TURFGRASS TRENDS

FERTILIZING FAIRWAYS

Reducing N Inputs with a Soil Test

Soil testing can help in adjusting fertilizer rates.

By Brian Horgan, David Gardner and Kevin Frank

Fertilization practices are highly scrutinized on golf courses across the United States due to environmental concerns. The majority of research indicates that turfgrass nitrogen fertilization poses little risk to the environment. However, recent research has identified nitrate leaching as a greater risk than previously thought on mature turfgrass stands (Frank et al., 2006). Other studies have identified that soils are capable of storing large amounts of N as organic fractions but suggest that this capacity is not infinite (Qian and Follett, 2002).

What these researchers are suggesting is that as turf ages and soils mature, mineralization of organic N will exceed immobilization, thus creating a greater supply than plants need for growth and development.

Nitrogen Cycle Definitions:

Nitrate leaching. Nitrate is an anion (negatively charged) and is free to move with water through the soil profile. When nitrate leaches beyond the rootzone, the nitrogen is considered lost.

Immobilization. The conversion of ammonium (NH_4) to organic nitrogen. Organic N is not taken up by plant roots or tissue.

Mineralization. The conversion of organic nitrogen to NH_4. Plants take up NH_4 or NO_3, which are inorganic ions.

Don't consider just the color response from fertilizer but also the turfgrass's function and playability.

For example, in the North Central region of the United States, a golf course may fertilize fairways with 3 pounds N per 1,000 square feet per year. So if we go back to the initial establishment of that fairway, immobilization (NH_4 to organic N) of fertilizer N will dominate the soil N cycle. Turfgrass may only have access to two pounds of that N fertilizer with one pound getting stored in the soil organic matter. This starts the soil N storage process and the clock on the amount of organic N the soil can store.

As time passes and prescribed fertilization programs are followed, the soil will immobilize more and more fertilizer N to a point when it can store no more. That may take 10 or 30 years, depending on soil type and rate of soil organic matter accumulation. Regardless of the number of years, when this point is reached, the soil starts producing NH_4 through mineralization at a rate greater than immobilization.

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FIGURE 1

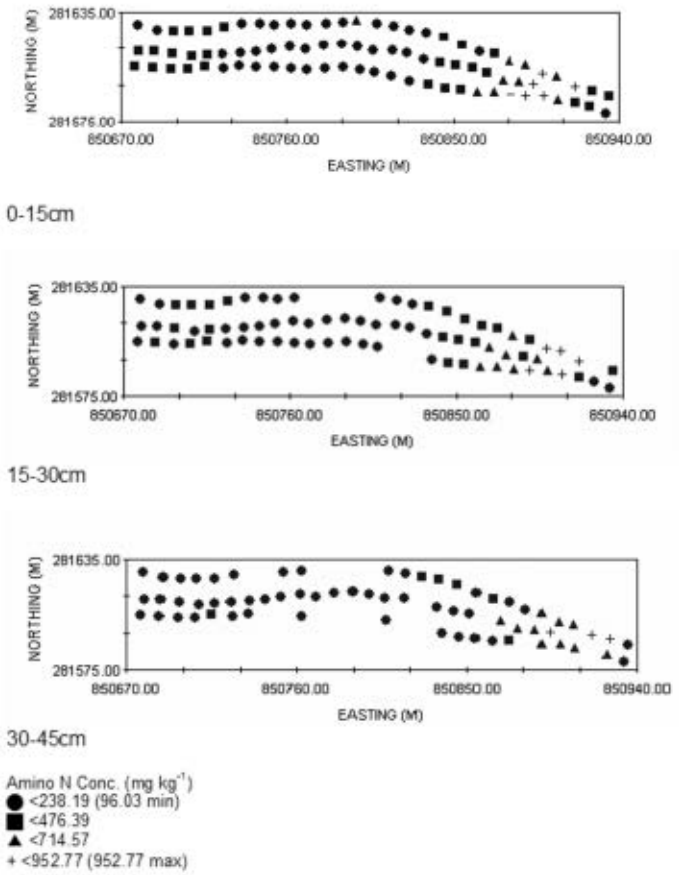

Figure 1. Spatial distribution of soil amino nitrogen (mg kg^{-1}) on Heritage Links fairway #3. Amino N level decreases uniformly over space as depth increases. Different shapes indicate a different amino N content and greater spatial variability.

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If the turf manager continues to fertilize at three pounds N and the soil is now mineralizing at a rate of one pound of N, simple math will tell you that four pounds N are in a form that is available for plant uptake.

But wait! For the past number of years, the plant has been living well on two pounds N. So what happens to the other two pounds N? The N can leach, denitrify or volatilize. In other words, the N is lost from the system and no longer available for plant uptake.

Wouldn't it be great for your budget, the environment and playing conditions if you could predict the amount of mineralizable N that would be available during the growing season?

