TURFGRASS TRENDS

DISEASE MANAGEMENT

Spring Dead Spot Research Targets Better Control in Bermuda

By Michael Anderson, Arron Guenzi, Dennis Martin, Charles Taliaferro and Ned Tisserat

Spring dead spot (SDS) is a major disease that affects bermudagrass in the United States and worldwide. Within the United States, the disease is most prevalent in the northern range of bermudagrass adaptation.

Oklahoma State University and Kansas State University researchers are focusing their efforts on gaining a better understanding of the way bermudagrass is infected, with the ultimate goal of developing improved control options.

Today we know the disease is caused by three root-rotting fungi: *Ophiosphaerella herpotricha*, *Ophiosphaerella korrae*, and *Ophiosphaerella narmari* (Tisserat et al., 1989). All three fungal species are found in the United States with *O. herpotricha* being the most abundant causal agent in the Midwest. *O. korrae* has been located throughout the United States and Australia. *O. narmari* has been isolated in California, Oklahoma and Kansas, and is a major pathogen in New Zealand and Australia (Wetzel et al., 1999).

We know Spring Dead Spot is caused by three root-rotting fungi.

The fungus usually takes from two to three years to become fully established. Symptoms of the disease include circular bleached and depressed thatch areas from 6 inches to 3 feet in diameter.

Once established, the below-ground roots and rhizomes are typically covered with dark brown to black fungal hyphae. Like many root-rotting fungi, this fungus is most active in the early fall and spring when temperatures and moisture favor fungal growth and when bermudagrass growth slows down.

In the fall, infection weakens the bermudagrass root system and predisposes it to winter injury. For this reason, the disease is more common in Northern colder climatic areas and during years of severe winter.

Researchers have shown there is a close association between resistance to SDS and resistance to cold temperatures (Baird et al, 1998). In other words, bermudagrass varieties that resist the cold also resist SDS infection. Since freezing temperatures tend to increase damage, it stands to reason that cold-resistant varieties would show less damage than nonresistant varieties and would be less susceptible to attack by opportunistic fungi. Nus and Shashikumar (1993) showed that infection with *O. herpotricha* and *O. korrae* reduced the ability of a single bermudagrass line to adapt to cold temperatures, and that this lack was possibly related to changes in cell membrane properties.

With the coming of spring and warmer temperatures, bermudagrass breaks dormancy and spring growth continues. In diseased areas, damaged tissue often fails to regrow, leaving

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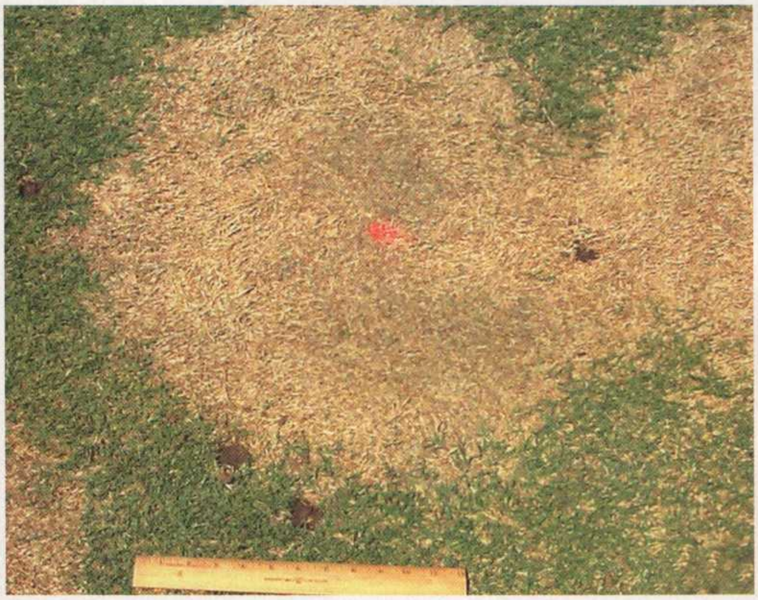

Spring Dead Spot weakens the bermudagrass root system and predisposes it to winter injury.

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the characteristic circular patches containing dead and dying tissues. However, regrowth can occur from the margins of the infection zone and from surviving plants within the patch that results in a recolonization of the dead areas. Often recolonization by aggressive varieties may cause the summer patches to completely disappear. This seasonal cycle of infection and recolonization results in a variation in patch size from year to year. After five to six years, the symptoms usually subside and can even disappear for unknown reasons.

