By Thomas Serensits and Dr. Andrew McNitt

Can plant growth regulators *improve your field?*

WE HAVE ALL SEEN FOOTBALL GAMES when a player goes to make a cut only to slip and fall, kicking out a chunk of sod, leaving him to shake his head and go back to the huddle. These divots happen because the playing surface lacks stability.

As athletic field managers, we know that it is often what lies beneath the surface that ultimately determines the playability of our fields. We tailor our maintenance practices to promote rooting so we can go into the season with a "tight" field. We do things like core aerify and verticut to stimulate root growth and select plant species that have aggressive stolons and/or rhizomes. Most of us would agree that anything that makes our field "tighter" is a good thing.

So what about plant growth regulators (PGRs)? The old

rule of thumb was that PGRs have no place in athletic field management because the turf will not be able to recover from damage. And in some cases that is correct. For instance, on high-use fields that are continuously used throughout the year, spraying a PGR may not be the best idea. But, on a field that is only used in the fall, like a football stadium field with moderate wear, applying a PGR can help improve surface stability.

In order to understand why PGRs can improve playing surface conditions, we need to look at how they work. We will focus on products containing the active ingredient trinexapac-ethyl (TE), such as Primo Maxx. TE inhibits the biosynthesis of the plant hormone responsible for cell elongation, gibberellic acid. As a result, the plant's newly produced cells are smaller, thereby reducing vertical growth.

While it is easy to see the effects of TE on shoot growth, it is what is happening at and below the surface that really matters to us as athletic field managers. Turfgrass plants absorb TE through their leaf blades and crown. Less than 5% of the applied TE is actually moved to the root and rhizome system of the plant. So, while shoot growth is reduced, root and rhizome growth is not. In fact, TE application can stimulate root and rhizome growth. In addition, TE can also increase tiller density. An increase in tiller density means more plants to provide more surface stability.

With the idea that TE could increase both root/rhizome growth and tiller density, we investigated how TE applications affected divot resistance compared to cultivation methods and an untreated control. Research plots were constructed at Penn State's Joseph Valentine Turfgrass Research Center on both a USGA sand-based rootzone and a silt loam soil. Nine cultivars of Kentucky bluegrass were planted on each soil type. Each cultivar received TE treatments and a cultivation treatment in addition to a control area. We also applied various levels of simulated wear to each cultivar from late July through October to replicate the stresses of a football season. Divot resistance was measured once per year in November using a weighted pendulum with the head of a pitching wedge attached to one end.

We evaluated two TE treatment regiments. One regiment included TE (0.5 fl oz/1000ft2) applied monthly from May-July (3 applications). We chose this treatment schedule so that our last treatment coincided with when football practices typically begin. In essence, our goal was to pre-condition the turf before the onset of the stresses of our simulated football season, then, allow the turf to resume normal growth for the duration of the season.

The other treatment regime included TE applications from May-October (6 applications). The cultivation treatment was performed in early May and consisted of core aerification coupled with a deep vertical mowing. The vertical mower blades were set to penetrate one-half inch below the soil surface. The reason for setting the blades this deep was to sever existing roots and rhizomes with the hopes of stimulating additional growth.

While our main objective was to measure divot resistance, we also evaluated a number of other factors related to playing surface stability. For instance, we measured tiller density and root/rhizome weight. We also evaluated wear tolerance throughout our simulated football season.

Results from our research show that TE applied from May-July increased divot resistance by up to 20% on the sand-based rootzone and up to 15% on the silt loam soil. Applying TE from May-October resulted in little change from the control. Also, results from the combination of core aerification and vertical mowing showed slight divot resistance improvements.

Why was the application of TE from May-July our most effective treatment? For the answer to this question we need to look at the effects of TE on our other measured factors. TE applied May-July was the only treatment to affect root/rhizome weight, increasing it by about 10%. TE May-July also increased tiller density by about 10%. No other treatment affected either root/rhizome weight or tiller density with the exception of the application of TE from May-October, which increased tiller density.

We included various wear levels to determine if our treatments showed consistent performance under different field conditions. If we observed divot resistance improvements with a particular treatment under no wear, we wanted to evaluate if those same improvements were observed under high wear. If the effectiveness of a treatment disappeared under high wear, the treatment would have less value late in the season or in the high wear areas of a field. Our data indicates that our most effective treatment, TE applied from May-July, consistently improved divot resistance at each wear level compared to the control.

