Rapid blight: A new disease of cool-season turf

Rapid blight is caused by an organism that usually affects turfgrass irrigated with poor-quality water.

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EDITOR'S note:

The field experiments cited in this paper were each carried out for only one year, even though most articles published in the research section of *GCM* report on at least two years of field research. In this case, the decision was made to publish one year of data concerning rapid blight control because the disease is an emerging problem that warrants immediate attention.

Photo courtesy of Mary Olsen

Figure 1. Symptoms of rapid blight in *Poa trivialis* are bronzing of turf in patches that later coalesce and form large dead areas.

Rapid blight is a relatively new disease of cool-season turfgrasses such as *Poa annua* (annual bluegrass), *P. trivialis* (roughstalk bluegrass), *Lolium perenne* (perennial ryegrass), *Agrostis tenuis* (colonial bentgrass) and *Agrostis stolonifera* (creeping bentgrass). The common name "rapid blight" was proposed because of the rapid progress of the disease on affected golf greens (3). Rapid blight has been reported in 11 states to date with occurrences at more than 100 golf courses (6). In Arizona, rapid blight has occurred in landscape turf and golf courses irrigated with poor-quality water such as effluent or reclaimed water and/or high-salinity well water. The disease has been most severe on golf courses using perennial ryegrass, colonial bentgrass and/or *P. trivialis* as overseed for bermudagrass. In California, it occurs in *P. annua* and in South Carolina on salt-stressed creeping bentgrass (2).

KEY points

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Rapid blight is a new disease of cool-season turfgrasses that causes rapid collapse and death of turf foliage.

The organism that causes rapid blight was recently identified as *Labyrinthula*, which was previously not known to be pathogenic on terrestrial plants.

A year of field and lab studies has shown that rapid blight is usually associated with poor-quality irrigation water with high salinity.

Initial field studies showed that some chemicals do an excellent job of containing the disease if they are applied preventively.

Symptoms of rapid blight

In the initial stage of disease, leaves of affected plants have a water-soaked appearance, and symptoms develop in small irregular patches. As the disease progresses, these patches enlarge and coalesce to form large dead areas. Some turf varieties, such as *Poa trivialis*, turn a bronze color (Figure 1).

Mowing and foot traffic increase disease incidence. On golf courses, the disease is most severe on greens, and in some cases, mowing patterns are evident (6). Rapid blight also may be a problem in other high-traffic areas such as green surrounds. In landscapes, the disease seems to be most common on slopes or in dry areas.

Causal organism

Until recently, the causal organism of rapid blight was unknown. The pathogen was tentatively identified as a fungus, a chytridiomycete, and the disease mistakenly became known as "chytrid disease." We now know that rapid blight is caused by a species of *Labyrinthula*, an organism unlike any other previously described turfgrass pathogen. *Labyrinthula* was isolated from symptomatic turfgrass and grown on an artificial culture medium in our lab in spring 2003 (5). Cells harvested from cultures were used to inoculate healthy *Poa trivialis* and perennial ryegrass. Symptoms identical to those observed in the field developed on all inoculated plants, and pathogenicity was proved when *Labyrinthula* was re-isolated from the inoculated diseased turfgrass (5). *Labyrinthula* has been found in marine and freshwater systems, but until our discovery, no species of *Labyrinthula* had been shown to be pathogenic on terrestrial plants.

Description of Labyrinthula

The taxonomy of *Labyrinthula* is uncertain. It has been classified in different ways since it was first described in 1867 (1). It is now placed in the kingdom Chromista (also called the Stramenopiles) with organisms such as diatoms and the Oomycetes (species of *Pythium* and *Phytophthora* are in this group), but it is not closely related to these organisms.

Labyrinthula was first thought of as a marine slime mold or net slime mold, but it is not related to the cellular slime molds that are common in turfgrass or in other moist habitats. Cells of *Labyrinthula* have unique organelles that produce slimeways through which the cells move and acquire nutrition. Produced in mass, the slimeways become a network in which cells move at a surprisingly rapid rate of up to 250 micrometers per minute (about 0.5 inches/hour) (4). These networks and moving cells can be observed under the microscope. As cells multiply, colonial networks are formed and expand to as wide as 5⁄32 inch (4 millimeters) in 24 hours on agar culture media.

