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Turf Grass TRENDS

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An overview

Pythium diseases of turfgrasses

by Dr. Eric B. Nelson

Of all the pathogens causing diseases on turfgrasses, the Pythium species are perhaps the most versatile. They cause diseases on nearly all the managed turfgrass species, affecting all the organs of those turfgrass plants. They infect both young and mature turfgrass stands under an extremely wide range of temperatures. Furthermore, these pathogens can cause significant problems on low maintenance as well as on high maintenance turf.

One of the characteristics of Pythium infestations of turfgrasses, is that the symptoms the pathogens cause can appear quite suddenly, whether that symptom be a root-rotting disease under snow cover or foliar blighting disease under hot, humid conditions.

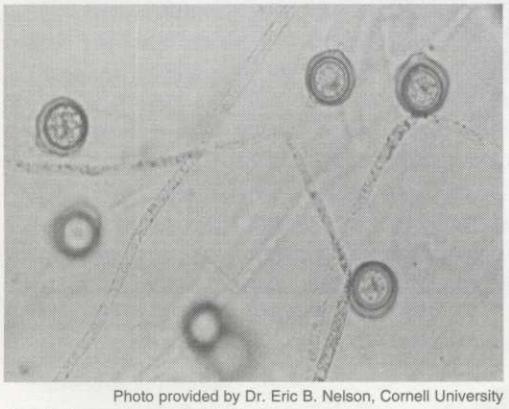


Photo provided by Dr. Eric B. Nelson, Cornell University

Typical oospores of a Pythium species.

This rapid onset of symptoms, sometimes within less than 24 hours, combined with the fact that there are only a limited number of fungicides and control strategies that are affective against these pathogens, have made Pythium diseases the dread of many turfgrass managers. Regardless of the conditions under which the many Pythium diseases develop, the explosive potential for growth of these diseases often makes the correct diagnosis and implementation of appropriate management strategies difficult, but extremely important.

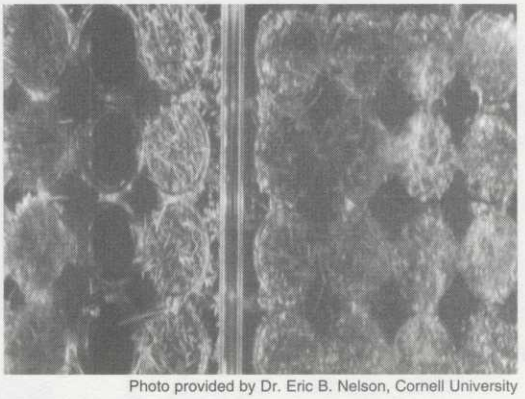


Photo provided by Dr. Eric B. Nelson, Cornell University

Damping-off of creeping bentgrass seedlings.

Versatility characterizes Pythium spores

The versatility of these pathogens can be partially attributed to the diversity of spores produced

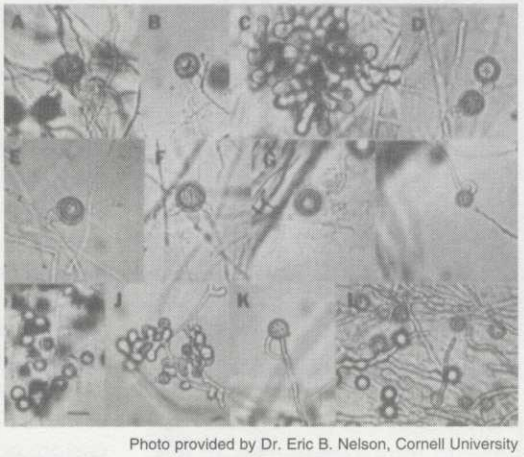


Photo provided by Dr. Eric B. Nelson, Cornell University

Oospores and sporangia of Pythium species:

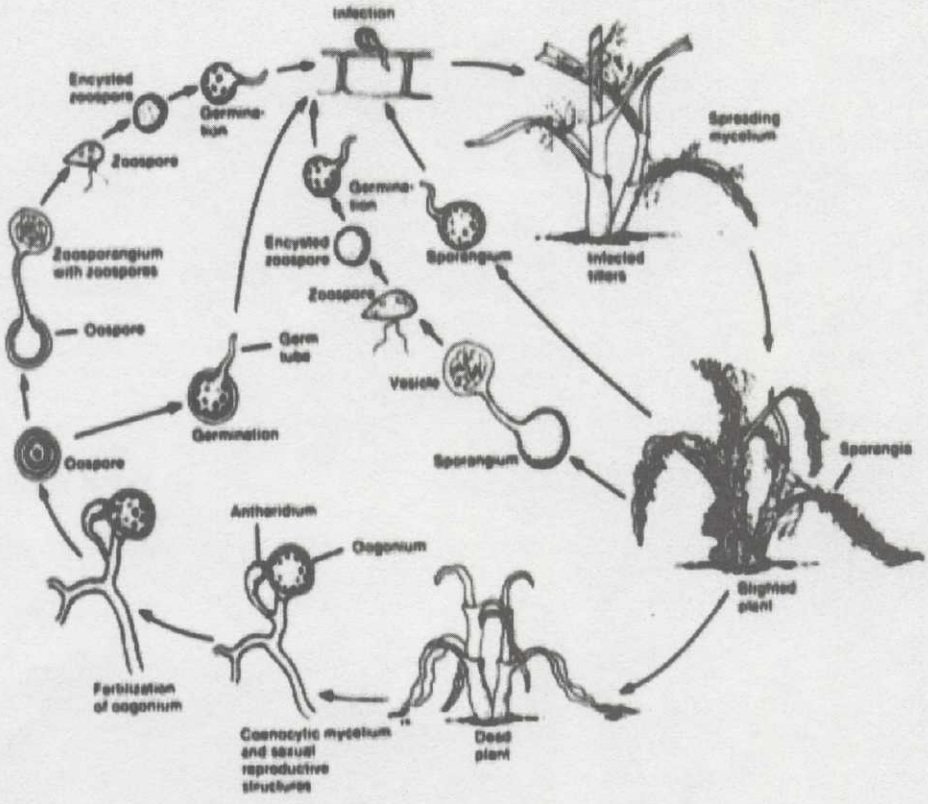
A,B,C = P. graminicola
D,E = P. aphanidermatum
F,G = P. aristosporum
H,I,J = P. torulosum
K,L = P. vanterpoolii

IN THIS ISSUE

IN-DEPTH ARTICLES

by nearly all of the turfgrass-infecting species. Pythium species may produce up to four types of these survival and propagative structures: oospores, zoospores, chlamydospores, and a mycelial structure called hyphal swellings.

Oospores are the main survival structures of Pythium species. (See left photo on page 1.) These are thick-walled spores produced in infected turfgrass tissue. Oospores allow Pythium species to persist in soil and survive extremes of temperature and moisture, as well as resist the effects of fungicides. They germinate under favorable conditions (conditions that will vary with the species) to form either a germ tube or a sporangium (See bottom photo on page 1).