What about wear tolerance?

What about the effect on wear tolerance? There is a school of thought that TE increases wear tolerance because it increases tiller density. The reasoning goes if there are more plants, it will take longer to see the effects of wear. However, we also need to consider the fact that because shoot growth is slowed, recuperation may also be slowed. In our studies, we found minimal effects from each of our TE treatments on wear tolerance. We did see a slight trend that under heavy wear conditions, wear tolerance was slightly reduced when the turf was treated with TE through October.

Another thing to consider when applying TE is the post-suppression growth surge or "rebound effect." Once the turf breaks from growth regulation, a flush of growth occurs. If applied at the labeled rate, this flush typically occurs 28 days after application. Growth rates can be as much as 160% of the normal growth rate in the days following the break. We can use this flush of growth to our advantage. If we follow the research-based suggestions and apply TE from May-July, we can time the final application of TE to wear off immediately after the first game. This provides an increased growth rate for accelerated early-season recovery.

In our study, we also evaluated the divot resistance of various Kentucky bluegrass cultivars. On the USGA sand rootzone, 'Limousine,' 'Rugby II,' and 'P105' were the most divot resistant cultivars. 'Midnight' was least divot resistant, with 33% less divot resistance than Limousine. The differences in divot resistance among cultivars on the silt loam soil plots were minimal. 'Julia' had the highest divot resistance on silt loam soil while all other cultivars had the same resistance to divoting.

Our treatment of TE applied from May-July produced some interesting effects on the tested cultivars. For example, the least divot resistant cultivars benefited most from TE application. In fact, TE-treated Midnight, the least divot resistant cultivar, had greater divot resistance than untreated P105. So, while your field may not contain the best cultivars, by applying TE from May-July, you can make your turf perform like the most divot resistant cultivars.

We have found that plant growth regulators can indeed fit into an athletic field maintenance program. Golf course superintendents often talk about pre-conditioning their turf with TE before summer stress. Our research shows that TE can pre-condition athletic fields before the stresses of a football season. So, give plant growth regulators a second thought. They can be another tool for improving field playability. ■

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 By Gordon Kauffman III, Ph.D.

Sample your Soil

SOIL TESTING may seem like a routine practice, but how many of you actually do it regularly? And then use the data to make management changes? Understanding the key concepts will allow you to make better educated decisions regarding fertilizer and/or soil amendment applications.

Traditional soil testing consists of a soil chemical analysis including pH, CEC, and exchangeable nutrient concentrations, likely with a fertilizer or lime recommendation, but little consideration given to nutrient solubility, organic matter and dominant cation percentages, irrigation water quality, and soil physical properties. Agriculture fertilizer recommendations are based on crop requirement, yield goals, weather and soil characteristics. Recommendations for turfgrasses are more comprehensive and based on crop requirement, quality goals, playability, establishment, species competition, disease management, weather, water quality, and soil characteristics.

Rely on the careful consideration of the most meaningful soil test data to generate the best and most practical management considerations.

Sampling

Most error associated with soil testing occurs during sampling, therefore doing it right and staying consistent is important. Pull samples (10-12) at the same depth and randomly at a given location. Sample to a desirable depth, generally where most roots inhabit the soil, and typically 4-6 inches for grasses mowed at 1-2 inches. Combine sub-samples into a single, composite, sample and send to the laboratory for analysis.

Carefully discard any thatch and place the soil in a labeled brown paper bag. Allow the samples to dry thoroughly. Pull soil cores for analysis at the appropriate time to maximize your opportunity to implement changes based on the information.

For example, test the soil if a nutrient deficiency is suspected and routinely during a growing season in order to generate baseline levels, and then to determine if management strategies implemented are working to alter/correct soil physical or chemical problems/concerns. Sampling a minimum of two times annually is usually sufficient.

Laboratories often use different methodologies (extraction agents) for the same test or perform a different variety of tests to generate data. This data could subsequently be interpreted differently; therefore stay consistent with a laboratory once you have identified the best format and/or services provided.

Testing soil physical properties will provide information pertaining to soil drainage, aeration, and/or compaction. A rootzone particle size analysis, infiltration rate, total porosity, and capillary pore space determination will be useful to assess drainage capabilities

Tests such as saturated hydraulic conductivity and bulk density provide an indication of the level of compaction. Labs can also test to determine the moisture content where the soil becomes prone to compaction. A complete analysis of soil physical properties will be helpful for evaluating the potential use and/or effects of added soil amendments such as organic matter, zeolite, calcined clays, or diatomaceous earth.

