Does N source impact nitrate leaching?

By Dr. Marty Petrovic

Sports fields are often highly fertilized to compensate for traffic damage and can be composed of high sand content soil mixes coupled with irrigation. Sites with sand that are well fertilized and are irrigated are more prone to fertilizer nitrogen (N) leaching losses than other sites. The source, season and rate of application have been shown to affect the extent of N leaching losses from turfgrass sites. Water-soluble sources of N fertilizer are more likely to leach from sandy-turfed areas than slow release sources.

It has been shown that Kentucky bluegrass did not have more N leaching from late fall applied N fertilization than other seasons of the year after establishment in Ohio, while the most N leaching from the warm season bermudagrass occurred in the winter months in Florida. The rate of applied N can in some cases affect the extent of N leaching. With a slow release source it was found that there were no difference in the nitrate leaching from golf turf areas when fertilizer at 0.5 or 1 lb. N/1,000 sq.ft., whereas, with a soluble N there was less N leaching when fertilizing at lower N rates.

Above: fields with high traffic can benefit from more fertilizing, but what is the risk to the environment?

The objectives of this study were to determine if N source had an affect on N leaching when applied at low and high rates on sites with different climatic conditions and at different seasons. We believe that 1) slow release N sources leach much less than water soluble sources, 2) a late fall application of N can result in substantial N leaching in milder climates, and 3) higher rates of N applications can result in more N leaching losses. Will the study confirm our beliefs?

Studies

The studies were conducted at three sites in New York. Riverhead and St. Charles are located in southeastern NY (Long Island, USDA Plant Hardiness Zone 6a) and Ithaca is in central NY (USDA Plant Hardiness Zone 5a). The soil texture of each site was a sandy loam, with the Riverhead site having slightly more sand than the other sites. All sites were composed of Kentucky bluegrass that was 2 to 4 years old. There were two basic types of studies, late fall N application only and growing season long fertilization. Each of the three sites had a late fall leaching study where various N fertilizers were applied once at a rate of 2 lbs. N/ 1,000 sq.ft. applied in the late fall period, after the last mowing, at about mid-November.

To determine N leaching form typical season long fertilization, a 3-year study was conducted at the Riverhead site. Fertilizers were applied in May, June July and September at

Table 1. Average percent of applied nitrogen that leached as a function of nitrogen source.

Source	Year 1 (%)	Year 2 (%)	Year 3 (%)	Mean (%)
ureaformaldehyde	4 ab1	4	3 b	3.7 b
methylene urea	2 ab	5	7 b	4.6 b
IBDU	2 ab	7	4 b	4.9 b
SC urea-non wax	5 ab	5	5 b	4.8 b
SC urea-wax	2 ab	7	6 b	5.4 b
urea	2 ab	4	12 b	6.1 b
calcium nitrate	1 b	5	30 a	12.5 a
PC-urea (100day)	2 ab	6	4 b	4.2 b
PC-urea (200day)	0.5 c	3	3 b	2.0 b
biosolid	6 a	4	2 b	3.7
Precipitation[2]	87	99	124	

[1]Means within columns followed by different letter are significant. [2]The percent of normal precipitation.

Table 2. Average percent of nitrogen applied in the late fall studies that leached as a function of N source and location.

Source	Riverhead (%)	St. Charles (%)	Ithica (%)
ureaformaldehyde	0 c1	4 c	-
IBDU	-	-	1 ab
sulfur-coated urea with wax	12 b	11 b	-
urea	29 a	47 a	5 a
polymer coated urea (100 day)	-	-	0.4 ab
polymer coated ureaCU (150 day)	0 c	0 c	-
biosolid	0 c	3 c	0.2 b
Day below freezing	36	36	72

[1]Means within each column for followed by different letter are significant.

KENTUCKY BLUEGRASS DID NOT HAVE MORE N LEACHING FROM LATE FALL APPLIED N FERTILIZATION THAN OTHER SEASONS

1 lb. N/ 1,000 sq.ft. or twice a year (May and September) at 2 lbs. N/ 1,000 sq.ft. The sources of N fertilized used in the various studies included: ureaformaldehyde (Nitroform Blue Chip, Nu-Gro); methylene urea (Scotts Co.); isobutylidine diurea (IBDU, Estec Corp); sulfur coated urea (SCU-waxed, Scotts Co.); SCU non-wax (Pursell Industries); urea, calcium nitrate, polymer coated urea (PCU, experimental fertilizers labeled as 100, 150 and 200 day release rate, Pursell Industries); and a biosolid (Milorganite). For all studies an unfertilized control was included and used to determine the release of soil organic matter N via mineralization and inputs of N from rain and irrigation.