Damage reduction

What can be done to reduce the damage caused by SDS? Unsightly patches of infected bermudagrass often require expensive remedies. The severity of disease symptoms increases with a number of environmental conditions and cultural practices.

Generally speaking, factors that delay fall dormancy or reduce winter hardiness tend to promote the disease. Excessive fall fertilization and an accumulation of thatch will also increase SDS infection.

Bermudagrass growing on soils that are poorly drained or have been compacted also show greater symptoms. Ned Tisserat, Kansas State University plant pathologist, recommends dethatching and core aerification to reduce damage cause by SDS (Tisserat, 2001).

What about fungicides? Unfortunately, disease control through chemical fungicides has been erratic. Control varies from year-to-year and usually requires more than one application.

One of the best approaches for reducing SDS is the use of resistant bermudagrass varieties. The programs of Charles Taliaferro and Dennis Martin have been active in producing and evaluating SDS response in elite breeding lines and commercial varieties, respectively. Resistant varieties such as Guymon, Midlawn, Midfield, Midiron, Yukon, Mirage and Sundevil typically show less damage from SDS.

Yukon is a recently released seeded variety with substantial resistance to SDS. However, none of these varieties are immune to the disease, and some do not offer the quality demanded by golfers.

Susceptible varieties include Arizona Common, Cheyenne, Jackpot, NuMex Sahara, Oasis, Poco Verde, Primavera, Princess, Sonesta, Shanghai, Tifton 10, Tifway, Tifgreen, Tropica, Vamont and Sunturf.

Biocontrol of SDS may be a possibility in the future. Biocontrol agents usually consist of microorganisms that when applied kill or inhibit the growth of specific disease-causing organisms. Several biocontrol agents have been successful in controlling specific plant diseases. Recently, a bacterium was found by the laboratory of Michael Anderson that dramatically suppressed the growth of O. *herpotricha* on nutrient agar.

Incorporation of an aggressive bacterium into the soil may suppress the infection enough to tip the balance in favor of the bermudagrass plant. The bacterium could be applied as a soil drench during the fall when the fungus is most active or in the spring to improve the rate of recovery during spring greenup. Plots are currently established for the testing of this biocontrol agent in the field. Results should be forthcoming in a couple years. Research to better understand the basic biology behind the infection process is also continuing.

There are many constraints in studying SDS and in breeding for resistant varieties. One of the major constraints is that it takes two to three years to establish the disease in the field, and an additional three years to collect and analyze the data. All in all, at least three to five years' work is required before field trials provide meaningful data. This evaluation bottleneck is the major obstacle for the breeding varieties resistant to SDS.

Taliaferro's breeding program evaluates turf bermudagrass varieties in the advanced stages of development for SDS response as a final measure of commercial fitness. The lack of a quick effective screen for SDS response makes direct selection for resistance untenable.

Breeders are reluctant to tackle this problem directly if it takes five years to evaluate the material after each round of genetic selection.

Conceivably, controlled environmental studies could take less time. However, results from controlled studies often fail to correlate with those from the field. This indicates that certain factors contributing to resistance may be missing in the controlled studies.

Tisserat is studying infections under controlled environmental conditions to identify these missing factors. Tisserat is focusing primarily on low-temperature applications and inoculum levels to simulate field conditions.

Other factors, such as differences between the microbial composition of field soils and the presence of a heavily infested thatch layer, may also be associated with resistance manifestation. Successful identification of the missing factors will provide valuable information concerning the infection process and allow the construction of a more rapid screening system.

Until a better system is in place, screening for SDS resistance will have to be performed using the current time-consuming field-screening method.

Last but not least, a better understanding of the infection mechanism at the molecular level could lead to novel and improved control methods. In the laboratory of Arron Guenzi, research is underway to identify genes that are activated and deactivated during the infection process. Genes direct the biological activity of all living organisms. All biological processes are driven by the pattern of activation or deactivation of specific genes.

Research shows that many plant defense genes are activated in response to fungal infection. The idea behind this research is that if one could identify the pattern of gene expression, one could better understand how the plant defends itself against pathogen attack and ultimately engineer a better defense response.

At this time, little is known concerning defense mechanisms against root-borne pathogens. A student of Guenzi's, Yan Zhang, constructed a library of more than 900 gene sequences that are potentially expressed when bermudagrass is infected with the causal agent of SDS. The sequences in Yan's libraries were found to contain many known genes that defend against pathogens.

