Study Shows Little Nitrate Leaching from Turfgrass on Fine Texture Soil

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Ohio studies indicate that soil disturbance during establishment is a primary source of nitrate-N (NO_3-N) in leachate from bluegrass turf. Nitrogen fertilization practices had little if any effect on NO_3-N leaching from established turf.

RECENTLY, NO_3-N leaching from turfgrass has been of concern due to increased desire to protect groundwater from surface contaminants. Studies have shown that quick release fertilizers, heavy irrigation and high rates of fertilizer nitrogen (N) on sandy soils can cause significant nitrate leaching losses from turfgrass.

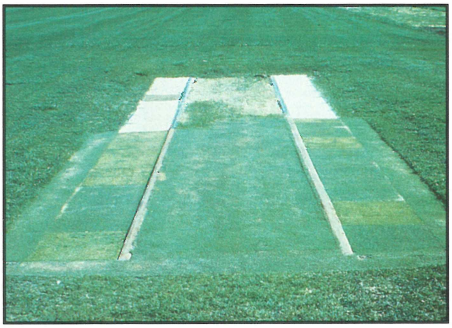
However, many leaching studies have used a sand medium in order to easily observe differences in treatments. In addition, studies usually involved heavy rates of N fertilization and excessive irrigation. That resulted in data that were not representative of nitrate losses from turfgrass in most areas and under typical management schemes.

Ohio Studies

To meet the needs for more representative information, we established a study to determine loss of NO_3-N from a fine textured soil. Field experiments were conducted to determine the effects of Kentucky bluegrass (cultivar "Baron") establishment methods (sodded and seeded) on nitrate-N leaching. Additionally, late season fertilization practices were compared with a more traditional fertilization program. Moderate rates of slow release and quick release N fertilizers were also examined.

The rhizotron-lysimeter facility at The Ohio State University Turfgrass Research Center was utilized for this project. The rhizotron consists of lysimeters measuring 24 x 24 x 30 inches. A 1/4-inch thick sheet of porous polyethylene plastic at the base of each lysimeter allowed water and nutrients to percolate while preventing soil loss. Leachate from each lysimeter was collected in glass 5 gallon bottles.

For this study, twenty-eight lysimeters were filled with Miamian silt loam. The A, B and C horizons were mixed in equal volumes off-site to simulate land disturbances common in newly constructed turfgrass sites.



LYSIMETERS at Ohio State University provide the opportunity to study leaching of nutrients from turfgrass.

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Maintenance programs simulated normal fertilizer practices utilized in the Midwest. Turfgrass was maintained at a 2-inch mowing height and grass clippings were returned to the plots. The plots were irrigated to prevent wilt. Irrigation did not result in percolation to collection depth except on one occasion.

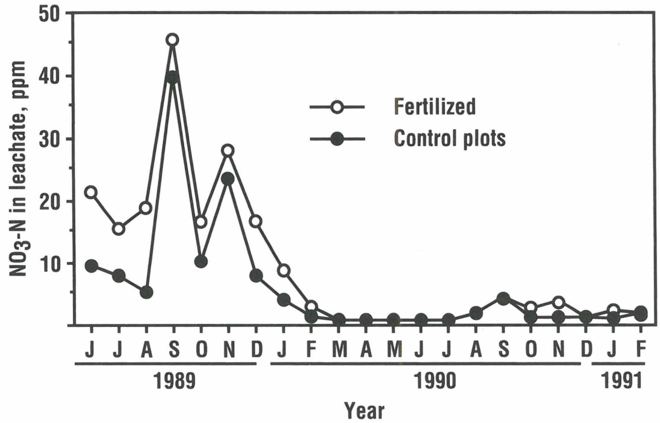

Figure 1. Nitrogen fertilization initially increased NO_3-N leaching from seeded bluegrass turf, but had little effect on NO_3-N leaching from established turf.

