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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.

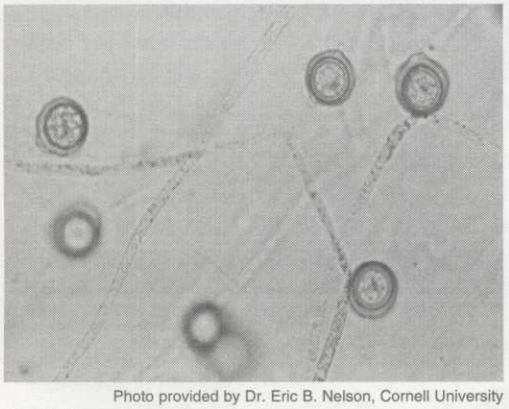

Photo provided by Dr. Eric B. Nelson, Cornell University

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.

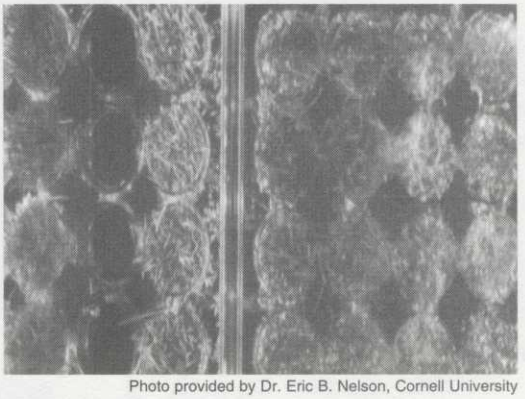

Photo provided by Dr. Eric B. Nelson, Cornell University

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

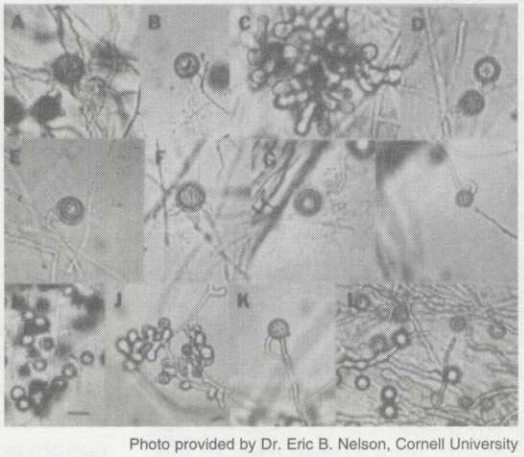

Photo provided by Dr. Eric B. Nelson, Cornell University

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

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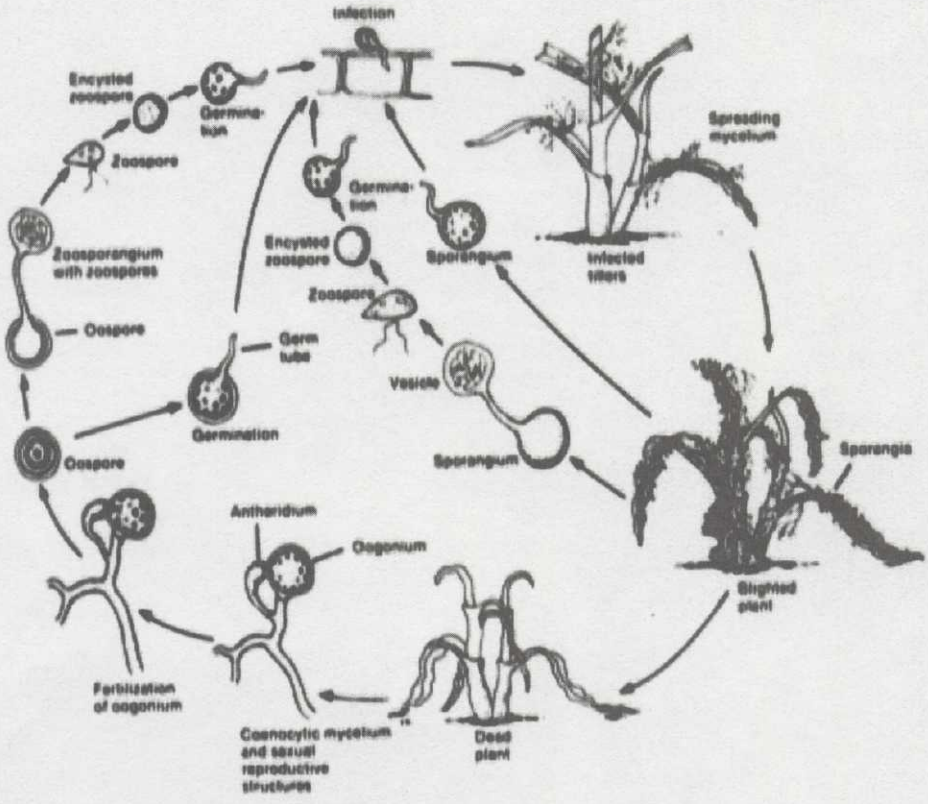
by nearly all of the turfgrass-infecting species. Pythium species may produce up to four types of these survival and propagative structures: oospores, zoospores, chlamydospores, and a mycelial structure called hyphal swellings.

