Movement of Nitrogen Fertilizer in a Turfgrass System

by University of California-Riverside Research Team

Nitrogen (N) aids many plant processes and components. It's necessary for growth and development, appearance, and recuperative ability of all turfgrasses. However, its mobility makes N a potential environmental hazard.

In nitrate form, N won't bind with soil or organic colloids. It can move from the application site to ground/surface water or the atmosphere by leaching and runoff, or by volatilization.

Our study monitored N movement below the root system of cool-season turfgrasses. We looked at situations where N was applied at high rates and frequent intervals.

Methods

Turfgrass Research Project at the Agricultural Experiment Station of the University of California (U.C.) - Riverside provided study plots of mixed Kentucky bluegrass and perennial ryegrass.

We applied N at 2.5 lbs. per 1000 sq.ft. to Hanford fine sandy loam soil, and reapplied every eight weeks. We sampled the experimental plots through two consecutive application periods, and performed nitrate analyses with a Technicon Autoanalyzer II.

We used a randomized, complete block of 4-ft. by 6-ft. plots, and performed three replications. Weekly mowing maintained a 2-in. height of cut, and clippings were collected to limit thatch. Sprinkler irrigation replaced soil moisture according to estimates of natural evapotranspiration.

Our nitrogen sources included granular urea (46-0-0), sulfur-coated urea (SCU: 37-0-0), and blood meal (13-0-0). These sources are classified as soluble, slow-release, and natural organic, respectively. They represent a range of nitrate-leaching potential. An untreated control balanced the study.

We collected two samples from each plot every week using Irrometer lysimeters. Samples of tap water from the irrigation source and deionized water accompanied each batch of leachate samples.

Results

Granular urea provided the highest concentration of nitrate sampled. The concentration peaked 10 to 14 days after application. At no time did nitrate leachate exceed federal safety limits.

Sulfur-coated urea treatments demonstrated significantly less leaching of nitrate than urea during peak leaching times. SCU regularly showed more evidence of leaching than blood meal and the untreated control, but there was no significant difference among the three treatments at any rating date during the study.

Even at very high N fertilization rates, there was little probability of significant nitrate leaching from any of the tested sources. Only urea gave levels that were above tap water content, but these readings still fell below federal guidelines.

Discussion

Other studies found similarly low levels of N leaching. A Michigan State University researcher recovered less than 0.2% of applied N below the turfgrass root system. The N he detected was well below the drinking water standard.

A Nevada study reported a total leachate loss of 1.0% or less for tall fescue and bermudagrass turf,

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and another study at Cornell University found minimal N leaching.

In contrast, a Washington State University study found that nitrates could leach from newly constructed sand putting greens in golf course applications. In this creeping bentgrass study, leaching was strongly tied to N application rate, and was strongly modified by rooting medium and application frequency. N leached more from pure sand than from a sand-peat medium.

Leaching was much greater in the first year of the study than in the second, possibly due to more extensive rooting in the second season. Modified-sand rooting medium, moderate levels of total annual N, and frequent applications produced the lowest leaching loss (3-5% annually).

Studies show further that gaseous loss of N can be minimized by applying water immediately after application. This ionizes ammonia that can be produced by rapid mineralization, and prevents it from escaping into the air.

Gaseous N loss can also result when microorganisms chemically reduce nitrate. This produces elemental nitrogen and nitrous oxide gasses. Further research is necessary to explore this phenomenon.

Fertilizer nitrogen applied to a dense, mature, well-maintained turf is normally used rapidly by the turfgrass plant and soil microorganisms. There appears to be little chance of downward movement of nitrogen other than on pure sand with immature turf present. The following cultural practices help minimize potential leaching:

- Water-in fertilizer immediately following application.
- Do not over-apply N.
- Use low application rates or slow-release sources on sands.
- Avoid over-irrigation directly after application.

University of California Researchers Victor Gibeault, Marylynn Yates, Jewell Meyer, and Mathew Leonard contributed to the study. Their complete report is published by the University's Cooperative Extension in California Turfgrass Culture Vol. 48, Nos. 1 and 2.

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