Fertilization treatments included a) spring/summer fertilization (SSF) involving N applications of 1.0, 1.0, 0.5, 1.0, and 1.0 lb/1,000 sq.ft. in April, June, July, August and September, respectively, and b) late season fertilization (LSF) which consisted of N applications of 0.5, 1.0, 0.5, 1.0, and 1.5 lb/1,000 sq.ft. in April, June, July, September and November, respectively. Nitrogen sources used were urea and resin coated urea, a slow release N source. Plots were seeded at a rate of 1.0 lb/1,000 sq.ft. and sod was cut to a depth of 1 inch and to the dimensions of the cells (May 1, 1989). Two sod plots and two seed plots were established for controls which received no fertilizer treatments throughout the study.

Fertilizer applications were made on the 15th of the month indicated. Following rain events, percolate volumes were measured and subsamples were removed and frozen until filtering and NO_3-N determinations could be completed. Rainfall was recorded and collected for NO_3-N analysis in order to determine the amount of NO_3-N supplied by rainfall.

Results

Percolate NO_3-N concentrations were high from June 1989 to March 1990 (year 1). Average nitrate-N concentrations for this period ranged from about 10 to 20 parts per million (ppm) NO_3-N depending upon treatments **(Figure 1)**. During this time, the average percolate concentrations for all fertilized and unfertilized treatments exceeded 10 ppm NO_3-N (maximum concentration for drinking water standards). It is suspected that high levels of NO_3-N in percolates resulted from soil mixing when each lysimeter was filled. This soil disturbance stimulated degradation of organic matter and N mineralization. High N mineralization occurred since the soil was taken from a grassland high in organic N.

Lower NO_3-N concentrations in late winter of 1990 and early spring of 1990 indicated that the excessive mineralization of N due to soil disturbance had ceased and that the lysimeters had stabilized during the winter. Ninety-one percent of the precipitation events in the first year yielded percolate NO_3-N levels higher than drinking water standards; this dropped to 16 percent in the second year.

There are important factors related to soil disturbances which should be considered when land is being developed for golf courses, real estate or any other uses. Soil disturbance in golf course or housing development could result in temporary high losses of NO_3-N, higher than would be observed on a mature site. However, the long-term effect of NO_3-N contamination of the environment is minimal. Evidence from this study indicates that high losses of

WITH appropriate fertilization and other typical management practices, there is generally no threat to groundwater from nutrients leaching where established lawns are on fine-textured soils.

NO_3-N will subside in approximately one year. Data for the second year are more representative of a stable turfgrass environment. Average concentrations on treated plots ranged from about 1 to 4 ppm NO_3-N.

The greatest NO_3-N leaching occurred during late summer and early fall. Highest leachate mean NO_3-N concentrations (above 10 ppm) occurred in sodded plots in September. Seeded treatments also generated higher percolate NO_3-N concentrations from August to November.

These high NO_3-N leachate levels in early autumn occurred after substantial N fertilizer applications in June, July, August and September. However, NO_3-N losses cannot be attributed to these applications alone since maximum leaching losses in the control plots were also recorded during late summer and early fall, suggesting a high rate of mineralization or organic N and less NO_3-N uptake during these warm months.

Seed versus Sod. High concentrations of NO_3-N in leachate immediately after establishment were not surprising. More NO_3-N leached from seeded than sodded turf during the first summer of the study. Percolates from seed and sod turfgrass averaged 16 and 9.5 ppm NO_3-N, respectively.

Percolate NO_3-N concentrations from seed and sod plots were similar from September through December of 1989, but concentrations from sod turf began to exceed seed turf during the winter months of 1990. Nitrate-N leaching from sodded plots remained higher throughout the remainder of the study.

Root measurements at the termination of the leaching study showed greater root mass in the top 15 in. of soil under seeded turf. These data suggest that root penetration in sodded turf was inhibited at the sod-soil interface, restricting rooting in the soil below. This may account for greater leaching losses of NO_3-N under sodded turf, since it is likely that less N was intercepted by the restricted root system. It is important to note that even though NO_3-N losses in sodded plots were higher than seeded plots, mean NO_3-N concentrations were well below drinking water standards.

