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.

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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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FIGURE 1

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

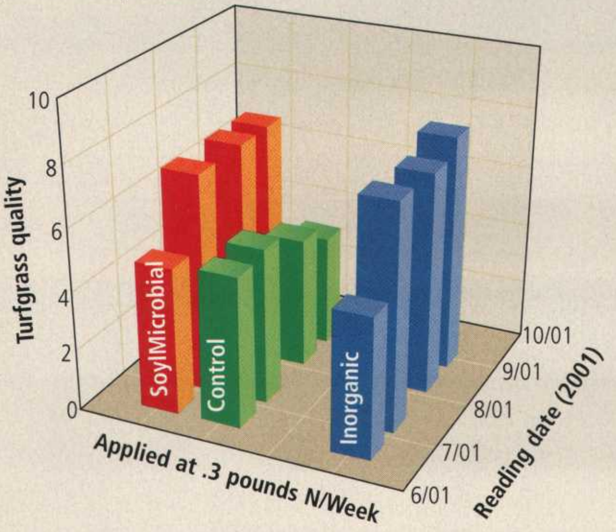
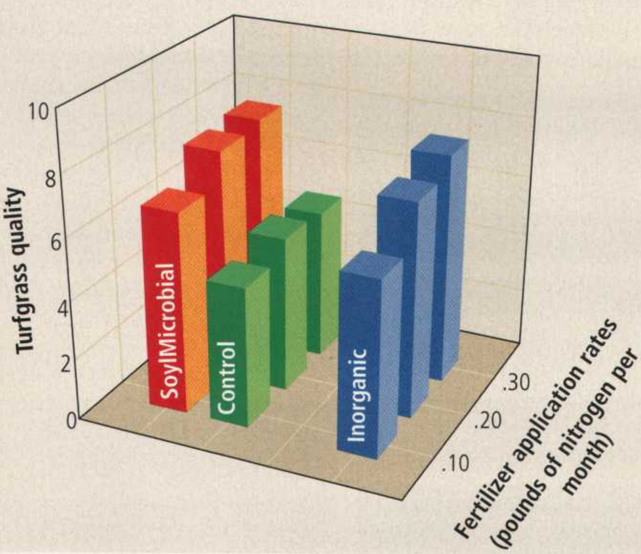


FIGURE 2

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.

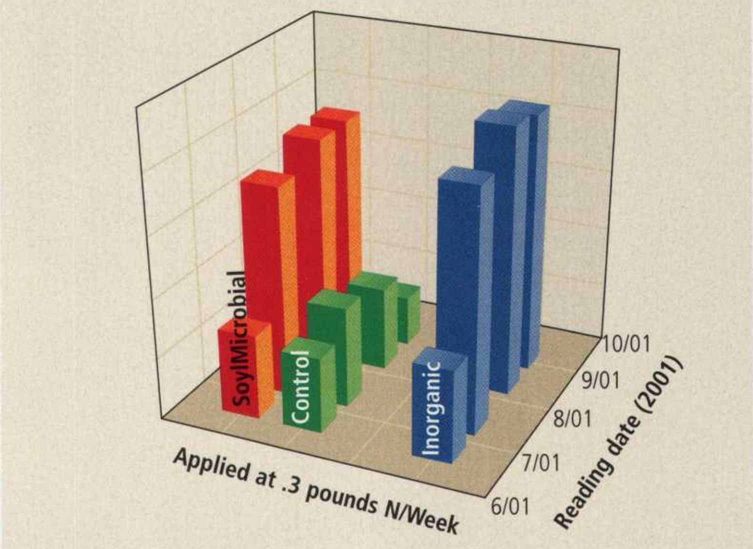
Conclusions

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.

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