Given the hypothetical example above, a soil test that could measure organic nitrogen in the soil is desirable. Furthermore, over-application of N fertilizers may be reduced if estimates of mineralizable N were available. Use of a soil test could also result in more quantitative N fertility recommendations rather than the current practice of applying based on visual appearance.

The Illinois Soil Nitrogen Test (ISNT) has been developed by researchers at the University of Illinois to identify sites in production agriculture that are non-responsive to N fertilizer. The test measures amino sugar N fractions in the soil organic N pool, which supplies the plant with N through mineralization. Amino sugar N is relatively stable compared to NO_3 and NH_4, thus making it a better predictor of season-long N fertility requirements.

The potential advantages of this test for golf turf managers are that soil N availability could be predicted and the information could be used to adjust fertilizer rates. This would be both environmentally and economically advantageous.

To adopt the ISNT for turfgrass systems, researchers at The Ohio State University, University of Minnesota and Michigan State University have been studying the temporal and spatial variability of the amino sugars in golf course fairways (Gardner et al., 2008); the content of amino sugars in the soil and the resulting turfgrass response; the mineralization rates of soils with varying amino sugar contents; and if amino sugars can be correlated to nitrate leaching potential of a turfgrass system.

Take home messages

We believe this soil test has merit and can provide golf course superintendents with an additional tool to reduce fertilizer N inputs by relying on soil N to some degree. Further study is ongoing.

Amino sugar N content varies over space (Fig. 1), but there is adequate spatial correlation so that standard soil sampling

Figure 2. The clipping yield response of turfgrass over a 4-week period following the application of 1 pound N per 1,000 ft² as affected by the level of amino nitrogen detected in the soil. Our hypothesis is that as the level of amino nitrogen in the soil increases, the clipping yield response due to added fertilizer decreases.

techniques are sufficient to predict higher and lower amino sugar N values on golf course fairways. Also, amino sugar N in the soil decreases with depth, which means no special attention to depth of soil core is necessary when sampling.

While the exact number from which we would not expect a response from added fertilizer N has yet to be determined, numerous field studies have been conducted across the North Central U.S. Based on our preliminary data, our hypothesized value for turfgrass response to fertilizer is a soil amino sugar N value of 200-300 ppm (Fig. 2).

The relationship between organic matter and amino sugar N was very strong at some

FIGURE 3

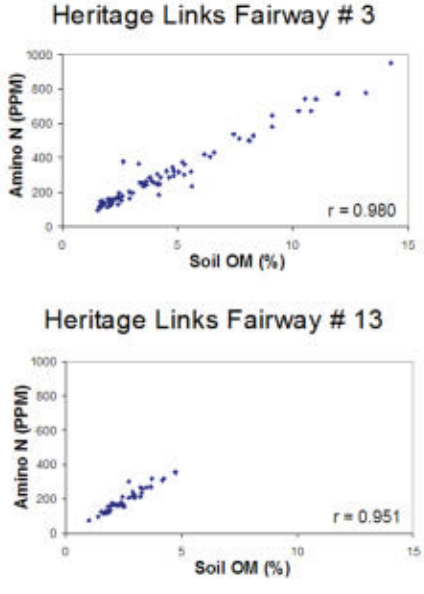
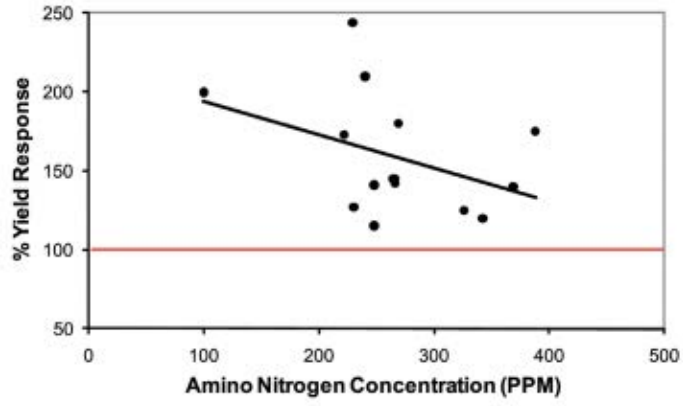


Figure 3. Correlation between soil organic matter and amino nitrogen content in the 0-15 cm soil horizon for the sampled fairways at Heritage Links.

FIGURE 2



locations (Fig. 3) which would further simplify the prediction of mineralizable N. Unfortunately, that was not the case at all the golf courses we sampled and we are no longer pursuing the possibility.

This work is ongoing and enjoys the support of the USGA. Next time you fertilize your fairways, conduct your own experiment. Instead of applying a full rate of N, only apply a half-rate on a small area in play. Don't consider just the color response from the fertilizer but also the turfgrass's function and playability. If the half-rate is sufficient to maintain playability, your soil may be exhibiting the very process described in this article, which can save you money and protect the environment at the same time.

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