During most of the study, percolate NO_3-N concentrations were not affected by the use of resin coated urea. Leachates from urea were slightly higher in NO_3-N during the second winter of the study. Our study showed that N source does not affect NO_3-N loss in turfgrass.

Late Season versus Traditional Fertilization. All fertilizer applications in the spring-summer fertilization (SSF) program were made between April and September. The late season fertilization (LSF) program included an application of approximately one-third of the annual N during November. The only period where LSF impacted NO_3-N concentrations was during the winter of 1991 when average leachate NO_3-N concentrations were slightly higher, 3 and 2 ppm LSF and SSF, respectively. In effect, LSF had little or no impact on groundwater quality.

Summary

The highest concentrations of NO_3-N leaching from turfgrass resulted from

Crop Removal of Chloride

By P.E. Fixen

IT IS OFTEN useful to farmers and their advisors to be able to estimate the amount of chloride (Cl) removed in harvested crops. Crop removal and leaching below the root zone are the only significant losses of Cl from cropping systems.

Table 1 below indicates that very little Cl is removed in grain. For example, a 60 bu/A wheat crop removes less than 2 lb of Cl in the grain. Harvest of grain and straw (assuming the straw hasn't been rained on extensively) could remove 10 to 30 lb/A, depending on soil level and the level of Cl applied.

Plant material with a high water content at harvest usually contains substantial amounts of Cl. A 6 ton/A alfalfa crop would remove approximately 45 lb of Cl using the levels in the table. Soil or applied Cl levels can markedly alter Cl removal in forage crops. Plant analysis is the only means of accurately determining removal.

The removal values in **Table 1** are based on limited data and should be viewed as rough estimates only. For further information on the subject, a review of the references listed below is suggested. ■

Table 1. Chloride removal by selected crops.

Crop	Plant part	Cl content	Reference
Alfalfa	Shoot	7.6 lb/ton (dry wt)	NRC, 1981
Barley	Grain	0.024 lb/bu[1]	Fixen, 1993
Potatoes	Tubers	0.06 lb/cwt	Saffigna et al., 1977
Sweet clover	Shoot	7.4 lb/ton (dry wt)	NRC, 1981
Wheat	Grain	0.026 lb/bu	Fixen, 1993
Wheat	Grain + straw		Schumacher, 1988
	Low soil Cl	0.17 lb/bu	
	High soil Cl	0.44 lb/bu	

[1]Calculated using same concentration as wheat.

Fixen, P.E. 1993. Crop response to chloride. In (Sparks, D.L. ed.) Advances in Agronomy, Vol. 50. p. 107–150. Academic Press, Inc. San Diego, CA.

National Research Council (NRC). 1981. US/Canada tables of feed composition. National Academy Press. 2101 Constitution Ave. NW. Washington, DC 20418.

Saffigna, P.G., D.R. Kenney and C.B. Tanner. 1977. Nitrogen, chloride, and water balance with irrigated Russet Burbank potatoes in a sandy soil. Agron. J. 69:251–257.

Schumacher, W.K. 1988. Residual effects of chloride fertilization on selected plant and soil parameters. MS Thesis, South Dakota State University.

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soil disturbance during establishment. Soil disturbance stimulates organic matter degradation and N mineralization.

After sod establishment, percolate NO_3-N concentrations decreased to levels well below drinking water standards, indicating that N fertilizers applied to mature, undisturbed turf are generally no threat to groundwater quality.

Highest percolate NO_3-N concentrations in late summer and early autumn are probably due to diminished root initiation and elongation and less plant uptake of N during this time of year. Seasonal variation in climate is likely to have more effect on nitrate leaching than fertilization treatments.

Although establishment method, fertilization program and N source treatment effects were significantly different, percolate NO_3-N concentrations from established turf were well below the current drinking water standard of 10 ppm NO_3-N. ■