Pythium life cycle.

Figure provided by Dr. Eric B. Nelson, Cornell University

Sporangia are additional spore-bearing structures that give rise to unique spores called zoospores. Zoospores are motile spores that can swim in water films in soils and on plant surfaces to rapidly spread throughout a turfgrass planting. Once zoospores reach susceptible turfgrass tissue, they stop swimming and attach to the plant, where they quickly germinate and infect the plant.

In some species, however, sporangia produce no zoospores but instead germinate to form a germ tube. In this case, sporangia are often called chlamydospores. Germinating oospores, zoospores, and chlamydospores may give rise to germ tubes which, in turn, give rise to an extensive mycelium. Within this mycelium, a fourth type of structure, called hyphal swellings may develop. These too can persist in soil and "germinate" to form a germ tube and an extensive mycelium. In a sense, they function as chlamydospores.

Water and temperature: the determining factors

Air and soil temperatures, coupled with soil moisture levels, are the principal factors determining the form, extent, and severity of Pythium diseases on turfgrasses, with water relations being perhaps the most important. Due to the strict requirement of the presence of free water or water film in order for zoospores to be released from sporangia and to swim from plant to plant, most severe Pythium disease epidemics occur under high moisture conditions.

Rainfall or irrigation are not the only prerequisite to disease development, as falling temperatures and high humidity will combine to form dew and insure the presence of free water. When turfgrass managers develop control strategies for Pythium diseases, water management must be the centrally important non-chemical control tactic. Any control strategy that fails to mitigate the effects of free water in the disease development process will prove to be ineffective.

Specific diseases caused by Pythium species

The table on page 6 lists the Pythium species that cause the various diseases on turfgrasses. These species, in combination with many others, that are non-pathogenic are continually associated with turfgrass plants. Pythium species are perennial inhabitants of turfgrass roots and crowns and old infected leaf tissues. In general, the presence of the pathogen is not a limiting factor in disease development, but environmental conditions and plant stresses determine when symptoms appear.

Damping-off: diseases of seeds and seedlings

Turfgrass plants arising from new seedlings in newly established areas or from over-seedings on established turf are susceptible to seedling diseases caused by Pythium Damping-off diseases are a particular problem to seedlings growing under warm air and soil conditions.

The symptoms of Pythium induced damping-off diseases can be grouped into pre- and post-emergence symptoms. Pre-emergence symptoms include seed decay and

Photo provided by Dr. Eric B. Nelson, Cornell University

Early spring symtoms of Pythuum root rot damage on a creeping bentgrass/annual bluegrass putting green.

radical necrosis. Post-emergence symptoms occur after seedlings emerge and the plants may display typical damping-off symptoms of rapid seedling wilt and collapse. Seedlings may also suffer from root necrosis which generally results in a slower wilting and collapse of the plant. Occasionally, foliar mycelium may be apparent during the post-emergence damping-off phase, particularly during periods of high temperatures and relative humidity (See top photo on page 1.). As turfgrass plants become more established, the symptoms may progress into root and crown rot symptoms and foliar blight symptoms.

Root and crown rots

Early symptoms of Pythium root and crown rot diseases may be visible in the spring immediately after snow melt, but they are most common in the early spring — March through May. Symptoms, however, may be evident at any time throughout the growing season and disease activity may continue into late autumn. Occasionally, some turfgrass sites are more prone to Pythium root and crown rot damage in early spring and late autumn, whereas other areas experience the problem in warmer parts of the season with little or no damage at other times of the year.

This is perhaps related not only to variation in the native complex of pathogenic Pythium species associated with different sites but also to the management practices unique to particular areas, which may limit the activity of certain species and favor the activity of others.

Under the cool wet conditions typical of early spring — March through May — and late autumn — October through November — symptoms may first appear as small diffuse yellow or reddish brown to bronze colored patches of turf approximately two to three inches in diameter (See photo left.) often closely resembling the early stages of pink snow mold, *Microdochium nivale*, infestations. In spring, plants under light to moderate disease pressure may be slow to come out of dormancy and early growth may be less vigorous than in uninfected plants. Like light to moderate infections of Necrotic Ring Spot, affected turf may show little response to the applications of slow-release fertilizers and exhibit only limited response after several weeks to applications of water soluble fertilizers.

Under severe conditions, areas of infected turf may coalesce into larger patches that will often appear yellow and in a generally weakened condition (See photo below.).

As the season progresses and temperatures warm and these larger areas of previously infected turf become stressed, they may rapidly wilt, turn yellow to brown and die. These areas do not respond to any attempts to mitigate the disease symptoms, as large portions of the plant's root structure have been damaged or destroyed and the roots can no longer function to provide the leaf structure with the water that the plant requires to remain healthy.

Things get worse in summer

Under the warm, wet conditions of mid-summer — June through August — initial symptoms on bentgrass appear as small tan to brown or bronze patches of turf, very similar in appearance to dollar spot patches. These patches may converge and affect large areas of turf where extensive

Photo provided by Dr. Eric B. Nelson, Cornell University

Advanced spring symtoms of Pythium root rot damage.

stands of plants rapidly wilt and die. With severe infections, plants may wilt rapidly under heat stress and thinning may be so extensive that large areas of turf may become devoid of plants.

Recovery of these severely affected areas may be quite

difficult taking an entire season, as subsequent efforts to reseed the affected areas may become victims of seedling damping-off diseases.

Unlike the foliar blight diseases, no aerial mycelium is evident during periods favorable for infection of the Pythium root and crown rot diseases. Because of this lack of diagnostic mycelium and because of the similarity of symptoms to other root damaging diseases, such as Necrotic Ring Spot, Pythium root and crown rot diseases can rarely be diagnosed from field symptoms alone. Only the microscopic

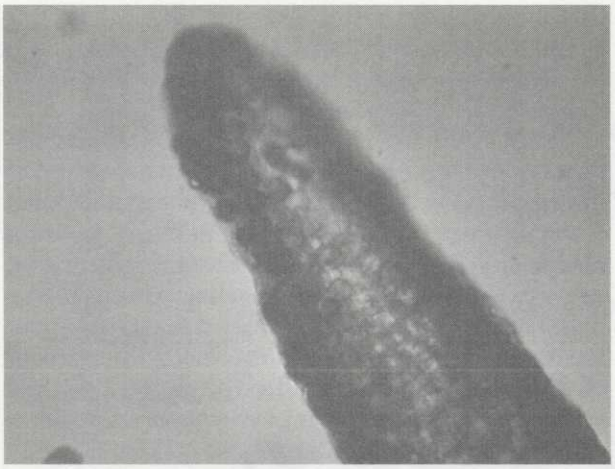


Photo provided by Dr. Eric B. Nelson, Cornell University

Oospores of Pythium species in a creeping bentgrass root tip.

examination of roots and crowns can effectively and clearly establish whether root and crown damage from Pythium species has occurred.