To estimate nitrogen leaching, ion exchange resin bags were installed 12 in below the soil surface. Bags were inserted prior to the first fertilizer application and removed at the end of the sampling period and analyzed for total N and for nitrate (NO3 + NO2-N).

Results

In the annual leaching study, the average of 3 years N leaching results showed that the percent of N leaching of the amount applied ranged from a low of 2 % to a high of 13 %, depending on the source of N used (Table 1). N applied in the late fall leached at a rate of 0 to 47% of the amount applied depending on the site and N source used (Table 2).

In both studies, N source affected the extent of N leaching losses (Tables 1 and 2). When N was applied in the late fall, the more water soluble and faster releasing the N source had a greater percent of applied N that leached. Urea was the source that had the highest percent of N leached, ranging from a low of 5 % to 47 % of the amount of N applied; whereas the slow release sources like ureformaldehyde and biosolid had little or no N leaching losses

LATE FALL N FERTILIZATION IS AN IMPORTANT TIME FOR DEVELOPING A STRONG AND DEEP ROOT SYSTEM

However, the magnitude of leaching was highly dependent on the location. The greatest losses were from the two southeastern coastal sites on Long Island (Riverhead and St. Charles) that had similar soils compared to the more northern Ithaca site, but had half as many days (36 days for Riverhead and St. Charles compared to 70 days for Ithaca) that the average temperature was below freezing. The amount of groundwater recharge during late fall-late to spring period for Riverhead 75-90 % of precipitation (October 15 to May 15) explaining the potential for a large amount of N leaching if water soluble N sources are applied in the late fall. We have observed a lower amount of groundwater recharge in Ithaca.

When N was applied during the growing season, similar results were observed with N source and leaching losses, depending on the year of the study. In years 1 and 2 of the study, where rainfall values were below or close to average amounts, N leaching percent of the amount applied was low and not highly influenced by N source. Year 3, where about 24 % more rainfall than the average, N leaching losses were much greater and soluble N sources like urea and calcium nitrate had large amounts of N leaching. The other N sources had much less leaching ranging from 2 to 7 % of the amount of N that was applied.

In addition to N source and weather, application timing influenced the extent on N leaching losses we observed. The extent of N leaching in the late fall was greatest with water soluble sources and was about four times greater than the N leaching losses observed during the growing season study, even though the growing season study had twice as much N applied over the entire year than the late fall study.

Late fall N fertilization is an important time for developing a strong and deep root system. However, the differences on the extent of freezing conditions in the winter months does play a role in N leaching losses from late fall or winter N applications, especially with water soluble N sources like urea. Thus, areas with less frozen soil conditions in the dormant or slow cool season growth periods when high amounts of rainfall or snow melt is likely to occur, can be prone to excessive N leaching if water soluble N sources like urea, ammonium sulfate, ammonium nitrate and calcium nitrate are used.

Based on the results of this field study, one can conclude that slow release N sources like IBDU, ureaformaldehyde, PCU and SCU and natural organic fertilizers like biosolid appear to significantly reduce the potential of N leaching losses into groundwater compared to the very water soluble calcium nitrate. However, long-term studies are needed to better understand the risk of using slow release N sources as a best management practice to reduce N contamination of groundwater.

To answer the three points we believed would be true, two out of three isn't bad. In addition, apply high rates of N (2 lbs. N/ 1,000 sq.ft.) did not increase the amount of N leaching when fertilizing in late spring and early fall.

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Using inorganic soil amendments

By George Toma

In my travels and working with soils over the past 60 years I have seen a number of soil amendment products. In the early days Lusoil was the only soil amendment product available. Later Danny Litwhiler, former player for the Cincinnati Reds, introduced another soil amendment. Danny's product was made from calcined clay. My how the times have changed.

Inorganic soil amendments have been gaining in popularity over the past few years. These products are used in golf course greens, tee boxes, and fairways, sports field rootzone mixes, and topdressing applications. Interest in inorganic rootzone amendments has been amplified due to the potential potable water supply shortages, the increased use of reclaimed water as well as concerns regarding runoff. Until recently, peat was about the only amendment allowed by the USGA for use in greens. These inorganic products may be better suited to rootzone construction or manipulation because they are less prone to biological degradation and may maintain the original rootzone physical properties longer than organics.

Three types of popular inorganic soil amendments that I am familiar with include calcined clays, zeolite, and diatomaceous earth.

Calcined clays: Marketed as porous ceramics, these are products that have been heat treated or calcined at a very high temperature. The heating increases the structural integrity. Once calcined, they are often screened to a uniform particle size to be used in various rootzones. They do possess a high inherent water-holding capacity that is the result of small internal pores. This stored water may be available to plants. They also have some nutrient holding capacity.