The spindle-shaped cells are about 5-6.6 micrometers by 13.4-17.1 micrometers, making them the size of some fungal spores, but small enough to fit inside plant cells. They have one distinct nucleus. The cells divide by mitotic division, forming new crosswalls within the vegetative cell.

Laboratory studies

Materials and methods

We currently are conducting laboratory studies to determine the nature of disease development and pathogen biology of rapid blight. In this article, we report results of replicated experiments completed to date in our laboratory on the effect of wounding of turfgrass on infection, the effect of temperature on growth of *Labyrinthula* in culture, the movement of *Labyrinthula* from plant to plant, the effect of salinity of irrigation water on symptom development, and turfgrass species susceptibility.

The *Labyrinthula* isolate used in these studies was isolated from symptomatic *Poa trivialis* at a golf course in central Arizona and was maintained by sequential infections of *P. trivialis* and perennial ryegrass.

Studies were conducted using turfgrass established in autoclaved silica sand in containers 3.1 inches (8 centimeters) in diameter. Irrigation water was adjusted to appropriate salinities after being amended with nutrients for half-strength Hoagland's nutrient solution. Containers were irrigated to excess daily and allowed to drain to maintain salinity levels. Plants were inoculated by pipetting 1 milliliter of a 40,000 cells/milliliter of inoculum suspension of *Labyrinthula* cells over the turf.

TURF QUALITY AND INFECTION

Salinity (decisiemens/meter)	Days after inoculation: 6		9		12		21	
	Quality*	Infection†	Quality	Infection	Quality	Infection	Quality	Infection
0.5	9.0 a	-	9.0 a	-	9.0 a	-	9.0 a	+
0.8	9.0 a	-	8.3 a	-	7.7 a	+	7.0 b	+
1.4	9.0 a	-	7.7 a	+	3.0 b	+	3.0 c	+
1.8	7.7 a	+	5.0 b	+	3.0 b	+	3.0 c	+
2.3	8.0 a	-	3.0 c	+	1.0 c	+	1.0 d	+
2.8	8.0 a	+	1.7 d	+	1.0 c	+	1.0 d	+

*Turf quality is a rating of 1-9, where 1 = all dead or dying and 9 = all healthy. Values are the average of three replications. Values in a column followed by the same letters are not significantly different.
†Infection indicates that *Labyrinthula* was isolated from plant tissue at the time of rating.

Table 1. Average turf-quality rating and infection of perennial ryegrass seedlings at 6, 9, 12 and 21 days after inoculation with *Labyrinthula* and irrigation with water ranging in salinity from 0.5 to 2.8 decisiemens/meter.

had significantly better turf quality than all the other varieties.

Field trials for chemical control

Field trials to determine efficacy of selected chemicals for control of rapid blight were conducted in Arizona in fall 2002 and fall-winter 2003-2004. Chemicals were applied preventively at a central Arizona golf course with a history of severe rapid blight. Rates and results are given in Tables 2 and 3.

Based on our trials, and on previous trials by other researchers (2), the most effective chemicals for prevention of rapid blight were trifloxystrobin (Compass), pyraclostrobin (Insignia) and mancozeb (Fore, Protect). Compass and Insignia mixed or rotated with mancozeb gave excellent control as did Insignia alone. Copper fungicides, particularly Bordeaux and Kocide, also controlled disease, and results indicate that copper products may have potential as rotation treatments. Micronized sulfur spray (Microthiol Disperss) and biologicals or nutrients alone (Ecoguard, Floradox) gave little or no control.

Field observations indicate that, if applied early, curative applications of chemicals usually contain disease but do not eradicate it.