Typically, symptoms from Pythium root and crown rot diseases are first evident in the crown. Crown areas may appear water-soaked and discolored with tissue damage

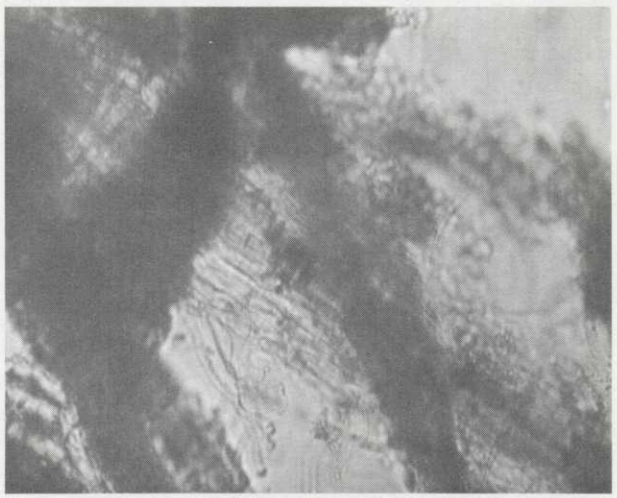


Photo provided by Dr. Eric B. Nelson, Cornell University

A sporangium of Pythium in a creeping bentgrass root cortex.

that appears slimy in advanced stages of infection. Examination of the roots of infected plants often reveal that the larger digital and seminal roots structures may be largely stripped of root hairs. On severely infected plants, root systems are greatly reduced in volume and vigor and may be extensively discolored with few if any functioning healthy, white roots.

If root systems are not well developed prior to infection by Pythium species, or any of the root damaging diseases, the level of damage that a root system can sustain and still function becomes dramatically reduced and severe plant decline will occur. When viewed under a microscope, the roots and crowns of advance stage infections may contain abundant oospores (See top left photo.). These resting stages allow the fungus to survive unfavorable environmental conditions in a dormant state and as a result are insensitive to many control measures, including most fungicide treatments. Occasionally, lobate sporangia may be seen in the outer cell layers of the root cortex (See bottom left photo.).

Foliar blights

Pythium induced foliar blights are typically a problem during very warm, humid weather, particularly during periods where the relative humidity remains high and nighttime air temperatures do not drop below 70 - 75 F (22-

Photo provided by Dr. Eric B. Nelson, Cornell University

Early stages of Pythium blight symtoms on a golf green.

24 C). Initial symptoms of foliar blight may appear as small, less than 1 inch (2 cm) in diameter tan to bronze-colored patches (See photo above.). Multiple initial symptom sites may enlarge very rapidly resulting in the extensive blighting of large areas of turf in a matter of a few hours. Very early symptoms, prior to the blighting phase, sometimes appear as solitary, upright individual leaves, whose tips may be wilting but are very light green in color.

In the early morning hours, when abundant dew is present on the foliage, grass blades may take on a bluish to bluish-green water-soaked appearance. As the infection progresses, the blighted patches may appear orange to bronze to tan in appearance with individual leaf blades wilted from the bottom up and fully blighted leaves appearing matted when dry. Often, the onset of tissue destruction

can be so rapid that the upper portion of an individual leaf blade, though appearing to be healthy, has collapsed to form more than a 90 degree angle.

Aerial mycelium

The most prominent feature of foliar blight versus root and crown diseases is the abundance of aerial mycelium, visible principally during the early morning hours when the grass is wet and the humidity is high (See photo below.). Under severe

Photo provided by Dr. Eric B. Nelson, Cornell University

Foliar mycelium of Pythium aphanidermatum on perennial ryegrass.

conditions, the mycelium appears to have "boiled" out of the infected areas. The foliage and the crowns of later stage infections are water soaked in appearance with extensive tissue rotting that is slimy or greasy to the touch.

These prominent characteristics have lead to the inaccurate naming of these symptoms as cottony blight and grease spot by earlier turfgrass managers. Frequently, these blighted areas are associated with areas of water flow over the turfgrass surface or with areas of consistently high soil moisture levels. Occasionally, symptoms coincide with the movement of equipment on the turfgrass area or the discharge of infected clippings over wide areas of previously uninfected turf.

Upon microscopic observation of infected leaf blades, oospores of the pathogens are often readily apparent. Occasionally, sporangia and zoospores may be evident as well.

Snow blight

In contrast to foliar blights, symptoms of Pythium snow blight occur during the winter months in more northerly parts of the U.S. Symptoms are not typically recognized but are sometimes evident, particularly in the winter during a snow melt or in the early spring where soils remain flooded for a prolonged period of time. Small patches, ranging in color from tan to orange may appear, usually in low-lying areas where soil moisture remains quite high (See photo right.).

Foliar mycelium is not usually evident but can be visible occasionally. Leaf blades and crowns become necrotic and extensively rotted and filled with abundant oospores. Plants with extensive crown rotting rapidly collapse and die. Roots of snow blighted plants that survive are largely unaffected. These diseases have not been frequently diagnosed and much remains to be learned about this group of Pythium species.

Diagnosis of Pythium diseases

From observations of many Pythium diseases in both laboratory and in field settings, it is clear that symptoms alone are not suitable diagnostic features for this disease. Typically, diagnosticians have relied on the observation of oospores in various tissues and organs as indicative of Pythium damage. Although oospores are frequently observed in root and crown tissues, much of the damage during seedling diseases, early stages of foliar blights, and even root and crown rots can occur as a result of Pythium growth inside the plant in the absence of oospore production. This can affect diagnoses based strictly on oospore observations.

It is likely that a large number of Pythium diseases are overlooked by relying strictly on the presence of oospores in plants for disease diagnosis. It is critical, therefore, that turfgrasses suspected of being affected by Pythium diseases be diagnosed by a qualified diagnostician.

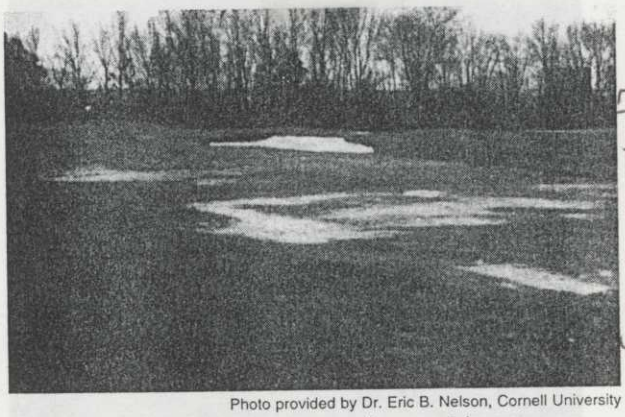


Photo provided by Dr. Eric B. Nelson, Cornell University

Symptoms of Pythium snow rot on a golf course fairway.

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Control of Pythium diseases

The severity of Pythium diseases can be minimized by adjusting cultural practices to minimize plant stress. Maintaining balanced fertility and managing the turf to produce an extensive and vigorous plant root system as well as the effective management of water are key elements in minimizing environmental stresses conducive to Pythium-incited diseases of turfgrasses.

