryegrass has established a good track record on many courses with small equipment inventories and older irrigation systems because it can be maintained over a wide range of cutting heights and has good heat and drought tolerance. To successfully convert 30 or more acres of perennial rye-

grass to an alternative species, such as creeping bentgrass, can cost several hundred thousand dollars if the purchase of new equipment and a multi-row, computerized irrigation system is required. Besides, creeping bentgrass and other alternatives have disease problems of their own that require costly pesticide applications.

Third, the cost of establishing another turfgrass species must be considered. This cost consists of two components. The first component is the cost of establishing a new stand of turf from seed, sprig, or sod. This cost can vary from $1,200 per acre for seeding to $20,000 per acre for sodding. The second component is the hidden cost of complete or partial course closure during the establishment of an alternative species. This can include the loss of green fees, clubhouse revenues, special event revenue, and membership sales. In many cases, the loss of revenue from the various segments of course operations dwarfs the cost of turf establishment.

Fourth, courses must consider the attractiveness of alternative species to the golfing public. In some cases, the attractiveness of alternative species can be narrowed to pure economics. For example, a course located in southern Missouri may discover that zoysiagrass and bermudagrass are not attractive enough to entice golfers from North Dakota to go south for golf during March and April. As such, the loss of revenue from green fees could be greater than the cost of fungicidal treatments for gray leaf spot control on perennial ryegrass.

Attractiveness can also be a purely subjective issue. For example, golfers who have become accustomed to playing on perennial ryegrass may elect to continue paying for its adequate care as opposed to supporting the establishment of an alternative species with different playing characteristics. The irrational element of this argument is that most golfers can easily adapt to the different playing conditions offered by the major turfgrass species grown. The clearest evidence of golfers' innate adaptability to different turf types is the fact that they prefer to travel with their clubs on vacation from north to south and from east to west.

## Conclusion

Gray leaf spot has proven to be a formidable opponent and has, in many respects, humbled a proud turfgrass industry. Only time will tell whether it proves to be the proverbial arrow that strikes the vulnerable immune system of perennial ryegrass.

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*When gray leaf spot is suspected, it is important to take immediate action. To illustrate, this area was covered by a healthy crop of seedling perennial ryegrass just 72 hours before this photo was taken.*