DISEASE AND SALINITY

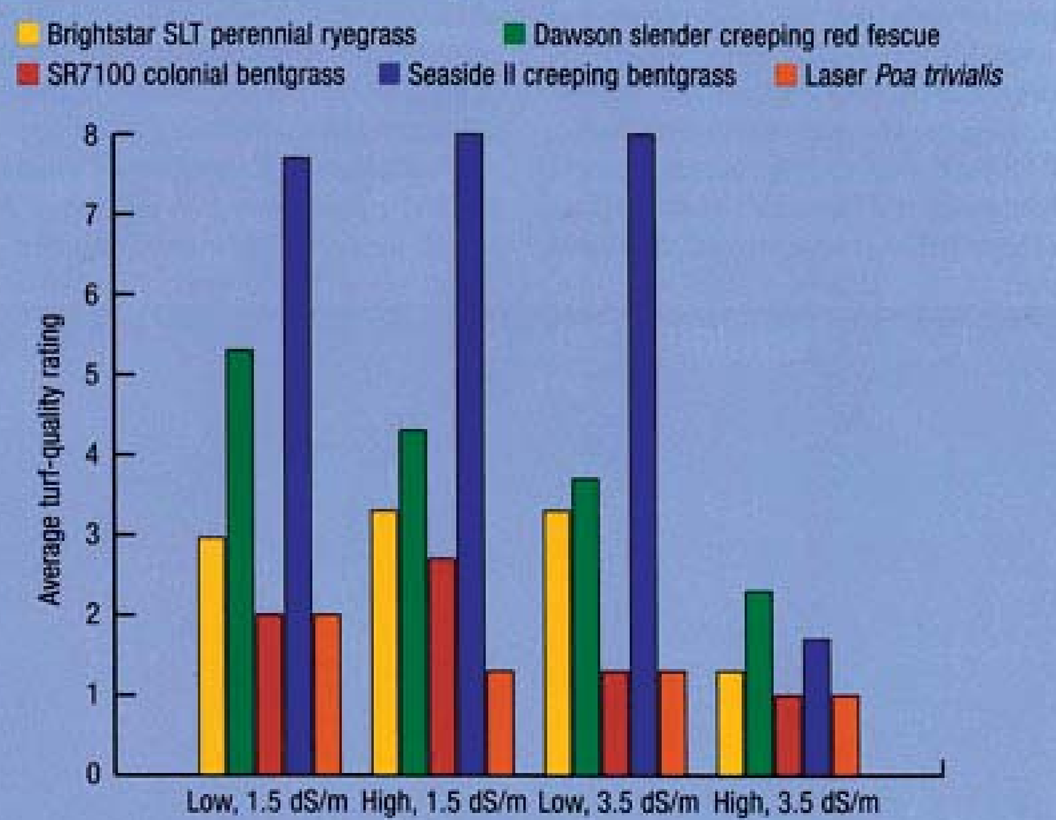

Figure 2. Quality of turf varieties inoculated with two different levels of inoculum (low = 400 cells/milliliter; high = 40,000 cells/milliliter) and irrigated at two levels of salinity (1.5 and 3.5 decisiemens/meter). Turf quality is a rating of 1-9 with 1 = all dead or dying and 9 = all healthy. Values are the average of three replications.

Diagnosis of rapid blight

As with most diseases, early detection and maintaining records of confirmed diagnoses are the key to prevention. *Labyrinthula* can be identified in infested plant tissue by viewing thin sections of grass leaves under a compound microscope at 200-400×. It also can be cultured on artificial media. *Labyrinthula* cells grow out of infected plant tissue quickly, and diagnosis must be made within 24-48 hours because other fungi or contaminants will overtake the smaller *Labyrinthula* colonies. As soon as symptoms appear on turfgrass in the field, samples should be sent to a diagnostician trained to recognize *Labyrinthula*. Samples that are shipped should be sent by overnight mail. Samples can be taken with a soil corer or any type of turf sampler and should be placed in a sealed container and kept cool until shipped.

Conclusion

It may be that *Labyrinthula* has been a turfgrass pathogen and/or associated with terrestrial plants for some time but has been overlooked because of its unique growth habit and the distinctive media necessary to isolate it from its host. Its emergence as a turfgrass pathogen may be related to increased acreage in turf and changes in cultural practices such as increased use of poor-quality water for irrigation. Management of rapid blight depends on several approaches: using species, varieties or seed blends or mixtures of salt-tolerant turfgrasses; using alternative sources of low-salinity water wherever possible; and making preventive applications of effective chemicals. As the availability of good-quality irrigation water for golf courses and landscapes decreases, rapid blight may become more widespread. Wherever use of poor-quality irrigation water is anticipated, management practices for the future prevention of rapid blight should emphasize water-quality issues.