Sites that have a recurring history of Pythium-incited diseases should be evaluated for soil compaction, soil layering, organic content, water percolation and soil drainage, and appropriate cultural practices, such as the use of soil amendments, wetting agents, top

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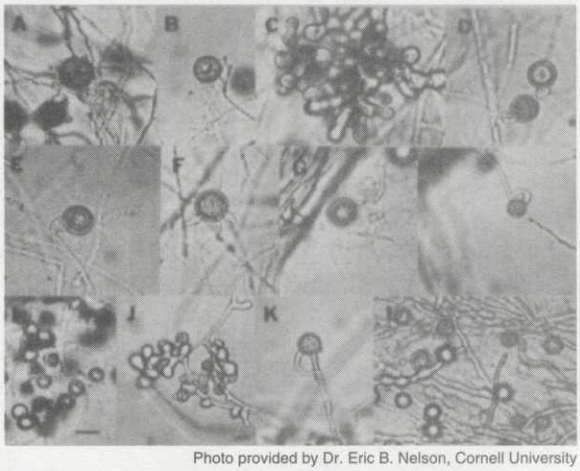

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dressing and aeration, should be instituted. In cases of very poor soil structure and drainage, extensive renovation of the site should seriously considered as all other cultural practices will probably fail.

Biological control of Pythium diseases, particularly seed and seedling diseases, and root and crown rot diseases, appears promising. Numerous biological agents have been effective when coated onto seeds as a seed treatment. Furthermore, recent studies on established turf have shown that the application of topdressings amended with certain composts and organic fertilizers will reduce the symptoms of Pythium root rot on golf course putting greens. Unlike fungicide applications, applications of composts and organic fertilizers may also reduce populations of Pythium species in soil, thus reducing the risk of severe Pythium epidemics the following season.

If conditions warrant the application of fungicides, it is recommended that a currently-labeled fungicide be carefully chosen and properly applied. For seed and seedling diseases, seed treatments made prior to installation are perhaps the most effective application methods. These fungicide applications to the seed may control seedling diseases for up to three weeks after seed germination. The incorporation of granular formulations into soils at the time of sowing is also quite effective and offers disease suppression that is comparable to seed treatments.

Although turfgrasses affected with Pythium root rots and foliar blights respond to sprays or drenches with Pythium selective fungicides, symptoms may frequently recur. This may occur particularly as temperatures and precipitation levels change, since pathogen inoculum levels in soil are rarely suppressed following fungicide applications. Also the spectrum of Pythium species active at any given time may change with changing weather and management inputs.

Control strategies

Koban and Terrazole are contact fungicides that have also been effective in some locations for the control of Pythium diseases, particularly of seedling and root-rotting diseases and are probably the only chemical fungicides effective in reducing soil inoculum of Pythium. The mancozeb-based products as well as chloroneb do not appear to be consistently-effective in controlling Pythium diseases, and are thus not recommended.

For those sites with a history of early spring Pythium root rot problems prevention is the best approach. A fall application -- mid October to mid November -- of an appropriate Pythium fungicide (usually Banol) is the most effective time to suppress disease development the following spring. This should be followed up with another application in the spring: mid March to late April. In one field test of this strategy, a single fall application of Banol mixed with wetting agents and root stimulating compounds produced excellent results on transient spring-time root and crown rot infestations.

At any time during the season, for control to be effective when using systemic fungicides, the application must reach the root zone. Therefore it is recommended that all fungicides be thoroughly watered-in at the time of application.

Regardless of the Pythium disease one tries to control, it is also advisable to avoid continuous application of any one fungicide on the same site since this practice may enhance the development of fungicide-resistant Pythium populations. This phenomenon has already been observed among some strains of foliar blighting and root-rotting Pythium species.

Damage from some Pythium diseases, particularly root-rotting diseases has also been observed to be enhanced following applications of high rates or the continual use of several of the newer broad-spectrum systemic fungicides (particularly Bayleton, Banner and Rubigan). It is therefore recommended that these types of fungicides be used sparingly or rotated with other fungicides on sites with a history of Pythium disease problems.

The currently available Pythium fungicides and application recommendations are listed in Table 2 opposite.

Table 1

Species of Pythium associated with diseases of turfgrasses

Damping-off	*Pythium aphanidermatum, P. aristosporum, P. graminicola, P. irregulare, P. myriotylum, P. ultimum*
Root & Crown Rots	*P. aphanidermatum, P. aristosporum, P. arrhenomanes, P. catenulatum, P. dissotocum, P. graminicola, P. intermedium, P. myriotylum, P. rostratum, P. tardicrescens, P. torulosum, P. ultimum, P. vanterpoolii, P. vexans, P. volutum*
Snow Blights	*P. aristosporum, P. graminicola, P. iwayami, P. okanoganense, P. addicum*
Foliar Blights	*P. aphanidermatum, P. arrhenomanes, P. graminicola, P. irregulare, P. myriotylum, P. torulosum, P. ultimum, P. vanterpoolii*

Table 2

Fungicides for the control of Pythium diseases

Fungicide	Trade Names	Formulations	Application Rates (per 1000 square feet)*
Chloroneb	Teremec SP	65W	Not Recommended
	Tersan SP	65W	Not Recommended
	Scott's ProTurf Fungicide II	6.3G	Not Recommended
Ethazole	Koban	30W	7-9 oz
		1.3G	8 lb
	Terrazole	35W	8 oz
Mancozeb	Fore	80W	Not Recommended
	Lesco 4	80W	Not Recommended
	Lesco Mancozeb	DG	Not Recommended
	Manzate 200	37F	Not Recommended
		75DF	Not Recommended
	Tersan LSR	80W	Not Recommended
Metalaxyl	Apron	25W	2-4 oz/100 lbs. seed
	Subdue	2E	2 oz
		2G	1.5 lb
		5G	10 oz
	Scott's Pythium Control	1.2G	2.5 lb
(+triadimefon)	Scott's Fluid Fungicide II	16as	Not Recommended
(+mancozeb)	Pace	7+14S	Not Recommended
Fosetyl-Al	Aliette	80W	4-8 oz
Propamocarb	Banol	6S	2-4 oz

* All fungicides must be thoroughly watered-in to get effective Pythium root rot control. Only Aliette can be applied as a foliar spray and still maintain control of Pythium root rot. Of the systemic fungicides, Banol or Aliette have been most effective in controlling Pythium diseases in the Northeastern U.S. Subdue has been effective in some locations but has failed in others. The granular formulations of Subdue, at equal rates of active ingredients have been more consistent than the liquid formulation.

Confusion reigns

Naming cool- and warm-season Pythium diseases

by Dr. Eric B. Nelson

As the cover story describes, there are basically four types of disease groups incited by Pythium species:

- damping-off
- root and crown rots
- snow blights
- and foliar blights.