Interpretation

Soil testing laboratories can interpret chemical soil test reports differently because they often use different data to generate the interpretative feedback. *Correlative*data compares laboratory recommendations (known fertilizer applied) with actual plant uptake. *Calibration* data focuses on the relationship between known soil test values and plant response after fertilizer application, providing an indication of how much fertilizer is needed to meet plant demands. Calibration data is more meaningful in ag where increased growth typically leads to improved yields.

Turfgrass responses are different and often more complex. Calibration data on different soils types and using quantifiable turfgrass (species and cultivar) responses remains limited. As a result, caution must be taken when interpreting soil test data from too many laboratories or from too few tests.

For example, laboratories may report two primary types of data to indicate fertilizer requirements. One involves the percentages of basic cations [calcium (Ca), magnesium (Mg), and potassium (K)] that occupy exchange sites, called the base cation saturation ratio (BCSR). This interpretation reflects the notion that basic cations (target Ca ~ 65-75%, Mg~10-15%, and K~2-5% as a percentage of total CEC) dominate soil exchange sites and therefore dictate the extent to which other nutrients,

including hydrogen ions (H+ and therefore pH), occupy exchange sites and ultimately find their way *into solution*. Another approach is to determine the amount of nutrients to sufficiently meet plant needs now, called the sufficiency level of available nutrients (SLAN). This interpretation uses established sufficiency levels (based on calibration data) for all nutrients other than N and if soil test reports show they are low, a positive plant response from fertilizer added can be expected. In either case, an integrated approach works best where many factors are taken into consideration and used as rough guidelines but in combination with your direct observation and data from soil physical tests.

Soil tests reports will provide data used to make additional fertilizer applications including the remaining primary macro nutrients phosphorus (P) and potassium (K), secondary macronutrients Ca, Mg, sulfur (S), and micronutrients. The most efficient method to supply adequate nutrients for optimum growth and performance is through foliar feeding.

Manage soil pH and CEC using the correct fertilizer, soil amendment, and/or correcting irrigation water problems. Apply lime (CaCO3) as necessary to increase pH, gypsum (CaSO4) to supply Ca without changing the pH, and acidifying fertilizers such as ammonium sulfate, or those that contain elemental sulfur. Increase CEC by adding organic matter (i.e. humus, peat, or compost) or zeolite clinoptilolite, which can be tilled to a 4-6 inch depth before establishment or incorporated as topdressing during aerification until the desired CEC is reached. ■

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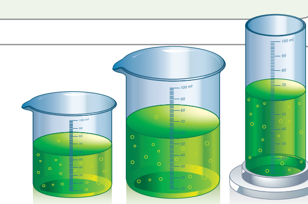
BestManagement Practices

Best fertility management includes the use of soil tests, an understanding of the nutrient requirements for each turf species, careful observation, and balancing aesthetics v. function. Proper interpretation of soil tests will allow you manage both components and develop the best fertility programs. Meticulous recording keeping of soil test reports, fertilizer applications (rates, formulation, dates), and turfgrass responses are essential to developing a strong and consistent fertility program.

When observing turf responses look for turf color, growth, quality, recuperative capacity, establishment speed and consistency, wear tolerance, playability and responsiveness to fertilizers. Use soil tests to uncover underlying poor turf performance or overt and negative turfgrass conditions like nutrient deficiencies. Soil chemistry and microbiology are complicated; therefore keep it simple use soil tests as a rough guideline with strong consideration to basic agronomic principles, including subsurface and surface drainage, promoting the correct ratios of air, soil, and water, adequate fertility, and thatch management using frequent mechanical cultivation. ■

Common lab tests for sports turf



Lab equipment illustration courtesy of istockphoto.com

Exchangeable nutrient data/Nutrient sufficiency levels. Represents the amount of each nutrient present in the soil and the extent to which plant requirement are met (sufficiency) for optimum growth (lb/A). Usually expresses as low/optimum/high.

Extractable Nutrient Data (i.e., soluble paste extract). Represents the nutrients that are easily extracted from the soil and therefore the best indication of plant availability (ppm).

