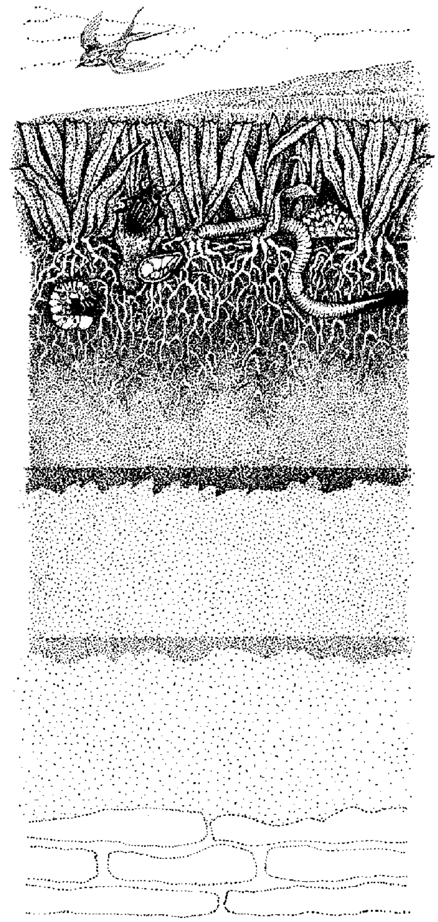
CORNELL UNIVERSITY TURFGRASS TIMES

CUTT

Spring 1998 • Volume Nine • Number One • *A Publication of Cornell Cooperative Extension*



Understanding Seed Treatments for Turfgrass Establishment

Seedling establishment is the most critical stage in new turfgrass installations or renovations. Establishment efficiency can be affected by many different factors including speed of germination, inherent competitiveness with other turfgrass varieties as well as grass and broadleaf weed species, and susceptibility to seed rotting and damping-off pathogens. These pathogens are perhaps the most troublesome yet one of the most infrequently recognized cause of establishment failures. To understand ways of improving stand establishment, it is important to understand the nature and control of seed rotting and seedling pathogens of turfgrasses. ■

Seed and Seedling Pathogens of Turfgrasses

As mentioned previously, many times the major limiting factors to stand establishment are seed rotting and damping-off fungi. The more common seed and seedling rotting fungal pathogens include species of *Pythium*, *Fusarium*, and *Rhizoctonia*, along with a myriad of other minor species comprising over 15 fungal genera. Few studies have focused on the ecology, epidemiology, and control of *Fusarium*- and *Rhizoctonia*-incited damping-off diseases of turfgrasses. However, turfgrass seedling diseases caused by *Pythium* species have been widely studied and this group of turfgrass pathogens are perhaps the most important in limiting stand establishment .

Not only are *Pythium* species major seed rotting and seedling rotting pathogens, but, once established in a turfgrass planting, become major root rotting pathogens as well. In a survey if pathogenic *Pythium* species recovered from mature bentgrass turf, the more aggressive creeping bentgrass damping-off pathogens included *P. graminicola*, *P. aphanidermatum*, *P. aristosporum*, *P. vanterpoolii*, *P. myriotylum*, *P. tardicrescens*, and *P. volutum*. All of the highly aggressive isolates were more virulent to creeping bentgrass seedlings at warm temperatures (28°-32°C) than at cooler temperatures (16°C).

In another study of *Pythium* species on creeping bentgrass and perennial ryegrass, *Pythium graminicola* was isolated most frequently from mature stands of turfgrasses and nearly all isolates tested were highly virulent as seed rotting pathogens of creeping bentgrass and perennial ryegrass. Additional pathogenic species recovered were isolates of *P. aphanidermatum*, *P.*

continued on page 4

This Times

1. *Seed Treatments for Turfgrass Establishment*
2. *Short Cutts*
   • Successful Grants
   • Field Day
   • Short Course
3. *Scanning the Journals*
8. *Silicon: The Universal Contaminant*
11. *Tree Leaves and Bluegrass Quality*
12. *Communication Skills for Interaction*
13. *CUTT Index Update*
16. *Moisture Effects on Entomopathogenic Nematodes*

Turfgrass Establishment

continued from front cover

Pythium *damping-off of turfgrasses is known to be affected by a number of factors which directly impact establishment efficiency:*

- ***Germination time***
- ***Soil Moisture and Oxygen Levels***
- ***Soil Temperatures***
- ***Planting Depth***
- ***Sowing Density***
- ***Cultivar Selection***

aristosporum, *P. torulosum*, and *P. vanterpoolii*. At least one isolate within each species was highly virulent to creeping bentgrass seeds and seedlings. *Pythium torulosum* was the most frequently recovered species from turfgrass roots and crowns, but nearly all isolates were nonpathogenic. Five pathogenic isolates of *P. torulosum* were recovered and, with the exception of one isolate, all were only weakly virulent to creeping bentgrass seedlings at cool (13° C) or warm (28° C) temperatures.