There has been a considerable amount of confusion over the common and quasi-scientific names applied to describe these different Pythium diseases. For example, we commonly hear the terms:

- "cool-season Pythium"
- "root Pythium"
- "cottony blight"
- "grease spot"
- "spot blight"
- "Pythium blight"
- "Pythium root rot"
- "warm-season Pythium"
- or just simply "Pythium"

applied to these four disease groups.

The elimination of confusion over which disease is being identified and discussed, through a clarification of terms for turfgrass managers, is critical to the successful management of Pythium diseases since the control strategies for each of the four types are quite distinct.

Cool- and warm-season Pythium: the difference

Perhaps the greatest confusion has developed over the distinction between "cool-season Pythium" and "warm-season Pythium". Often, those speaking of "cool-season Pythium" are referring to Pythium root rot, whereas those speaking of "warm season Pythium" are commonly referring to Pythium blight. The conditions that have typically been associated with cool- and warm-season Pythium disease are listed in Table 1. Both Pythium root rot and Pythium blight can occur any time of year under the appropriate conditions. However, most commonly, Pythium blight only occurs under the warm temperature conditions, whereas Pythium root rot can occur under both sets of conditions. In fact, the Pythium species responsible for Pythium root rot under warm temperatures are essentially the same as those causing Pythium blight under warm conditions (See Table 2 opposite). Similarly, the major root-rotting species at cool temperatures — *P. aphanidermatum, P. graminicola, and P. torulosum* — are also foliar blighters at cool temperatures. Important species such as *P. aphanidermatum* and *P. graminicola* are serious pathogens, regardless of the temperature.

Table 1

A comparison of cool and warm weather conditions for Pythium diseases on turfgrasses

Condition	Cool-Season Conditions	Warm-Season Conditions
Temperatures		
Day	50 - 65 F (10-18 C)	82 - 98 F (28-36 C)
Night	45 - 55 F (8-13 C)	68 - 75 F (20-24 C)
Relative Humidity	near 100% (day & night)	near 100% (night)
Cloud Conditions	overcast	hazy sun
Rainfall/Moisture	high/excessive	high
Turf Stress	important	not as important

Which species are the most significant?

The highly virulent species *Pythium aphanidermatum* and *P. graminicola* along with *P. myriotylum*, are usually the principal foliar blight species at warm temperatures. The same two species *P. aphanidermatum* and *P. graminicola* along with *P. arrhenomanes*, are principal root rot species at high temperatures. Although *P. ultimum* can been shown in testing to be highly virulent to turfgrass plants particularly at warm temperatures, it has rarely been encountered on golf courses or lawn turf.

The principal cool season root rot species are, again, *Pythium aphanidermatum* and *P. graminicola* with the addition of *P. torulosum* and *P. vanterpoolii*. Now little is known about the principal causes of cool weather blights,

as they are rare and studies of these diseases even rarer.

It is evident from Table 2 that *P. aphanidermatum* and *P. graminicola* are perhaps the most important Pythium species involved in both root rot and foliar blight symptoms, regardless of weather conditions. Additionally, both are important damping-off pathogens and *P. graminicola* may be an important snow blight pathogen, as well.

Much variability exists even within a species

Studies have shown that, at any given turfgrass site, on virtually any occasion, nearly all of the above-mentioned Pythium species are present within the turfgrass plants, usually in the roots and crowns. The question of how and whether or not symptoms are expressed may well depend not only on the species present, the amount of stress the plant is under, and the environment, but also which isolates of a given species is active.

Within a given species there is so much genetic diversity, that there are populations that behave differently in response to cool conditions than they do in response to warm conditions. For example, some isolates of *P. graminicola* recovered from bentgrass roots may cause high levels of disease at warm — greater than 82 F (28 C) — temperatures, but cause little or no disease at cool — less than 55 F (13 C) — temperatures. Other isolates of the same species may behave in just the opposite manner, with most disease symptoms apparent at cool temperatures. Still other isolates of *P. graminicola* have no temperature preference at all: they cause disease equally severely under both cool and warm temperatures.

Warm- and cool-season Pythium: no distinction

All of the important disease-causing Pythium species in turfgrasses are capable of inducing symptoms in turfgrass plants at both cool and warm conditions. Therefore, there are no distinct "cool-season" and "warm-season" Pythium diseases. Rather, root rot diseases and foliar blight diseases may occur over a wide range of temperatures.

Perhaps the concept of Pythium diseases can best be understood as being on a continuum in which perennial root infections first give rise to above- and below-ground symptoms of root rot under conditions of stress and high moisture but in the absence of any foliar mycelium. As temperatures increase and as dissemination of infection producing structures becomes more widespread and as the environment is more favorable to the activity of these Pythium species, the visual symptoms that we associate with Pythium infections become progressively more apparent on the surface of the turfgrass foliage. When the Pythium mycelium become clearly visible, late in the disease process, the possibilities for widespread epidemics are almost assured.

Table 2

Pythium species causing root rots and foliar blights at both cool and warm temperatures

	Root Rots		Foliar Blights		
Pythium Species	Cool	Warm	Cool*	Warm	Distribution
P. aphanidermatum	+++	+++	+	+++	All of U.S.
P. aristosporum	++	++	-	+	Mid-West & N.E.
P. arrhenomanes	?	+++	-	-	Mid-West & South
P. graminicola	+++	+++	++	+++	All of U.S.
P. myriotylum	-	++	-	+++	South
P. tardicrescens	+	+++	?	?	South
P. torulosum	++	-	+	-	All of U.S.
P. ultimum	?	?	+++	+++	?
P. volutum	+	+++	?	?	N. E. & Mid. Atlantic
P. vanterpoolii	++	-	+	-	Mid-West & N.E.

+++ = highly damaging, ++ = moderately damaging, + = slightly damaging, ? = disease-causing abilities unknown. * = very little is known about these diseases

How should turfgrass managers look at it?

From the turfgrass managers point of view, the actual temperature at which the symptoms occur has little to do with how control measures should be enacted. The critical factor in determining the success of a control strategy is whether the disease activity is localized in the root zone of the plant or whether it has progressed to the foliage. ■

Part two

A successful fairway conversion program

by Richard Bator

This is the second of two articles dealing with the conversion of fairways from Poa to Bentgrass at the Merion Golf Club in Ardmore, Pennsylvania, during the 1990 golf season while I was golf course superintendent. *(Editor's note: See the June issue for the first article.)*

This article and its accompanying field tips deal with the 16-step procedure, the equipment, and the corresponding staff assignments. I will say what I would do differently to improve the procedure. I will also outline what procedures are needed to be substituted, if one is to successfully convert from Bermuda-Ryegrass to Bentgrass in the transition zone.

Photo by Rick Holanda

Scalping the fairway.

To repeat: nothing new under the sun

As I said earlier, my ways of doing this are not new, different or necessarily better than another superintendent's, but for me they were successful. Any program can be improved upon and it is my hope that anyone who reads about my experience and who undertakes such a program will seek a better way to fit his needs and his course. As a matter of fact, I would like to hear from other superintendents about the methods they have employed. *(Editor's note: please send comments to Turf Grass Trends.)*

Finally, one other point to be repeated from last month is that 100% Poa control will not be attained. But, with a good initial conversion program and a fine-tuned Bent management program, there is no reason why an 80% to 95% Bent population cannot be achieved in the long term.