These genes were further evaluated using microarray technology. A microarray consists of a glass slide containing thousands of microscopic spots of DNA from specific genetic elements deposited on a glass surface. Probing the microarray with a fluorescently labeled DNA from infected areas and non-infected areas allowed Yan to specifically determine which genes respond to infection.

Guenzi's laboratory hopes to uncover novel and important genetic relationships that are associated with the SDS infection process and SDS resistance mechanism.

This team approach by researchers from Oklahoma and Kansas State Universities should yield greater knowledge of the infection mechanisms and provide new tools to combat this costly disease.

As we advance into the future, it's our hope that research supported by the USGA will ultimately bring to producers and users improved turfgrasses, management procedures and biotechnological and microbiological tools to make SDS a subject of history.

Anderson, Guenzi and Taliaferro are members of the Department of Plant and Soil Sciences at Oklahoma State University. Martin is a member of Oklahoma State's Department of Horticulture and Landscape Architecture. Tisserat is on the faculty of the Department of Plant Pathology at Kansas State University.

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Exploring the Role of Nitrogen in Integrated Pest Management Strategies

By William A. Torello and Haim B. Gunner

Integrated pest management (IPM) programs have been developed for almost all agricultural and ornamental crop production systems over the past two decades. But only recently have IPM and organic management systems been considered a truly primary approach in professional turfgrass management.

The reasons for the dramatic increase in organic approaches are centered on public concern for the environment that has resulted in legislation at both the state and federal levels.

A multitude of research reports and on-site experiences have shown that switching partially or even wholly to organic management techniques have resulted in renewed and greatly increased turfgrass performance while reducing or eliminating pesticide and synthetic fertilizer use.

One of the more significant problems associated with organic turfgrass management, particularly on golf courses, is the inability to develop and maintain the high levels of overall turf quality and aggressiveness with natural organic fertilizers. Natural organic fertilizers are inherently low in available nitrogen levels ranging between 2 percent and 8 percent with only blood meal, bat guano and feather meals approaching the 10 percent to 12 percent levels.

Although feather meals tend to be high in nitrogen content, the nutrient is in a protein form that is slow to degrade and yield the needed results. Relatively low nitrogen levels found in natural organic products make it necessary to apply high amounts of material to achieve the desired seasonal effects because all natural organics depend upon soil microbial activity for nitrogen/mineral release.

As such, when soil temperatures are low in the spring and fall, release rates are limited at a time when cool-season turfgrasses are at their peak of performance and need higher levels of nitrogen to develop root zones and lateral stems.

This is particularly the case when using materials lower than 6 percent nitrogen having a comparatively high carbon/nitrogen (C/N) ratio, which would result in even slower mineral release.

To overcome this problem, the industry has developed organically based fertilizers that have increasing levels of inorganic nitrogen added to meet the high nitrogen demands. These bridged products have been successful but cannot be considered 100 percent natural organic.

Inorganically amended materials, however, do not have the same ability as purely natural organic materials to stimulate increases in soil microbial activities and populations. These are necessary for a range of positive effects encompassing increased soil structure, gas exchange, nutrient and water-holding capacities, native organic and thatch degradation, and suppression of disease.

Integrated pest management programs have been developed for almost all agricultural and ornamental crop production systems over the last two decades.

It's well-documented that increased soil microbial populations and activities compete with and suppress the populations of soil-borne plant pathogens resulting in significantly less disease occurrence and subsequent damage. Aside from temperature and adequate water levels, the amount and types of organic matter and fertilizers will have a profound effect upon nutrient availability and disease suppression.

Some types of organic amendments, particularly those with comparatively low C/N ratios,

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have been known to greatly suppress levels of disease.

The literature published regarding the effects and potential use of organic fertilizers and amendments on professional turf in the last 10 years is voluminous but can be summarized as follows.

The disadvantages include:

- nitrogen levels too low to maintain higher performance turf requiring a more rapid response;
- high levels of material need to be applied to achieve desired results;
- almost all materials are applied in a pelletized, solid application that can easily be picked up during mowing and take long periods to breakdown and release mineral nutrients;
- materials having high C/N ratios have extremely long residual times and may "bind" available nitrogen;
- organic fertilizers depend upon microbial activities for mineral release and on irrigated systems, which are much more effective during the warm summer months and not adequate during the high growth fall and spring seasons;
- bulky to store and transport because of comparatively low nitrogen analysis;
- may have a naturally foul smell; and
- usually more expensive compared to inorganics and urea.

