# Nitrogen Leaching through Sand-Based Golf Greens

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## Introduction

Environmental concern by the turfgrass industry and the public has promoted the development and implementation of best management practices (BMPs) for golf courses. A major area of concern on golf courses is highly leachable sand-based putting greens. Previous N leachate studies have been conducted (Brauen and Stahnke, 1995; Brown et al., 1977; Miltner et al., 1996; Rieke and Ellis, 1974). Also, a golf course study using suction lysimeters is being conducted in Rhode Island (Ruemmele et al., 1999). However, our study is unique, since no study monitoring leachate flow and concentration on a green receiving play has been conducted.

## Research Objectives

1. Quantify leachate flow and concentration, and percent recovery, of $NO_3$-N and $NH_4$-N through a large-scale sand-based putting green under golf course conditions.
2. Determine if microlysimeters can be used on golf courses to monitor N concentrations.
3. Provide data for development of turfgrass BMPs to promote environmental safety while maintaining quality turfgrass.

## Materials and Methods

A small 60°-trapezoidal flume (**Fig. 1**) attached to the main drain line is used for sampling leachate (every 24 hr) and monitoring flow (every 30 min). Leachate samples are stored within an automatic sampler (**Fig. 2**) at 1°C to insure sample stability, transported to WSU, and frozen until analysis.

Six microlysimeters (**Fig. 3**) were installed in the 35-cm rootzone at three green locations. Each location (high and low contour sites, and a high traffic area located at the entrance to the green) included two microlysimeters (**Fig. 4**). Data were collected approximately monthly during the 1999 and 2000 growing seasons.

A foliar fertilizer, 24-0-24 Nitro-K Plus II at 0.5 g N $m^{-2}$ (1.75% ammoniacal N, 3.0% nitrate N, 19.3% urea N) and 0.5 g K $m^{-2}$ (100% $K_2$0), was applied every 7 to 10 days. In addition, Ferromec (15% urea N, 3% sulfur, and 6% iron sulfate) was added to the foliar fertilizer at a rate of 0.3 g $m^{-2}$. The total N applied annually is approximately 17 to 20 g N $m^{-2}$. For research purposes, N was increased to 1.5, 3.0, 3.5, or 4.5 g N $m^{-2}$ (one application at each rate) to observe the effects of higher N rates. Nitro-K Plus II was applied at 1.5 and 3.0 g N $m^{-2}$ on 5 Aug. and 4 Sept. 1998, respectively. Scott's 26-4-13 with minors was applied at 4.5 g N $m^{-2}$ on 8 Apr. 1999 and 3.5 g N $m^{-2}$ was applied 17 Sept. 1999 as Scott's Starter Fertilizer 19-25-5.

Grass clippings are collected daily from the whole green (650 $m^2$), weighed, sub-sampled, and frozen. The clippings samples are dried in a 60°C oven for 3 days, then weighed. A seed density sorter is used to separate topdressing sand from the clippings. Clippings are analyzed for N using a LECO combustion auto-analyzer.

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Floating 14th green at the Coeur d'Alene Resort Golf Course

**Fig. 1** - Trapezoidal flume assembly

Drainage pipe layout during construction of the floating green

**Fig. 2** - ISCO 6700FR leachate sampler

**Fig. 3** - Porous ceramic cup microlysimeter

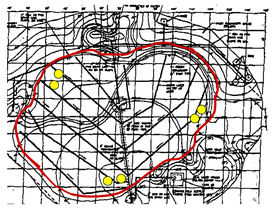

**Fig. 4** - Microlysimeter locations

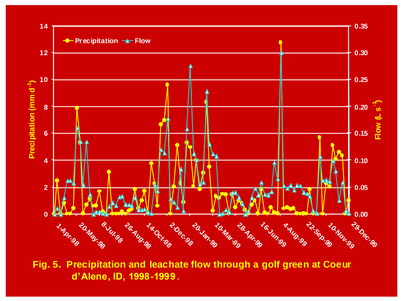


Fig. 5. Precipitation and leachate flow through a golf green at Coeur d'Alene, ID, 1998-1999.

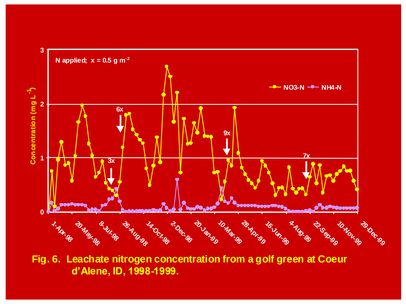


Fig. 6. Leachate nitrogen concentration from a golf green at Coeur d'Alene, ID, 1998-1999.