In the first of this two-part series, I stressed the ways to first sell the program and, secondly, the importance of

Field tips

The 16 steps

• 1st step: Scheduled closing of the course, Aug. 6-10, and a rain date of Aug. 13-17

• 2nd step: Apply Scotts Starter fertilizer seven days before, July 30-31, at a rate of 1 lb. Nitrogen/1000. Make the second application three to four weeks later at a rate of 3/4 lb. N/1000. Continue each month until December.

• 3rd step: Apply Subdue and Manzate as weather dictates, July 29-30, seven to 10 days prior to Aug. 6. Apply Subdue at the rate 1 1/2 oz./1000 and Manzate at the rate of 6 oz./1000.

• 4th step: Apply Embark five days before first slicing, Aug. 1, at a rate of 6 oz. product per acre in 30 to 50 gallons water per acre. Don't water this in. Obtain a special applicator for collars and approaches.

• 5th step: Shock mow fairways at 1/4" on the day of slicing. Dump clippings in a dump truck. Mow one fairway at a time. We used three Jake Triplexes.

• 6th step: Don't shut off the water. Use normal syringe and automatic watering practices. Some fairway turf, especially new enlargements, can be allowed to die back to facilitate a better turf catch in these areas.

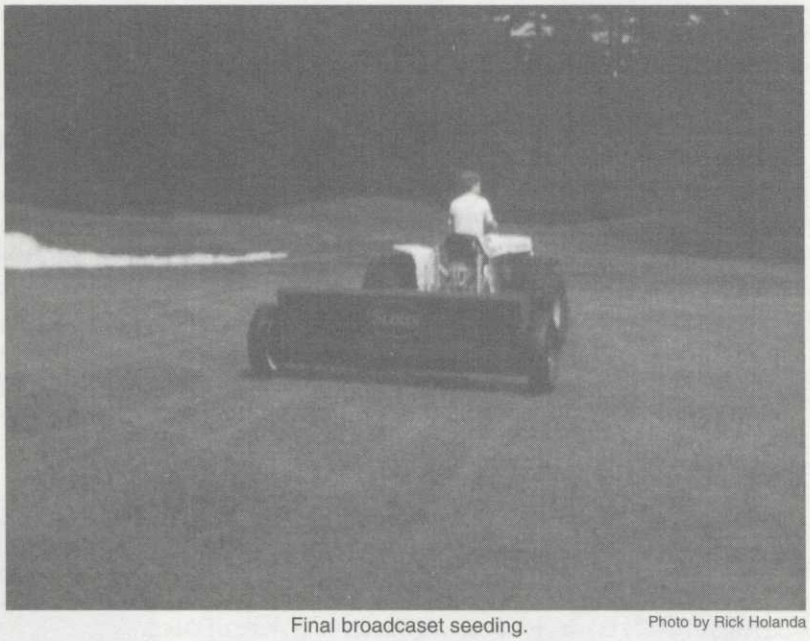
• 7th step: Slice in three directions. We used a Jacobsen 548 Slicer without a seeder box. The depth should be no more than 1/2" to 3/4". Slice collars and approaches in two directions. We used a Jacobsen 524 Slicer with medium blades, two available. Shock mow collars and approaches at 3/16" on Aug. 6.

• 8th step: Aerify in four directions. We used a Tara fairway aerifier without weight trays. We aerified the collars and approaches using 1/2" tines at higher depths. We cut off 1" of tine using a Toro aerifier.

• 9th step: Overseed the fairways. We used a Scotts 10' Drop Spreader in two directions at 3/4 lb./1000 in each direction. It was thus a total of 1 1/2 lbs./1000. On the collars and approaches we used a Scotts 3' Drop Spreader in two directions at same rates as on the fairways. We used Penncross Bent at a rate of 3/4 lb./

researching, planning and organizing the program, once it is approved by the club. Along with these two key factors there were listed various areas of concern which should be either corrected, implemented or checked before one undertakes the actual conversion program.

With all considerations now completed, the plan is ready for implementation. The field tips that accompany this article are key elements in organizing the staff, machines and materials. I won't say that "it's all in the organization," but that is a great part to finishing the conversion program successfully.



Final broadcaset seeding. Photo by Rick Holanda

Some adjustment may be needed

If I were to undertake such a fairway conversion program again, I would make one major adjustment. I would do everything the same way except that I would not use Embark five days prior to the start of the program. Instead, I would kill the fairway grasses using the non-selective vegetation killer Round-Up. I would do this seven to 10 days prior to the initial slicing, aerification and overseeding at a rate of 1 quart of product/acre or 1 lb. AI/acre. Through much observation and study from the successes or failures I have had using Prograss alone, I would use Round-Up in conjunction with Prograss for the following reasons:

- It would quickly eliminate the weak and nuisance colonial Bent grasses, and the non-desirable ryegrasses. It is far better and less aggravating in the long term to rid oneself of these problems in the beginning rather than to fight them later.

- By using Round-Up the possibility of gaining a 100% initial Bent covering is assured.

- In any Round-Up program one can expect a 30% to 50% reinfestation of Poa during the first three to 12 months. To prevent this reinfestation, applying Prograss in three

1000 sq. ft. in two directions for a total of 1 1/2 lbs./1000.

• 10th step: As soon as slicing and aerification are completed, mat it in. We used two Feust 10' drag mats in more than two directions. On the third matting we used two Keystone 10' mats after debris was blown off. On the collars and approaches we used a Keystone 5' drag mat behind a Cushman.

• 11th step: Blow off the debris. We used two Jacobsen 40 Blowers and one Olathe Blower on a 72" Toro Rotary. Use hand blowers for collars and approaches. We had three available. To facilitate clean up, mow fairways at 3/8" with Triplex Greensmowers.

• 12th step: Sweep roughs of all debris. We used an Olathe Sweeper and a John Deere Vacuum Sweeper.

• 13th step: Water daily, unless there is enough rain, three to five times a day with automatic sprinklers at six-minute intervals. Hand syringe collars and approaches and missed areas three times a day. Do this for two weeks or until rains come and grass starts to mature. If disease pressure builds, decrease irrigation frequency. Do not water at night. There is the possibility of stuck or missed sprinkler heads and the disease pressure.

• 14th step: Make a second application of Scotts Starter Fertilizer two weeks after all these steps are completed at a rate of 1/2 to 3/4 lb. Nitrogen/1000. Apply at same rates in September, October, November and December.

• 15th step: Apply, as conditions favorable to the development of Pythium-related diseases dictate, a combination of Manzate Z, at a rate of 6 oz./1000 and Subdue at a rate of 1 1/2 oz./1000, two to four days after germination.