Conditions Favoring Pythium Damping-Off of Turfgrasses that also Affect Stand Establishment

Pythium damping-off of turfgrasses is known to be affected by a number of factors which directly impact establishment efficiency. These include a number of important environmental and cultural factors and are described below:

1) Germination time. The longer seeds spend in moist soil, the greater the potential for seed and seedling rots. Kentucky bluegrass may take 2-3 weeks after planting before emergence whereas fescues and bentgrasses may take a week to 10 days. Perennial ryegrasses generally require less than 1 week for emergence.

2) Soil Moisture and Oxygen Levels. All *Pythium* species require abundant moisture for germination and dispersal. Prolonged wet soils will favor seed and seedling rots. Unfortunately, these prolonged wet periods are necessary for adequate seed germination and seedling establishment. Generally the greater the soil moisture, the lower the oxygen levels in soil. Increased soil compaction also decreases soil oxygen levels by decreasing the amount of air-filled porosity.

3) Soil Temperatures. *Pythium* species are capable of inciting severe seed and seedling rots at both cool and warm temperatures. In our laboratory, we have found that the majority of *P. graminicola* isolates and all *P. aristosporum* isolates recovered from mature stands of turf are highly virulent as seed and seedling rot pathogens at both 13° and 28° C. In these studies, damping-off severity of specific isolates of *P. graminicola* and *P. vanterpoolii* on creeping bentgrass was favored by either cool or warm temperatures, depending on the isolate. Although isolates of *P. aphanidermatum* were virulent at both temperatures, in general, they were more virulent at 28° C than at 13° C. At 28° C, some isolates of *P. graminicola, P. aphanidermatum* and *P. aristosporum* were pathogenic to perennial ryegrass in growth chamber experiments, whereas none of the isolates of *P. torulosum* and *P. vanterpoolii* were pathogenic. On perennial ryegrass, isolates of *P. graminicola* ranged from nonpathogenic to highly virulent. Because of the wide temperature optima of individual strains as well as the presence of both cool temperature and warm temperature strains in many turfgrass soils, it is difficult to find temperature conditions that are not favorable for seed and seedling diseases caused by *Pythium* species.

4) Planting Depth. Planting depth affects susceptibility of seedlings to damping-off by increasing the amount of time susceptible tissue spend in soil exposed to pathogens. The more quickly the seedling emerges, generally the more quickly the plant can escape infection from seed rotting pathogens.

5) Sowing Density. Seeds of turfgrasses are sown into a variety of habitats. Typically, seeds are sown into a well-prepared plant-free seed bed or they are overseeded into an established turfgrass stand. It is typical practice to continually overseed thinning areas of turf or to transition from a warm-season grass to a cool season grass. In both cases seeding rates are generally excessive. The notion among most turfgrass managers is the more seed you sow the better the stand. However, it has been shown in studies with other plant species that increased seedling densities may enhance *Pythium* damping-off severity. The increased seedling densities are comparable to increasing the soil inoculum of *Pythium*. Increasing the seedling density increases the germination frequency of *Pythium* propagules and also enhances the plant-to-plant spread of the pathogen.