Above: placing an inorganic soil amendment at a NFL practice facility.

INFORMATION PERTAINING TO THE AVERAGE PARTICLE SIZE IN YOUR ROOTZONE MIX MUST BE KNOWN BEFORE ADDING SOIL AMENDMENTS TO AN EXISTING SOIL PROFILE.

Zeolites: Long used in removing environmental pollutants, these have a strong affinity for cations or high CEC, which is good for holding on to nutrients. Be careful in the selection as some zeolites have rather high residual sodium contents that may be harmful to turfgrass.

Diatomaceous Earth (DE): These products are made up of the deposits of diatom shells that have a high degree of internal pore space. DE will retain a significant amount of water. I am very familiar with volcanic/diatomaceous deposits that not only absorb a considerable amount of water but also make the majority of this stored moisture available to the plant.

There have been numerous studies conducted at universities across the country and these studies should be reviewed before considering what type of amendment should be used. Particle size, water retention and release, and nutrient holding capacity should be taken into consideration when selecting the desired inorganic soil amendment. Also helpful is consultation with an accredited soil-testing laboratory.

George Toma, right, has seen it all when it comes to sports turf amendment products.

THE MAJORITY OF PROBLEMS WITH TURF ARE ROOTZONE PROBLEMS THAT CAN BE SOLVED BY DEVELOPING OPTIMUM SOIL CONDITIONS. INORGANIC SOIL AMENDMENTS ARE ANOTHER TOOL THAT CAN BE USED TO PRODUCE POSITIVE RESULTS.

Particle size considerations

Too many coarse or fine particles are undesirable. Particle size significantly affects the amount of porosity and water retention within a rootzone. Fine particles contain less macropores or air filled pores than coarse sands but tend to retain more water than coarse sands. Coarse particles tend to drain more quickly but will exhibit more air filled porosity. Information pertaining to the average particle size in your rootzone mix must be known before adding soil amendments to an existing soil profile.

Water retention

The growth of most plants is closely related to the amount of available moisture. Many inorganic soil amendments are known for their ability to absorb a considerable amount of moisture. The question is: "How much of this stored water is plant available?" If the amendment added to the rootzone releases its stored moisture too quickly, this may lead to droughty conditions or localized dry spots. If the amendment does not release this stored moisture and retain too much water, this will result in poor draining rootzones and cause excessive soil wetness.

Cation exchange capacity

Many inorganic soil amendments have a strong affinity for cations. High cation exchange capacities may allow for a reduction in the use of fertilizers but may also have high residual salt contents. With the increased use of reclaimed water (which may contain elevated sodium levels) on the rise, use of these amendments may prove harmful to turfgrasses.

Desirable criteria for the ideal turfgrass rootzone consists of the following:

1) Drainage
2) Resistance to compaction
3) Moisture retention/release
4) Oxygen retention
5) Nutrient retention
6) Microbial population
7) Temperature stability
8) Proper porosity balance

Nearly all of the desirable rootzone characteristics are directly tied to the proper balance of porosity.

It's hard to improve on Mother Nature. Mother Nature's perfect rootzone is made up of 50% solids and the remaining 50% consisting of capillary or water-holding capacity and non-capillary or aeration porosity. Capillary porosity is made up of small pores that hold water against the force of gravity. Depending upon the type of amendment, much of this retained moisture is available for plant use. Non-capillary is made up of larger pores that, when drained, provide for a source of oxygen required for root growth. The number one deficiency in most rootzones is the lack of air. Balancing and manipulating porosity in the soil can be achieved by the application of inorganic amendments.

Application

Incorporation of soil amendments during the construction phase of the soil profile is usually the best way to go. Rootzone characteristics including hydraulic conductivity, water-holding capacity, bulk density, particle size, and porosity can be pre-determined before construction. Inorganic amendments can also be applied during aerification and topdressing or pre-blended with your choice of sands. In addition application via hydraulic injection such as the hydraulic injection equipment of drill and fill may also be used. Several post-aerification applications are required to produce the desired results in terms of water-efficiency and improved growth characteristics.

Many times problems like brown spots or fungus are treated with water or fungicide and the turf manager is really treating symptoms and not causes. The majority of problems with turf are rootzone problems that can be solved by developing optimum soil conditions. Inorganic soil amendments are another tool that can be used to produce positive results.

Much like sports teams and individual players, some products meet the needs of their marketplace and thrive, while others fall short and ultimately disappear. My advice is to thoroughly research the needs of your individual circumstances. Don't be shy; experiment with a number of product options. Evaluate the results of each one. Then make an informed decision. I certainly have my favorites. Here's hoping you find yours and that it meets your needs . . . AND THEN SOME!