• 16th step: Have available four workers to spot seed and topdress any areas of the fairways that become torn up and have void patches.

The membership newsletter on conversion

Communication is a key ingredient

As I said last month, I cannot stress enough the two basic factors that will lead to success. First, sell the greens chairman, committee and membership. Exhaustive research on the subject and presentation to the people who matter is the key: the greens chairman and his committee, the board and finally the membership in a membership meeting, as well as in a newsletter sent to the entire membership.

Naturally not all members will be at a membership meeting. It is vitally important to tell the members who were not at any face-to-face meeting about the program. I did that with several newsletters. The following newsletter was sent to the membership after we completed the program:

To: Membership of the Merion Golf Club
From: Richard M. Bator, Course Superintendent
Date: September 6, 1990
Subject: Recap and Progress Report of East Course Fairway Bent Conversion Program

First of all, I would like to thank the membership for their patience and understanding during the two week period (August 6-17) in which we carried out the first stage of this program. I apologize for the partial closing of the course over a two week period, instead of the planned one week, but adverse weather conditions during the first week prevailed over our original planned starting and finishing dates.

Starting on August 13, and ending on August 16, all of the before mentioned (Newsletter No. 4) renovation and over-seeding procedures on fairways, collars and approaches have been completed one day ahead of schedule (four days or 45 hours), and exceeding my original planned time schedule.

Needless to say, I am more than pleased, not only with the completion dates, but also with the quick initial germination of the new seed (germination was three and one-half to four days), its uniformity in coverage, the lack of large areas of torn spots or damage, and the final general appearance of the existing fairways after they were completed. So far, it appears that we have gotten off to a good start during this initial stage of the transition.

The only real damaged areas that were incurred were in the first cut on the intermediate rough. This I expected, and was due to the slicing and aerification equipment, along with the puffiness and thatch that generally develops in an intermediate rough that consists of Poa and Bent. All areas void of turf have to be over-seeded with ryegrass, and should show full recovery in several weeks. Next season, the existing Poa-Bent population in these areas will be burnt off and over-seeded with a more desirable mixture of ryegrass.

The second, and most critical, stage of this renovation program will take place on October 1st when the first of three planned Fall applications of the Poa control herbicide, Prograss, will take place. The next applications will take place on October 23rd and November 15th.

This chemical will be applied at lower than recommended or full strength rates, and this is to lessen the chances of injuring the new Bent that was over-seeded. Also, by using lower rates, the death of the Poa will be more gradual and less drastic, and the turf will be more playable for the membership. It will be during this lat Fall time frame that the actual death of the Poa will take place, and the newly seeded Bent will hopefully take over and fill in the voids of dead turf left by the disappearing Poa.

If our seed catch of new Bent continues to mature as I expect, the transition period from Poa to Bent could be smoother and quicker than I originally planned. But, a big "IF"! To enhance the maturity of the new Bent, the fairways will be fertilized every two to four weeks.

I do anticipate that certain small areas, especially lower No. 12 and the left side of No. 5 closest to the green, will at some point next season require some minor reseeding.These areas are in need of drainage, which will be completed this Fall, and are the main problem if a poor catch of new Bent does occur. This is not a major project, and will cause minimal disruption in play.

Winter rules will be in effect until further notice.

In closing, I would be remiss if I neglected to give thanks to our golf course staff for their dedicated efforts and contribution to the success of such a program. Each individual staff member had their own duty or responsibility to perform, and they all worked as a well-oiled machine and team, with a minimum of mistakes. Their tireless efforts in following a planned and calculated attack was, I feel, the key to our success during this initial stage. We can all be proud of their efforts.

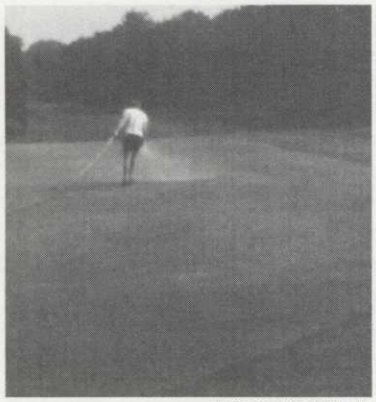


Photo by Rick Holanda

Hand watering of localized dry spots

applications from 36 to 40 days after seedling germination is a must. These applications will kill any emerging Poa plants, some Poa seeds and clover, too.

One can then apply Prograss during the next three seasons as needed, using the same initial rates. Using these two herbicides together or in harmony will ensure the goal of consistently having fairways with a Bent population of 90% or more.

Photo by Rick Holanda

Slicing and feeding of approaches and collars.

Bermuda-Ryegrass to Bent conversion for the transition zone

Contrary to turf folklore, Bent grass, if properly over-seeded initially and well-maintained, can survive very nicely in the transition zone, compared with Zoysia, Bermuda or Ryegrass.

I would stick with my initial conversion principles with the exceptions of pre-conversion aerification and deep slicing procedures and revised herbicide rates and applications.

One of the keys in getting the most long-term kill of the common Bermudas is — one to two years prior to their conversion — with an intensified aerification and deep

Photo by Rick Holanda

Finish mowing after renovation completed.

Field tips

Workers & schedules

At the Merion Golf Club I had available for this project 23 workers. Here is how I divided up the task according to the manpower I had available (using the names in this schedule, it is possible to make up one's own manpower allocation):

- Apply Scotts Starter Fertilizer, July 29 or 30. We used a pull-behind Lely or Vicon with Dwight. Also apply the same on collars on the same day with John and Greg. Hand water after application.
- Apply Embark using two sprayers with Dwight and Brandon. Apply Embark on collars with Bill. We used a borrowed applicator on July 30.
- Apply Subdue and Manzate Z with Dwight and Brandon on July 27, 28 or 29 at night. We sprayed the greens and tees, too.
- Shock mow fairways at 1/4", four to five fairways each day. We used a dump truck for the clippings. Our crew included Carlos, Miguel, Eli, and Dominic on Aug. 6. Shock mow collars all at once with Reggie, Greg, Bob. We used two dump body tractors for the clippings.
- Slice in three directions at same time: We used a 548 Slicer, a Ford with Corky, a 548 Slicer, a Massey with Jim, and a 548 Slicer, a Long with Ken. We tested all equipment and did routine preventive maintenance the week before.
- Aerify in four directions with a Tara Aerifier with Bob, Sam, and Greg. We used short tines and no weight trays.
- Seed with Scotts 10' Seeder with Dwight in two directions.
- Drag in two or three directions using 10' Feust Drag mat. We used the Ford with Frank and the Cushman with R. Holanda.
- Blow off debris: we used the Jake 50 with Greg, the Jake 40 with Reggie and the Olathe Blower on 72" Toro Rotary available as a spare.
- Sweep the roughs: we used the Olathe Sweeper with Miguel and the John Deere Vacuum Sweeper with Dominic
- The same operation must be done on the collars and approaches. We used the Jake 524 Slicer/Seeder in two directions, two hand leaf blowers, one Scotts 3' spreader for seed, tennis court rakes, a five-foot Keystone Drag mat on a Carry-All and one Toro Aerifier with tines cut off at 1" with Brandon, R. Tacconelli, and John.
- Water each fairway immediately. Do three-

Continued on page 15

slicing program. The goal would be to complete eight to 12 aerifications and six to eight deep slicings during this one to two year period. Or, accomplish as many of these aerifications and slicing as the club membership will tolerate. The principle behind this recommendation is to eliminate as much Bermuda thatch and as many runners as possible. This will ensure the best seedbed preparation for an initial 100% seed catch. This will also cut off a large percentage of Bermuda runners, which will cut down on the potential of Bermuda grass reinfestation, at the time of seeding and long term. To further enhance the seedbed preparation by thatch and runner elimination it would be best to aerify in three directions and slice in two directions one week prior to the first Round-Up application. By doing this one will thin the Bermuda to its maximum which can only benefit the program's total success.

