Gaseous Losses and Long-Term Fate of Nitrogen Applied to Kentucky Bluegrass Turf

University of Illinois

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Number of Years: 5
Total Funding: $124,270

Objectives:

1. *Detemine the quantity and form of gaseous nitrogen losses from turf.*
2. *Develop long-term (20+ years) field plots examining the fate of nitrogen applied to a mature turf.*

This project has made considerable progress in 1999. Two field studies were conducted at the University of Illinois to measure denitrification in the field. The long-term research plots at Michigan State University continue to receive inputs of 2 or 5 lbs. N/1000 ft^2/Yr; and the lysimeters in those plots are being continuously monitored for nitrate leachate content. Within each fertilization rate are two lysimeters that have been monitored since the spring of 1998. Beginning in August of 1998, the nitrate content of the leachate from the high N treatments has diverged markedly from the nitrate content of the plots receiving 2 lbs. N/1000 ft^2/Yr. In the early spring of 1999, the leachate draining from the turf receiving 5 lbs. N/1000 ^{2}ft/Yr was consistently in the range of 7 to 8 PPM of $N0_3$-N while the turf receiving 2 lbs. N/1000 ft^2/Yr was consistently in the 2 to 3 PPM range. These numbers are higher than those found in earlier studies and indicate that nitrate leaching may be a more important avenue of loss than earlier research indicated. These soils may be reaching equilibrium for the particular fertilizer rates they are receiving or they may still need additional time to reach equilibrium. In either case the data is very interesting.

The denitrification work at the University of Illinois is providing the first glimpse at denitrification under field conditions. Early work by Torello and Mancino indicated that denitrification would only occur under very wet soil conditions and at elevated temperatures. However, these studies were conducted in growth chambers under artificial conditions.

We conducted two denitrification experiments in 1999, one initiated on 20 May and the other on 9 August. Six lysimeters were sunk into the turf leaving approximately 3-inchheadspace in each cylinder. A brass plate is sealed on to each lysimeter to form a gas tight system that could be sampled for evolution Of $^{15}N_2$ gas. Each lysimeter is covered for 3 hours per day following the start of each experiment and a gas sample collected at the end of that 3-hour period for later analysis. At the start of each experiment, we applied 1 lb N/1000 ft^2 as $KN0_3$. The nitrate was 99% enriched with a stable isotope of nitrogen, ^{15}N, to permit detection of the nitrogen gas coming from the fertilizer. Since water is a critical factor in denitrification due to its role in causing anaerobosis, we were careful not to over water these sites and replaced 80% of ET twice per week.

Measurable gas loss was detected on 27 of the first 28 days following application. These values ranged from 13 µg N to 1,333 µg N per nine-hour monitoring period. By extrapolating the gas loss rates obtained over 9 hours of sampling to 24 hours, we estimated that 4.5% of the applied N was loss by denitrification.

The second experiment began in August when soil temperatures were warmer. A 3.5-inch rain event fell four days after the fertilizer application which favored denitrification. Denitrification losses were detected on 21 of the first 22 days following fertilizer application. We estimated a total loss of nearly 15% of the applied N. Losses ranged from 9.1 µg N at 19 days after fertilizer application to 4,368 µg N the day following the 3.5-inch rain.

While the observed losses are not huge, there are two very important points to be gained from this research. First, this research demonstrates that denitrification is a process that occurs frequently, almost daily, in fine-textured turf soils. Although the soil is not anaerobic, there are anaerobic micro-sites within the profile where denitrification may take place on a frequent basis.

Second, denitrification is a very difficult process to study. This approach not only allows us to measure the loss of ^{15}N by denitrification; it also estimates the loss of 14N from the soil nitrogen pool. By adding ^{15}N labeled fertilizer we not only measure the loss of the labeled fertilizer, the label-fertilizer lets us "see" the denitrification of unlabeled N as well. As long as the labeled fertilizer is present, we can measure denitrification of it as well as the total denitrification occurring in that soil lysimeter. This is a powerful technique to study this dynamic process.

Turf may represent an agricultural system that is susceptible to significant losses from denitrification. In most cropping systems, denitrification will occur in the spring when soils are wet and fertilizer has been recently applied. Denitrification is much less likely to occur in the summer because most cropping systems are unirrigated and the soil dries out quickly. Since denitrification is a microbially mediated process, potential denitrification rates are much higher under warmer soil conditions. In turf, because of frequent irrigation, we have soils that are much more likely to develop anaerobic profiles or micro-sites in the summer when denitrification rates will be highest.