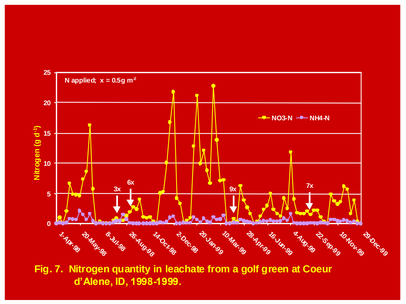


Fig. 7. Nitrogen quantity in leachate from a golf green at Coeur d'Alene, ID, 1998-1999.

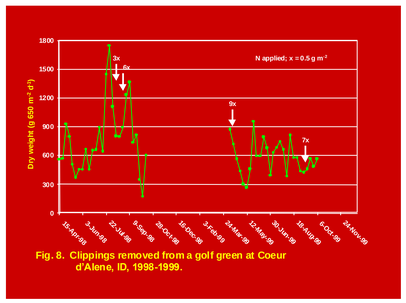


Fig. 8. Clippings removed from a golf green at Coeur d'Alene, ID, 1998-1999.

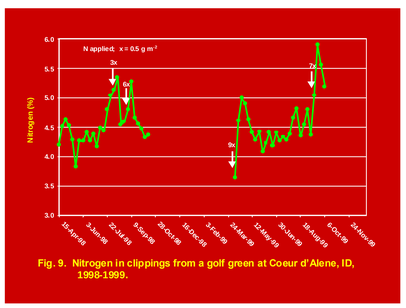


Fig. 9. Nitrogen in clippings from a golf green at Coeur d'Alene, ID, 1998-1999.

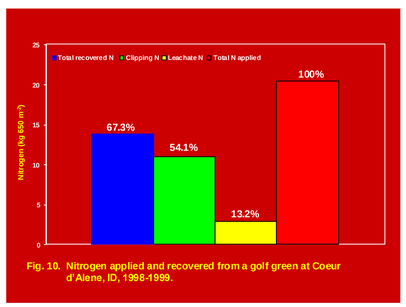


Fig. 10. Nitrogen applied and recovered from a golf green at Coeur d'Alene, ID, 1998-1999.

## Results and Discussion

Flow rate through the green ranged from 0 to 26,000 $L^{-1}$ (daily basis) (**Fig. 5**). Peak flow rates can be attributed to rainfall events.

$NO_3$-N ranged from 0.0 to 2.7 mg $L^{-1}$, well below the EPA limit of 10 mg $L^{-1}$, and $NH_4$-N levels ranged from 0.0 to 0.6 mg $L^{-1}$ (**Fig. 6**). Increased fertilizer rates of N increased leachate $NO_3$-N concentration and total N leached during the 1- to 3-wk period following application (**Fig. 6 and 7**). $NH_4$-N trends were not consistent. However, at no time during an 8-week post-application period were $NO_3$-N concentrations greater than 2 mg $L^{-1}$ (**Fig. 6** ). The highest amount of N leached occurred during late fall and late winter/early spring when water flow and N leachate concentrations were high (**Fig. 7**).

Microlysimeter $NO_3$-N concentrations showed significant differences with respect to location on the putting green. The high traffic area had the highest concentration (0.8 mg $L^{-1}$). Concentrations of 0.2 mg $L^{-1}$ and 0.3 mg $L^{-1}$ were recorded at the low and high contour areas, respectively. Microlysimeter data were comparable (1999; p=0.03, r=0.72) to those from the whole-green system, which indicates a potential use for monitoring N on golf courses.

Clipping dry wt. variation can be attributed to frequent sand top dressing, mowing height variation, periodic mowing of cleanup lap, and environmental factors (**Fig. 8**). The daily bentgrass clipping N ranged from 3.6 to 5.9 % (**Fig. 9**) and reflect increased N applications. Low leachate concentrations combined with high leaf tissue (clippings) N suggests efficient N uptake by the plant. Total recovered N (leachate and clippings) was 67.3 % (**Fig. 10**). Non-recovered N could be present in unavailable forms in both the soil and thatch with some potential loss to volatilization, but is believed not to be an environmental concern (Miltner et al., 1996; Starr and DeRoo, 1981).

## Conclusions

1. N fertilization of sand-based golf greens poses little potential for ground water contamination when healthy turfgrass is maintained.
2. Microlysimeters placed in the green can be used to monitor N concentrations; however, since concentration varied with location, placement of lysimeters on the green needs to be considered.
3. The large, sand-based floating green used in these studies is a unique field laboratory that should be utilized in future research for the development of BMPs for turfgrass management.

## References

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