Round-Up applications

I would apply Round-Up twice, at seven to 10 day intervals, before to the start of the actual renovation and seeding. Each application would be five quarts of product per acre or five lbs. AI/acre. With two applications and increased rates, the chance of early and long term Bermuda reinfestations will be minimized. The number of applications and increased rates are a must if a successful Bent conversion program is to be achieved.

Continuing the use of Prograss in the fall is also a must if Poa reinfestation is to be curtailed. Use the same rate and number of applications, three, that are listed in the Prograss schedule on this page. As for the use of Prograss thereafter, use the same number and rates of application during the following Fall. If Poa is not a problem, cease using the Prograss until an undesirable percentage of Poa returns.

Prograss schedule

Herbicide application

- 1st application: Oct. 1 1/2 lb. AI/acre Prograss or 1/3 gallon product/acre of Prograss. Apply 3/4 lb. Nitrogen/1000 sq. ft.
- 2nd application: Oct. 23 3/4 lb. AI/acre Prograss or 1/2 gallon/acre of product Prograss. Apply 1 lb. Nitrogen/1000 sq. ft.
- 3rd application: Nov. 15 3/4 lb. AI/acre Prograss or 1/2 gallon/acre of product Prograss. Apply 1 lb. Nitrogen/1000 sq. ft.
- Do not water for 24 hours after application as Prograss is a foliar absorbent herbicide.
- Prograss should not be applied until 42 days after initial germination.

Six to 12 months later

Naturally, one may have to spot over-seed or even spot-sod.

It is important to keep up fertilization levels. Use a complete fertilizer and iron.

One should not have to use Embark the following spring.

The following August one must check for reestablishment of Poa. Make the decision then if Prograss applications are needed. It is possible one may to use Prograss for the next three seasons, using the 3/4 lb. AI/acre rate for each of the three fall applications. This was our practice and it worked out well for us.

There are three possible negatives in using Prograss for the eradication of Poa. Although possible, they are very remote, with only short term effects that can quickly be corrected.

There might be not more than 5% perennial Poa in the fairway turf as opposed to predominant annual Poa. The perennial variety would probably not be affected by the lower rates of Prograss that would be applied during the conversion program. These low populations of perennial Poa could easily be eliminated during the next fall, using the higher application rate of Prograss.

In low, poorly drained areas phytotoxicity and death of grass in these areas could occur following any sudden or heavy rain within five days after each application. If this did happen, these areas would be sliced and seeded in the spring after the conversion. There would be only minor inconvenience to the membership and full turf cover would be the result. Phytotoxicity could also occur as winter kill in the winter after the conversion if there were a severe and prolonged cold spell then. Severe means temperatures at 10 to 15 degrees Fahrenheit below zero for more than two to three weeks. This did happen during the winter of 1994 with death of turf as a result of low temperatures. Over-seeding the following spring could correct this problem.

One area of concern in choosing Prograss with its gradual elimination as opposed to the total kill obtained by using Round-Up was that the Bent populations on our fairways were the old colonial varieties. These varieties are patchy, grainy and puffy, as well as susceptible to mechanical damage by aerification and de-thatching. They are also prone to damage by insects and fungus. These varieties are also damaged by most pesticides and by cold weather, causing discoloring and damage. Spot spraying them with Round-Up and over-seed the resulting dead areas should solve that problem.

It is certain there will some reinfestation of the old, common Bermuda variety three to six years later. If this the case, the choices would be to spot spray these patches with Round-Up and over-seed with Bent. If the reinfestation is more uniform and a nuisance, it may necessitate re-spraying all the fairways and carrying out the initial program again. This would be the worst-case scenario. It would be five years before this would be evident. With sound Bent management practices, this may be able to be avoided.

Bent survived the winter

I would suggest that the severe cold and ice damage that resulted from the winter and early spring weather this year, many superintendents might think about using Bents on their fairways. I say this because the highest percentage of turf losses were Poa, Ryegrass and Bermuda grass. The Bents showed little to no damage from the severe weather. That in itself should sell the program.

I will make one more point in favor of Bent fairways. It has always puzzled me that, if superintendents in the transition zone can grow Bent-Poa greens at between 1/8" and 5/32" and Bent tees at between 1/4" and 3/8" and hold them throughout the summer stress season, then Bent fairways, mowed between 3/8" and 1/2", can also be grown and held during these months. It should be somewhat easier to keep the Bent fairways, considering the height difference between fairway and greens and tees. I also believe there has been prejudice against Bent fairways. But, as more and more superintendents and university researchers complete the change-over program and see the results, this prejudice against Bent fairways will lessen to the benefit of the golfer as well as the superintendent.

This conversion program has worked at the Merion Golf Club and for other superintendents. It can work successfully for you. What is needed is for the superintendent and the club to be convinced of the benefits of Bent fairways. The parties — superintendent and the member — must commit themselves, as well as to learn the proper procedures and programs in maintaining Bent, to the program and must carry it out from start to finish to have the finest hitting surface that can be attained for the membership. ■

Workers & schedules *continued from page 13*

five moves a day with Charlie and Kevin. These two workers also assisted me in keeping the operation running as smoothly as possible. We used hand syringers for missed areas with Matt, Bill, and Dick. Water greens and tees with the automatic watering system where possible, and by hand if needed. Deep soak the night before or stay three holes ahead of slicers and use the automatic watering system. Water the first three greens by hand. Use the automatic watering system on the tees.

• West mowing schedule, Aug. 6-10: greens, tees, collars and fairways — Monday, Wednesday, and Friday.

• East mowing schedule, Aug.6-10: tees — Tuesday, Thursday, and Saturday. Greens — Tuesday, Thursday, and Saturday. If the operation is completed on time or earlier, step up these mowing schedules to normal mowing schedules. Intermediate rough, mow twice with Dominic on the National. Intermediate rough around the greens, mow twice and assign workers as they are available.

Mowing on both courses should be done as workers are available.

• Apply Subdue and Manzate on Aug. 13 with Brandon and Dwight. This date must be met.

Three weeks after completion.

Photo by Rick Holanda

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