6) Cultivar Selection. A number of studies of Pythium resistance among turfgrass species and cultivars have been conducted. Results from such evaluations are considerably incomplete, inconsistent, and focused on *Pythium* blight of mature stands of turf, not on damping-off of seedling turf. In early surveys of a limited number of turfgrass species, nearly all of the cool-season grasses, including creeping bentgrasses, were all susceptible to foliar blights caused by *P. aphanidermatum* or *P. ultimum* whereas warm-season species were not. However, results from a more detailed study of creeping bentgrasses in Georgia indicate that cultivars such as Providence, Penneagle Emerald, Cobra, Putter, and others were more resistant to foliar blighting caused by *P. aphanidermatum* than were cultivars such as Penncross, Pennlinks, and National. In contrast, results from a similar study in Texas suggest somewhat the opposite: that cultivars such as Providence were the most susceptible to foliar blighting caused by *P. aphanidermatum* whereas Pennlinks, Penncross, and National were among the most resistant. These conflicting results suggest that some level of *Pythium* blight resistance can be found in creeping bentgrass cultivars but that this resistance may be expressed differently in different climatic areas. To our knowledge, there are no complete and contemporary studies on susceptibility of bentgrass varieties to *Pythium* damping-off.

Why are Seeds and Seedlings So Susceptible to Damping-Off Pathogens?

Of all stages of plant development, the germinating seed and seedling stage are perhaps the most vulnerable to a variety of stress-related factors that could potentially be fatal. Not only are plants at this stage more vulnerable to water deficits, temperature extremes, and pesticide toxicity than mature plants, they are also much more susceptible to infection by soilborne pathogens.

One of the principle reasons for the increased susceptibility of germinating seeds and seedlings to infection, particularly by *Pythium* species, is the exudation of cellular compounds into the soil surrounding the seed or spermosphere during the germination process. The spermosphere is a zone of increased microbial activity around a seed. The spermosphere is established through the exudation of molecules into the surrounding soil during the germination of seeds (see Figure 1). Some of the molecules found in seed exudates stimulate the infection of plants by pathogens. Spores of *Pythium* species germinate when they are within the spermosphere. No infections are initiated from spores that are outside the spermosphere.

During initial stages of seed germination, the uptake of water into the seed results in the physical damage to cell membranes. Even though the plant eventually repairs this damage, many cell constituents leak out of the seed into the surrounding soil during the first few hours of germination before repair processes are complete. Under high moisture conditions or suboptimal conditions for seed germination, seeds release more exudates.

Nearly all seed- and seedling-rotting pathogens utilize these exudates as a food source and to sense the presence of a susceptible host plant. Many pathogens, such as *Pythium* species, are ecologically adapted to respond very rapidly to the presence of these exudates since they do not persist for long periods of time in the soil.

The presence of seed and seedling exudates are critically important in regulating responses of pathogens to plants and in supporting microbial interactions and processes in the spermosphere. If there are insufficient concentrations of exudates in the spermosphere, *Pythium* species do not respond to the presence of the plant and do not infect the seed or seedling.

continued on page 6

Many pathogens, such as* Pythium *species, are ecologically adapted to respond very rapidly to the presence of these exudates since they do not persist for long periods of time in the soil.