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

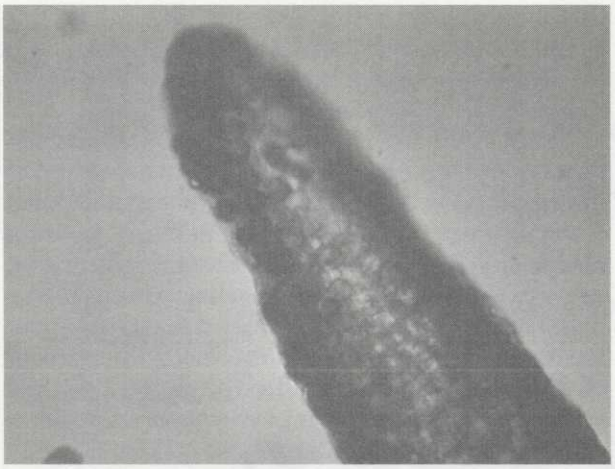


Photo provided by Dr. Eric B. Nelson, Cornell University

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

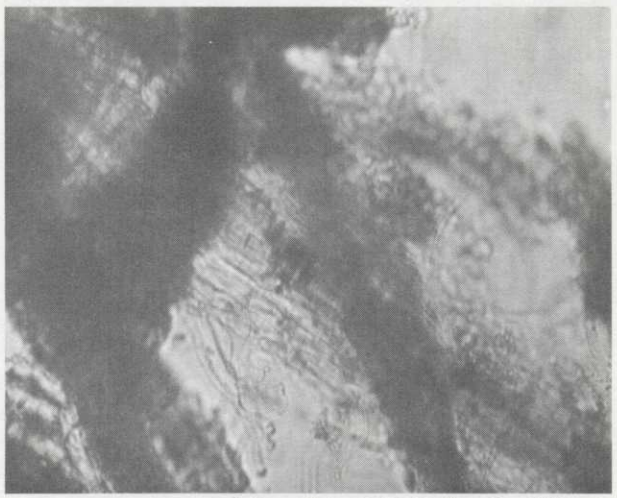


Photo provided by Dr. Eric B. Nelson, Cornell University

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.

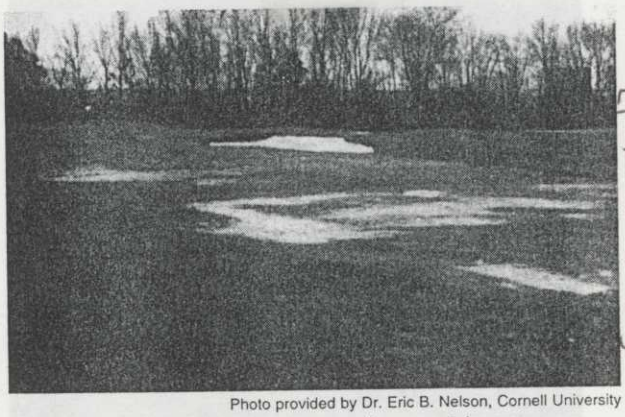


Photo provided by Dr. Eric B. Nelson, Cornell University

Symptoms of Pythium snow rot on a golf course fairway.

Symptoms of Pythium snow rot on a golf course fairway.

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

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.