The advantages are:

- little or no nitrate leaching or runoff into ground or surface waters;
- increased soil microbial populations and activities;
- decreased disease incidence because of enhanced competitiveness by increased soil microbial populations;
- decreased thatch accumulation because of increased soil microbial populations;
- increased nutrient availability through enhanced decomposition by soil microbial populations;
- increased soil nutrient and water holding capacities;
- little to no salt index, making high temperature applications safe; and
- positive effects on soil structure affecting gas/water exchanges.

In view of the above listed disadvantages, the most desirable natural organic fertilizer/amendment should have the following properties:

- the highest level of nitrogen available, preferably more than 12 percent nitrogen;
- the lowest C/N ratio possible, preferably under 12 for more rapid microbial breakdown and nitrogen availability, particularly during the spring and fall months;
- easy application, preferably a liquid soluble/flowable spray application to avoid particle pickup during mowing and to enhance response time; and
- high microbial populations and activities after application.

Until recently, the only way to approach the properties listed above was to blend an amended organically based material (which would have a base level of a natural organic component) with a high-nitrogen inorganic, synthetic organic or urea fertilizer. Unfortunately, although these materials meet high plant nitrogen demands, they fall short with regard to most of the positive properties listed above while providing a happy medium that superintendents have readily accepted.

Over the past several years, the industry has been active in attempting to develop totally organic materials that can be incorporated into management practices and provide the necessary mineral nutrition requirements. The hope is that they will also help in the soil-building, disease suppression characteristics previously mentioned.

Enhanced pelletizing procedures have allowed for the production of greens-grade organic granulars that can be applied at higher volumes, and composting procedures have resulted in elevated levels of natural organic nitrogen to meet the demands of high-intensity turfgrass management. These advances have resulted in a substantial increase in the use of natural organics as well as composted materials into golf course fertility programs, especially in spoon-feeding approaches on golf greens and tees.

EcoOrganics has developed and tested a natural organic material that is considered unique to the golf industry called SoylMicrobial. The material has been test marketed over the past two years where users have outlined both the positive and negative aspects associated with application and performance. The purpose of this paper is to report the both

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Poa Annua Reduction using Andersons TGR and Turf Enhancer Products

Andersons TGR (Turf Growth Regulator) and Turf Enhancer formulations are effective tools for reducing existing *Poa annua* in turf. Paclobutrazol, the active ingredient in TGR and Turf Enhancer, is a root-absorbed gibberillic acid inhibitor. Since paclobutrazol is a growth regulator, you will see a differential growth regulating effect on *Poa annua* in the desired turf species. *Poa annua* is very sensitive to paclobutrazol. When using TGR or Turf Enhancer products in a program, *Poa annua* is weakened and you will see increased density and tillering in the desired turf, which allows it to gradually replace the *Poa annua*.

Before beginning a *Poa annua* Reduction Program, it is helpful to understand the amount of active ingredient that you are applying. This will vary with the product used. Any of Andersons TGR and Turf Enhancer formulations can be used to successfully reduce and suppress *Poa annua*.

Since nitrogen is necessary for enhancing the effect of paclobutrazol, Andersons granular TGR and Turf Enhancer formulations are an excellent choice. All of our products are SGN 100 particle sizing and can be used on all turf areas, including bentgrass greens.

GRANULAR FORMULATIONS

Product	% Paclobutrazol	Label Rate Lbs/1000 sq ft	Nitrogen Lbs/1000 sq ft	A.I. Paclobutrazol/Acre
14-0-28 plus Turf Enhancer	0.13	3.33 1.67	0.50 0.25	0.20 0.10
31-3-7 plus TGR	0.42	2.90 1.94	0.90 0.60	0.53 0.35
14-0-29 plus TGR	0.34	3.33 1.67	0.50 0.25	0.50 0.25

SPRAYABLE

Product	% Paclobutrazol	Label Rate Oz/1000 sq ft	A.I. Paclobutrazol/Acre
Turf Enhancer	22.3%	6.4 8.0 16.0 32.0	0.10 0.125 0.25 0.50

Beginning a *Poa annua* Reduction Program

- It is best to start a program either in the fall or spring when turf is healthy and actively growing. Success is achieved only by continuing on a TGR/Turf Enhancer program until the *Poa* population is reduced to the desired level.
- TGR and Turf Enhancer application timings and rates vary with the type of turf being grown and the climate it is grown in. Your Andersons Territory Manager can provide specific information on the rates and formulations which best suit your area.