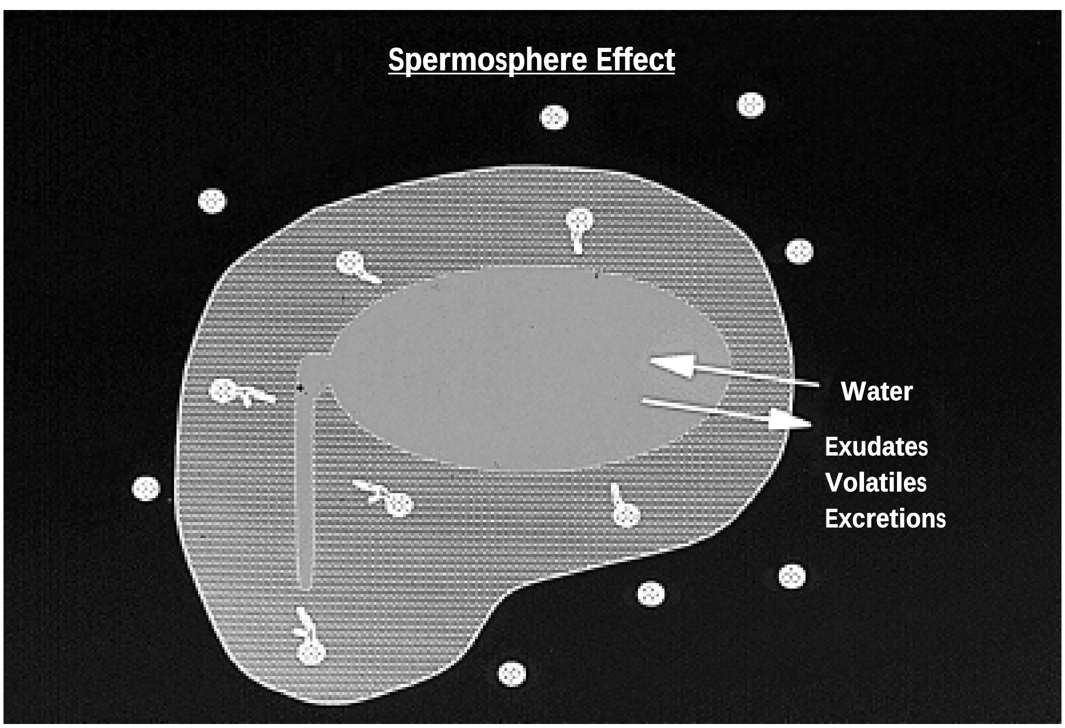


Figure 1

The spermosphere is established through the exudation of molecules into the surrounding soil during the germination of seeds. Some of the molecules found in seed exudates stimulate the infection of plants by pathogens.

Turfgrass Establishment

continued from page 5

Unlike pregermination treatments, primed seed can be rinsed and dried after the priming process and can be planted like untreated seed.

If done properly, pathogen stimulatory exudates are removed in both pregermination and seed priming techniques making seeds much less susceptible to* Pythium *seed and seedling diseases when planted.

Seed Treatments to Improve Stand Establishment

Pregerminated Seed. Presoaking seed treatments that result in the emergence of the radicle are referred to as pregermination treatments. These treatments generally involve the soaking of seed in until radicle emergence and then planting the germinated seed as a slurry. This is done to enhance the germination rate of seed once planted in soil. Even though this method greatly decreases the establishment time, seeds planted in this manner is not only difficult to handle since they must be planted immediately and require specialized equipment, but germinated seeds are much more susceptible to physical damage than are ungerminated seeds.

Studies with pregerminated seeds of other plant species have shown that the soaking process releases many pathogen stimulatory exudates within the first 24 hours of soaking. When these seeds are then planted in soil infested with pathogenic *Pythium* species, seeds and seedlings are much less susceptible to disease.

Seed Priming. Seed priming has also been referred to as osmoconditioning. This process differs from presoaking treatments in that the radicle never emerges from the seed coat. In the priming process, seeds are soaked in a solution of various salts or polyethylene glycol to limit water availability to the seed. Concentrations of these solutes are adjusted to allow the seed to imbibe just enough water to initiate the biochemical processes required for seed germination but not sufficient quantities of water to initiate radicle emergence. Unlike pregermination treatments, primed seed can be rinsed and dried after the priming process and can therefore be planted like untreated seed.

Both types of presowing treatments are most effective on slow-to-germinate species such as Kentucky bluegrass or bermudagrass and may increase the emergence time by up to 10 days over nontreated seed. These effects are particularly pronounced in cool soils where *Pythium* seed rots and damping-off can be more serious problems.

Different species, varieties, and even seed lots vary in the time it takes for each of these processes to run to completion. Without knowing the exact priming times required, it is possible to end up with insufficiently-primed seed or seed that has been soaked too long and is deteriorating.

In both pregermination and seed priming techniques, solutions must be aerated to supply sufficient concentrations of oxygen to the seed during water imbibition. This allows the seed to imbibe water normally. If done properly, pathogen stimulatory exudates are removed in both pregermination and seed priming techniques making seeds much less susceptible to *Pythium* seed and seedling diseases when planted in soil.

Fungicide Seed Treatments. In nearly all of the studies with fungicide seed treatments on turfgrasses, positive improvements in seedling stands have been obtained. Nearly all of the published studies have been conducted with annual or perennial ryegrasses. To my knowledge, only one study has been conducted on creeping bentgrass and this has not been published in widely accessible sources (Leslie MacDonald and Ken Ng, TurfLine Newsletter of the WCTA). In some cases, improvements in seedling stands of over 70% have been observed. In other cases, protection may last up to 10 weeks after sowing.