Cation Exchange Capacity (CEC). Represents nutrient holding capacity (target 4 cmol/kg soil).

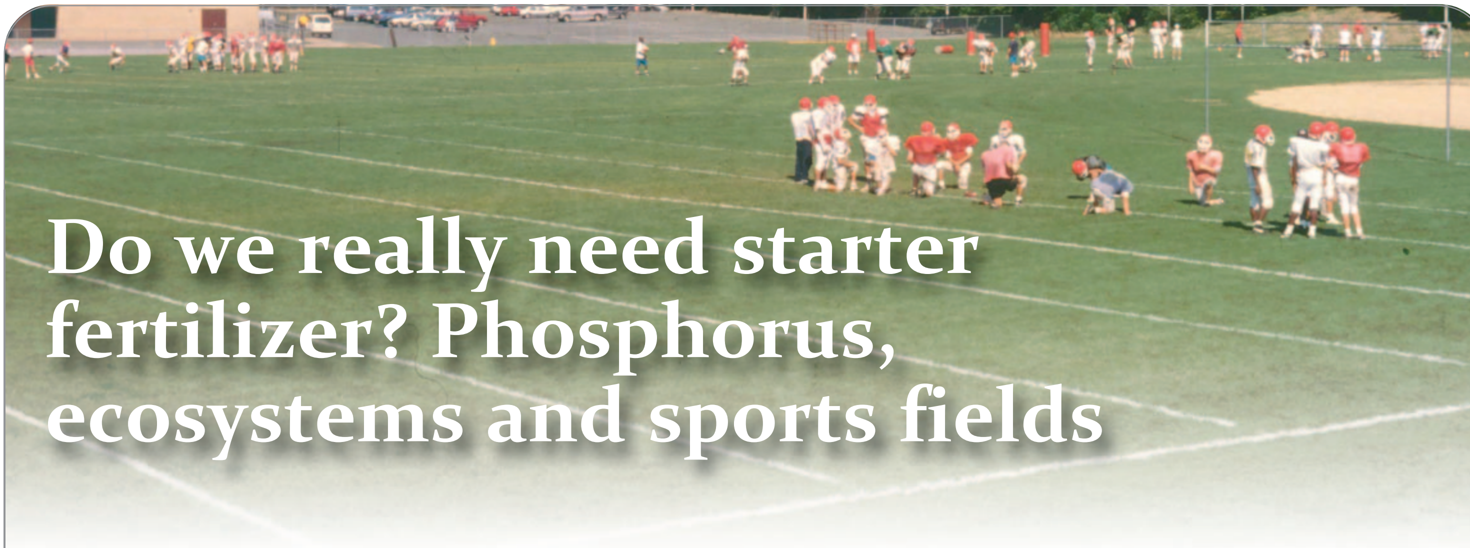
pH. Soil reaction affecting most notably nutrient availability and microbial activity

Organic Matter (OM) Percentage. Indicates degree of organic matter accumulation which can affect drainage, soil reaction, and presence/extent of localized dry spots (target ≤ 4%)

Soluble Salts/Sodium. Represents the level of salinity and sodium in the soil. High levels of salinity (various salts) will impact the soil reaction, infiltration in the top two (2) inches, and plant water relations. High sodium (≥ 3% of total CEC or sodium adsorption ratio > 2) will negatively impact soil structure and permeability. Salinity or sodium problems usually arise due to poor irrigation water quality or lack of rainfall, particularly in arid or semi-arid regions.

Irrigation Water Quality. In general it is good idea to test the irrigation water to determine if problems exist. Potential problems including high bicarbonates (HCO3-), or high Na+ and Cl- concentrations compared to calcium (Ca2+) and magnesium (Mg2+). ■

 By Kevin Trotta



Do we really need starter fertilizer? Phosphorus, ecosystems and sports fields

THE THINNING OUT of turfgrass is inevitable once fall sports practice begins. Here in New York State and other cool season areas, the wear and tear of soccer, field hockey and football extends into the latter half of fall when cooling temperatures inhibit seed germination and establishment. Spring seeding is usually the next option. Athletic field managers are familiar with the cycle of autumn sports damage and the need for spring reestablishment. Applications of starter fertilizers are often built into this annual cycle.