What to Expect

- *Poa* will begin to turn yellow about two weeks after the first application. Cooler spring temperatures can delay this somewhat. The degree of discoloration of the *Poa* will vary with the rate of a.i. that is applied. Below are two examples of the degree of discoloration of *Poa* after an initial application.

▲ 14-0-28 plus Turf Enhancer
0.2 a.i. paclobutrazol/acre

▲ 31-3-7 plus TGR
0.5 a.i. paclobutrazol/acre

- Under regulation, the desired turf species will begin to fill in areas of weakened *Poa annua*. You can enhance this effect by overseeding 10 to 14 days after an application of TGR or Turf Enhancer.
- The length of time that *Poa* is regulated will depend on the rate of active ingredient that is applied. Generally you will see about three to four weeks regulation at lower rates and eight to 12 weeks at higher rates.

For additional information on Andersons TGR and Turf Enhancer products, contact your local Andersons distributor or Andersons Territory Manager.

Article contributed by Rich Christ, territory manager for western Oregon, western Washington and Alaska.

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FIGURE 1

Seasonal turf quality comparison of SoylMicrobial with inorganic fertilizer on a modified USGA sand/silt-loam soil (70 percent/30 percent)

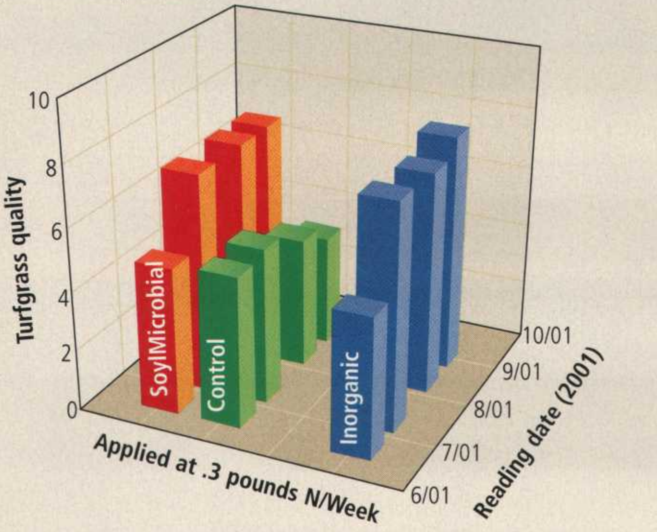
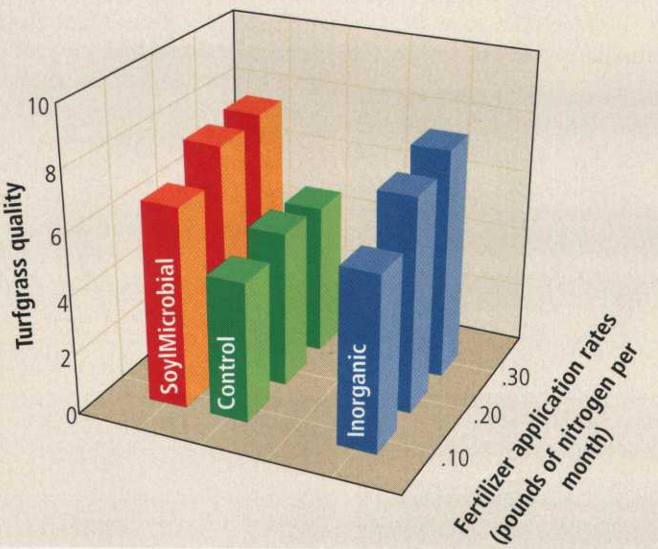


FIGURE 2

Seasonal turf quality comparison of SoylMicrobial with inorganic fertilizer on a silt-loam native soil



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research results as well as actual golf course performance.

Methods and materials

This enhanced product is a wettable powder that will form a fine suspension for spray applications. Its nutrient analysis is 15-2-0, and it's 100 percent natural organic materials derived through a complex extraction of soybeans.

The primary objectives of the tests performed on a number of golf course sites were to compare the new material with a standard and comparable inorganic source having approximately the same analysis.

Data were taken on overall turf quality every two weeks from experimental field plots of Providence and Penncross creeping bentgrass throughout 2000 and 2001.

Microbial activity and population analysis for these materials was obtained by sampling of the soil profile three, seven and 10 days after each application of all materials, followed immediately by a standard plate-count method of quantifying soil microorganisms.

> Although the soybean-based product performed equally well as the inorganic source, it must be noted that it is not a complete fertilizer source.