Acknowledgments

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Results

Wounding. Our laboratory trials indicate that wounding is not necessary for *Labyrinthula* to enter the plant, but that disease symptoms appear much more quickly on cut grass. Replicated trials in which perennial ryegrass seedlings were either cut or not cut with scissors immediately before inoculation showed that plants in both treatments became infected. Symptoms developed in the cut plants within three to five days. In uncut plants, symptoms developed within eight to10 days.

Temperature. In laboratory cultures, the isolate of *Labyrinthula* used in these trials grew well from 59 to 86 F (15-30 C). It grew very slowly at 39 F (4 C) and did not grow at all at 104 F (40 C).

Movement. Labyrinthula moves easily from infected plants to noninfected plants when only a few leaves are touching or when plants share common drainage water. We conducted experiments with 2-week-old perennial ryegrass seedlings in which inoculated plants were placed next to noninoculated plants so that a few leaves were always in contact, but all other parts of the plant were separated. Within 14-21 days, the noninoculated plants were infected. Other experiments showed that noninoculated plants became infected when they were placed in a container with inoculated plants and shared leachate water but had no other contact.

Salinity of irrigation water. Diseased turf is invariably associated with poor-quality irrigation water, particularly water with salinity higher than 1.5 decisiemens/meter. Our studies indicate that symptom development increases as the salinity of the applied irrigation water increases.

In our initial replicated laboratory studies, 2-week-old perennial ryegrass and *Poa trivialis* plants were inoculated with *Labyrinthula* or not inoculated and irrigated with 2.0, 4.0, 6.0 and 8.0 decisiemens/meter (= EC [electrical conductivity] units) salinity water. (We have seen golf courses with this disease that are irrigating regularly with water over 4.0 decisiemens/meter.) In inoculated plants, disease developed first in treatments with salinity at 6.0 and 8.0 decisiemens/meter, but all inoculated plants in all treatments died within 14 days. Non-inoculated control plants were visibly salt stressed at 6.0 and 8.0 decisiemens/meter, but none died.

In a subsequent study, 2-week-old perennial ryegrass plants were irrigated with water with salinities of 0.5-2.8 decisiemens/meter. (Results are shown in Table 1.) Plants irrigated with the lower-salinity water (0.5 decisiemens/meter) showed no symptoms of disease but became infected after 21 days. After 21 days, irrigation water with salinity of 0.8 decisiemens/meter had produced significantly lower turf quality than water with salinity of 0.5 decisiemens/meter, but few plants died. After nine days, irrigation water with salinities of 1.8 decisiemens/meter or greater had produced significantly lower-quality turf than water having a salinity of 1.5 decisiemens/meter or less. At salinity levels of 2.8 decisiemens/meter, most plants were dead or dying. These results confirm field observations that disease severity increases as the salinity of the irrigation water increases.

Species and variety susceptibility

Field observations indicate that bermudagrass varieties are tolerant to rapid blight; slender creeping red fescue and chewings fescue may have some tolerance and be useful

2002 FUNGICIDE TRIALS

Treatment	Active ingredient	Rate* per 1,000 square feet	Rate* per square meter	Application dates†	Turf quality‡
Control	NA			NA	3.8 a
Aqueduct	nonionic polyols	8.0 oz	2.44 g	2,3,4	4.6 ab
Aqueduct + Fore	nonionic polyols + mancozeb	8.0 oz 8.0 oz	2.44 g 2.44 g	2,3,4	
Fore alternated with Eagle	mancozeb, myclobutanil	8.0 oz 1.2 oz	2.44 g 370 mg	2 3,4	5.8 b
Compass	trifloxystrobin	0.25 oz	76.0 mg	2,3	6.4 bc
Insignia	pyraclostrobin	0.90 oz	275 mg	2,3	7.9 c
Fore alternated with Fore + Compass	mancozeb, mancozeb + trifloxystrobin	6.0 oz 6.0 oz 0.25 oz	1.83 g 1.83 g 76.0 mg	1,2, 4 3	7.9 c

*Rates are given in English units for product/1,000 square feet and in metric units for product/square meter; chemicals were applied in 60 gallons of water/acre at 30 pounds/square inch (227 liters of water at 207 kiloPascals).
†Application dates: 1 = pre-plant Oct. 4; 2 = Oct. 23; 3 = Oct. 30; 4 = Nov. 13, 2002.
‡Turf quality was rated on Nov. 27, 2002, using a scale of 1-9, where 1 = very poor and 9 = very good. Ratings are the average of eight replications. Numbers followed by the same letter are not significantly different.