In recent times these high phosphorus-containing materials have become the subject of justifiable environmental concern because of the risks associated with phosphorus runoff in surface waters. Excessive nutrients can throw aquatic ecosystems out of balance, a process called eutrophication. Even low levels of phosphorus can be detrimental to water quality by stimulating overcrowded plants and algal blooms, making the water unsuitable for drinking and recreation. The subsequent death and decomposition of this accelerated growth reduces dissolved oxygen, killing fish and other organisms. Although eutrophication does occur naturally, it is often triggered by nutrients associated with human activities.

Obviously, as sports turf managers we strive to make the world a better place, not to contribute to environmental degrada-

tion. While research has shown that a dense stand of turf impedes runoff, our routine applications of high-phosphorus "starter" fertilizer may pose risks because we're applying when turf cover is thin or even non-existent. Nutrients applied to thin turf or bare soil can readily become mobile. Also, our fields are typically graded to promote good drainage. In addition, the likelihood of seasonal rain compounds the potential for runoff and threatens environmental quality.

Conventional wisdom

If soil tests indicate adequate phosphorus, do we need additional P in the seedbed? Pick up most any turfgrass textbook and take a look at the section on establishment. Odds are there will be something that reads like this: "It is important to use a starter fertilizer because seedlings need a lot of phosphorus to develop. This application is recommended even if soil tests show adequate P levels because the seedlings' immature roots must have P right there where they can access it."

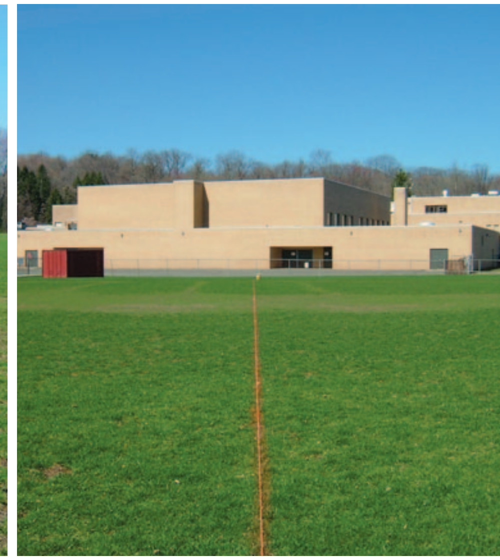
Some of us have always been skeptical of this last assertion. Two years ago I decided to test it.

Hash mark science

I designed and implemented a phosphorus study 2 years ago that was too complicated to be useful. I won't even bother to discuss it here. But it did clarify several issues for me, pointed the way to a better experiment, and gave me an early glimpse of what I would ultimately observe.

This past spring I had a better plan in mind that I wisely shared with turf guru A. Martin Petrovic, Ph. D. of Cornell. Marty was characteristically generous in his guidance, support and encouragement.

This second experiment would be simple. I had two football practice fields to work with. (These were no puny university test plots but a robust 2.6 acres of sports turf.) These bruised and battered practice fields were seeded in late March with a perennial rye blend at a rate of 10,000 lb/ft2. These fields would be need-



ed again for practice in August. Soil tests indicated existing P levels at 19 pounds per acre, by all standards more than adequate. I divided each field in half: one cross-field on the 50-yard line and the other lengthwise, goal to goal. On one side of each field I applied triple super phosphate at the substantial rate of 75 pounds of P per acre (8 LB 0-45-0 / 1000 ft^2) in early April, just before germination. The other side received no P. It had been apparent in the first study that applied nitrogen was absolutely essential for vigorous establishment so the entire 2.6 acre study area was fertilized with a controlled release 20-0-5 at a rate of 1 pound of N per thousand square feet just as the seed began to germinate.

Then I watched.

There was absolutely no difference anywhere in the study area. The rye established equally well across the two fields. The entire area got equally beaten up by PE classes and baseball outfielders and showed no detectable differences in response. There was no discernible disparity in density. No visible variation in vigor. No observable benefit from the added P.

The potential for problematic phosphorus concentrations in runoff and the risks of surface water contamination with resulting ecological threat compel us to exercise caution in the use of high P starter fertilizers. As stewards and green industry leaders, we're obliged to be responsibly prudent in the management of all inputs, including nutrients. I'm hopeful that this experiment encourages further study (with other species, in different climates, soils, how much P is enough, etc.).

So, if soil tests indicate adequate phosphorus, do we need to apply additional phosphorus when seeding perennial rye? It does not appear that we do. ■

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