Rates of application were .1, .2 and .3 pounds of nitrogen per 1,000 square feet applied monthly on native soil sites and .3 pounds of nitrogen per 1,000 square feet weekly on standard USGA sand greens and modified USGA sand greens mixed with 30 percent native soil.

Results

Turfgrass quality ratings for the three treatments were similar for all three soil types tested.

Applications rates between .1 and .3 pounds of nitrogen per 1,000 square feet per month on native soil resulted in virtually no significant differences between treatments over the course of the growing season (Figure 1).

A weekly application rate of .3 pounds of nitrogen per 1,000 square feet on both the USGA sand green profile (Figure 2) and the modified sand profile (Figure 3) again indicate that there are no significant differences in turfgrass quality between treatments.

Microbial population counts for all three soil profiles showed dramatic differences between soybean-based products and inorganic treatments within three days after each application. Applications of the soybean-based product to the

USGA pure sand profile resulted in explosive growth of microbial populations.

Applications of the soybean-based product for the modified sand and native soil profiles were similar yielding up to 600 percent more microbial activity within 72 hours.

Soil microbial activity

The rapid increase in microbial populations are relatively short-lived, indicating that soybean-based materials should be incorporated into a spoon-feeding program of seven- to 10-day application intervals to achieve the positive responses associated with increased soil microbial activities on a seasonal basis.

A granular version has recently been developed. It increases residual time to four to six weeks depending upon soil type. These results also suggest that the elevated microbial activities would enhance degradation of native soil organic matter as well as overlying mat and thatch. Actual golf course use reflects these results.

Response from field trials indicates that application rates in spoon-feeding programs should be reduced to one-twenty fourth to one-twelfth pounds of nitrogen per 1,000 square feet because of overstimulation of growth rates. As such, recommended rates of application are 10 pounds to 15 pounds of material per acre.

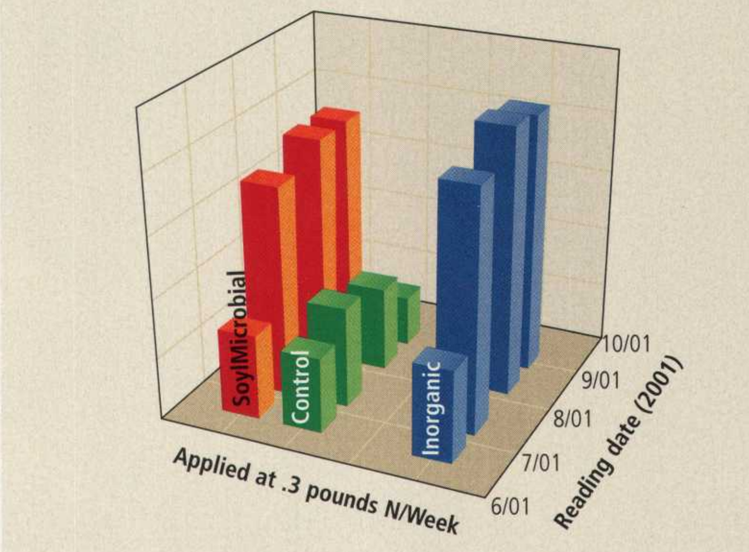
Conclusions

Although there was a two-day lag period after application of the soybean-based product, turf quality ratings for all soil types showed no observable differences. This appears to indicate that a natural organic material can perform equally as well as an inorganic material during a nitrogen spoon-feeding program, particularly to USGA sand greens.

The low C/N ratio (2.2) and the fact that the material is composed of highly degraded short chain protein/peptides and amino acids results in intensive soil microbial activity leading to an extremely rapid mineralization process and nitrogen availability levels approaching that of immediately available inorganic applications.

FIGURE 3

Comparison of SoylMicrobial with inorganic fertilizer on USGA sand



Although the soybean-based product performed equally well as the inorganic source, it must be noted that it is not a complete fertilizer source since there remain low levels of phosphorus and no potassium component. As such, it should be used in tandem with other fertilizer components. Furthermore, superintendent feedback concerning the "mixability" of the material has ranged from quick to difficult depending upon water quality and compatibility with other materials. This indicates that this material should be "pre-mixed" vigorously in a separate container, and standard "jar" tests should be performed to determine compatibility.

Torello is associate professor of plant and soil sciences at the University of Massachusetts in Amherst and executive vice president of EcoOrganics. Gunner is an emeritus professor of environmental microbiology at the University of Massachusetts, and president and CEO of EcoOrganics.

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