George Toma, one of the founders of the Sports Turf Managers Association, is the most famous turf manager in the country, and has worked on the turf for every Super Bowl.

This article was sponsored by Western Pozzolan. ■

Managing skinned areas

By Bruce Suddeth

When I was asked to write about infield skin management I thought, "Who, me?" How could I write such an article? I don't have the greatest of literary skills, I'm just a landscaper/field manager. Besides, I read every book and article I can find to learn from others how to manage skin areas. The list includes pros like George Toma and Floyd Perry, and that list goes on and on. Our field management team also puts great trust in the South Carolina STMA chapter membership's wealth of knowledge. So how can I write an article about skin management when it is an ongoing learning curve for me?

After much procrastination, I began thinking of what we as "dirt managers" do. Then I saw the light. Here at the University of South Carolina Upstate (USC Upstate) I'm very fortunate to have the situation and resources that we do.

I'd have a safe bet to say that Coach Chris Hawkins puts in more time and is more hands-on with his facility than any coach in the country. You'll see why later.

Coach Chris Hawkins (left) and Bruce Suddeth.

Composition

Six years ago, our skin area was built of 50% clay, 10% silt, and 40% sand. The field was then amended with three tons of calcined clay conditioner. Since that time more sand and conditioner has been added; the current composition is in the area of 45% clay, 10% silt, and 45% sand. This ratio gives Coach Hawkins the consistency he needs for his team.

Clay bricks are installed in the pitcher's circle and batter's box areas. The bricks are topped off with bagged clay to achieve consistency. The bullpen areas are constructed of the same materials in an attempt to simulate the field's playing surface. Irrigation heads as well as a quick coupler hose for hand watering have been installed in the skin area.

Pre-season prep varies depending on how extensively the skin needs to be repaired. This work typically happens during late November and December. Samples are taken of the skin area and a "cup test" performed to determine the consistency of the soil. We have determined a happy medium between drainage/firming up and moisture retention for playability. This test dictates whether more sand or clay should be added to the skin area.

Whether it is sand or clay the materials are spread with a small topdresser to achieve consistent results. Using a pulverizer, the materials are incorporated into the existing soil profile. A leveling bar is then used to smooth the soil composition so as to keep the grade (1%) for surface drainage.

Once the field is prepped to Coach Hawkins' satisfaction all play is suspended until practice begins mid-January. During the summer growing season we address any lip area issues. We typically cut two widths 16-inches wide with the sod cutter between second and third bases. We remove the built-up soil and return to the stockpile, then relay the sod. Edges are tamped so as not to have a large transition between skin and turf. In addition, the edges are cut once per week during the growing season. A sharp edge makes the turf and manicured skin stand out.

Tournament, game-day prep

Tournament and game-day prep are for the most part the same. Coach Hawkins applies water to the skin area depending on the nature of the tournament or game. For tournaments the field will be in service for extended hours if not days. Knowing this, Coach Hawkins monitors the amount of water applied to the skin depending on the weather, length of play, and time of year. Coach also takes into account the competition and regulates the skin speed based on the amount of moisture applied. It may

also be necessary to water the skin area between games to maintain a constant playing surface throughout the tournament.

For tournament play the field prep begins the day before. The skin turf interface is blown with a backpack blower to move any conditioner in the turf back into the skin. Water is then applied to the skin to the point of saturation, allowed to stand until absorbed, and the field nail-dragged to loosen the top of the soil layer.

Coach Hawkins also likes to mat (cocoa) drag the skin to break up any clumps and level the area for a more finished look. When dragging the skin he likes to alternate start and stop points at baseline to baseline and inside to outside. This reduces the amount of movement in the skin profile.

It is important to start and stop approximately a foot away from the turf areas to eliminate contamination with the skin soils. These areas should be hand-raked. Another important note is to lift the drag before leaving the skin so as not to pull soil into the turf.

Our practice and game-day prep is much the same as above. We water the morning of practice or game similar to tournament prep. The skin is then dragged with nail and mat for a smooth finish followed up by hand raking along the edges. After and before every event or practice the bullpens are hand raked to keep them looking ready for play.

Due to the amount of effort in keeping Cyrill Softball Stadium ready for play at all times, a constant look at the weather is necessary. During periods of practice, game-day, or tournaments it may be necessary to tarp the field to preserve the skin.

The preparation and work of the skin is not the hard part but the planning, scheduling, coordination, and communication that must happen that is difficult.

Bruce H. Suddeth is director of landscape services for the University of South Carolina Upstate, Spartanburg. He would like to thank USC Upstate Landscape Services, Shurburtt CampusScapes, and especially Coach Chris Hawkins for their contributions in winning the 2006 STMA College Softball Field of the Year. ■