Table 2. 2002 field trials to determine efficacy of fungicides for control of rapid blight.

in mixes; non-salt-tolerant creeping bentgrass is susceptible; and *Poa trivialis*, perennial ryegrass, annual ryegrass and colonial bentgrass are very susceptible (2,6). Results of one laboratory trial comparing Brightstar SLT perennial ryegrass, Dawson creeping red fescue, SR7100 colonial bentgrass, Seaside II creeping bentgrass and Laser *Poa trivialis* are given in Figure 2. Plants were irrigated with water having salinities of 1.5 or 3.5 decisiemens/meter and inoculated with one of two levels of inoculum (400 cells/milliliter or 40,000 cells/milliliter). Control groups were irrigated in the same way but were not inoculated (no infection, results not shown).

Brightstar SLT perennial ryegrass, SR7100 colonial bentgrass and Laser *Poa trivialis* were symptomatic and died after 12 days at both low and high amounts of inoculum and at both salinity levels. The Dawson creeping red fescue showed some tolerance, and its quality was significantly better than all other varieties except the Seaside II creeping bentgrass at 1.5 decisiemens/meter. Except for the treatment with 3.5 decisiemens/meter salinity and the high inoculum level (40,000 cells/milliliter), Seaside II creeping bentgrass

2003-2004 FUNGICIDE TRIALS

Treatment	Active ingredient	Rate* per 1,000 square feet	Rate* per square meter	Application dates†	Turf quality‡
Insignia	pyraclostrobin	0.90 oz	275 mg	1,3,5,6,7,8	8.3 a
Insignia + tank-mix Fore	pyraclostrobin + mancozeb	0.50 oz 6.0 oz	153 mg 1.83 g	1,3,5,6,7,8	8.4 a
Insignia alternate with Fore	pyraclostrobin, mancozeb	0.50 oz 6.0 oz	153 mg 1.83 g	1,5,7 3,6,8	8.3 a
Insignia alternate with Ecoguard	pyraclostrobin, *Bacillus licheniformis* & IBA	0.50 oz 20 fl oz	153 mg 6.38 ml	2,4,7 1,3,5,6,8	8.3 a
Fore	mancozeb	8.0 oz	2.44 g	1,3,5,6,7,8	8.4 a
Compass + tank-mix Fore	trifloxystrobin + mancozeb	0.20 oz 6.0 oz	61.0 mg 1.83 g	1,3,5,6,7,8	8.6 a
Compass alternate with Fore	trifloxystrobin, mancozeb	0.2 oz 6.0 oz	61 mg 1.83 g	1,5,7 3,6,8	7.8 ab
Kocide 2000	copper hydroxide	2.2 oz	671 mg	1-8	7.8 ab
Insignia	pyraclostrobin	0.50 oz	153 mg	1,3,5,6,7,8	7.5 ab
Bordeaux	copper sulfate and hydrated lime	3.5 oz	1.07 g	1-8	7.6 ab
Compass	trifloxystrobin	0.25 oz	76.0 mg	1,3,5,6,7,8	6.1 b
Ecoguard	*Bacillus licheniformis* & IBA	20 fl oz	6.38 ml	1-8	4.6 bc
Microthiol Disperss	soluble sulfur	1.8 oz	549 mg	1-8	3.8 c
Floradox	stabilized oxygen	3.7 fl oz	1.18 ml	1-8	3.6 c
Control		NA	NA	NA	3.9 c

Note. NA = not applicable.
*Rates are given in English units for product per 1,000 square feet and in metric units for product per square meter. Chemicals are applied in 60-gallons of water/acre at 30 pounds/square inch (227 liters at 207 kiloPascals).
†Application dates: 1 = Nov. 7; 2 = Nov. 14; 3 = Nov. 21; 4 = Nov. 28; 5 = Dec. 5; 6 = Dec. 17; 7 = Dec. 30, 2003; and 8 = Jan. 12, 2004.
‡Turf quality was rated on Jan. 12, five weeks after initial symptom development, using a scale of 1-9, where 1 = very poor and 9 = very good. Ratings are the average of eight replications. Numbers followed by the same letter are not significantly different.

Table 3. 2003-2004 field trials to determine efficacy of fungicides for control of rapid blight.

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