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.

Marty Petrovic, Ph.D., is a Professor of Turfgrass Science, Department of Horticulture, at Cornell University. ■