Biological Seed Treatments for Control of Seed and Seedling Pathogens

Biological seed treatments and seedbed amendments have proven to be quite effective in suppressing damping-off diseases of turfgrasses incited by *Pythium* species. In a study of bacteria suppressive to damping-off of creeping bentgrass and perennial ryegrass incited by *P. aphanidermatum*, nearly 45% of all bacteria recovered from mature turfgrass stands were suppressive to *Pythium* damping-off. A higher frequency of antagonistic strains was found among the general heterotrophic bacteria than within the selected groups of enteric bacteria and *Pseudomonas spp.*, groups known to be antagonistic to many turfgrass pathogens.

Although isolations of general heterotrophic bacteria yielded higher frequencies of effective antagonists, strains of enteric bacteria, particularly strains of *Enterobacter cloacae* were more highly suppressive to *P. aphanidermatum* on perennial ryegrass than general heterotrophic bacteria or *Pseudomonas spp.* The level of control was as good as that provided by the fungicide, metalaxyl.

Other studies have shown that, in addition to *E. cloacae*, a wide variety of bacterial strains are suppressive to damping-of of creeping bentgrass incited by *P. graminicola* when applied as seed treatments. These strains are effective at both cool (20 °C) and warm (28 °C) temperatures and, at least for some strains, they were highly suppressive for at least 11 days.

There are now a number of products on the market consisting of microbial preparations. These are marketed in a variety of ways but are generally targeted at improving soil properties. Particularly when sowing seed in a high-sandcontent environment where microbial activity may be somewhat low, some of these types of products may provide some benefit in reducing problems with *Pythium* damping-off and improving stand establishment. Unfortunately, there is no microbial-based product that is currently registered with the US EPA for control of *Pythium* damping-off diseases in turfgrasses.

In addition to bacterial seed treatments, some composted organic amendments are also suppressive to *Pythium* damping-off and the subsequent symptoms from root rot damage. Amending sand with composts prepared from a variety of feedstocks suppressed seedling and root diseases of creeping bentgrass caused by *Pythium graminicola*. Among the more suppressive materials in laboratory experiments are industrial sludge and municipal biosolids composts. Leaf, yard waste, food, and spent mushroom composts, as well as certain biosolids, cow manure, chicken/cow manure, and leaf/chicken manure composts are generally not suppressive to *Pythium* damping-off. *Pythium*-suppressive composts typically have higher microbial populations than non-suppressive composts. Furthermore, a strong negative relationship between compost microbial activity and *Pythium* damping-off severity was observed, indicating that much of the suppressive activity was due to microbial activities present in the compost amendment. A number of microbes recovered from these suppressive composts are equally suppressive to *P. graminicola*-incited damping-off when applied as seed treatments.

Conclusions

Pythium seed rot and damping-off takes a countless toll on newly developing turfgrass seedlings. In the past, seedling stand losses due to *Pythium* damping have never been of particular concern because of the relatively low cost of turfgrass seed. To my knowledge, the magnitude of losses during seeding and over-seeding programs has never been documented. However, there is now much more interest in stand losses because of the ever-increasing cost of seed and the increasing amount of over-seeding during transitioning of golf course turf. Seed treatments may provide a significant improvement in stand establishment and may provide a significant saving in seed costs.

Options are available for the treatment of turfgrass seed. Presowing germination and priming techniques appear to be of limited value to most turfgrass species, particularly those such as ryegrasses that germinate rapidly. The greatest benefit of these techniques has been seen with slowly germinating varieties (such as Kentucky bluegrass) sown in cold soils and in situations where a rapid weed-free turf cover is essential. Although there have been methods described for priming seed, it is advisable to leave the presowing treatments to the seed producers since light, temperature, oxygen levels, and solution concentrations are critical and must be monitored carefully. Any mistakes can result in the loss of the seed. Currently, fungicide seed treatments are the most effective approach for controlling *Pythium* damping-off in newly-sown areas. Several products are currently available as seed treatment formulations. Although microbiological products are not currently labeled for seed and seedbed treatments, many of these types of products can be used successfully to improve stand establishment by reducing damage from seed rotting pathogens.

ERIC B. NELSON
CORNELL UNIVERSITY TURFGRASS TEAM

Strains of* Enterobacter cloacae *were highly suppressive to* P. aphanidermatum. *The level of control was as good as that provided by the fungicide, metalaxyl.

Unfortunately, there is no microbial-based product that is currently registered with the US EPA for control of* Pythium *damping-off diseases in turfgrasses.