Progress Report

# The Effects Of Turfgrass Root Architecture On Nitrate Leaching And N Use Efficiency

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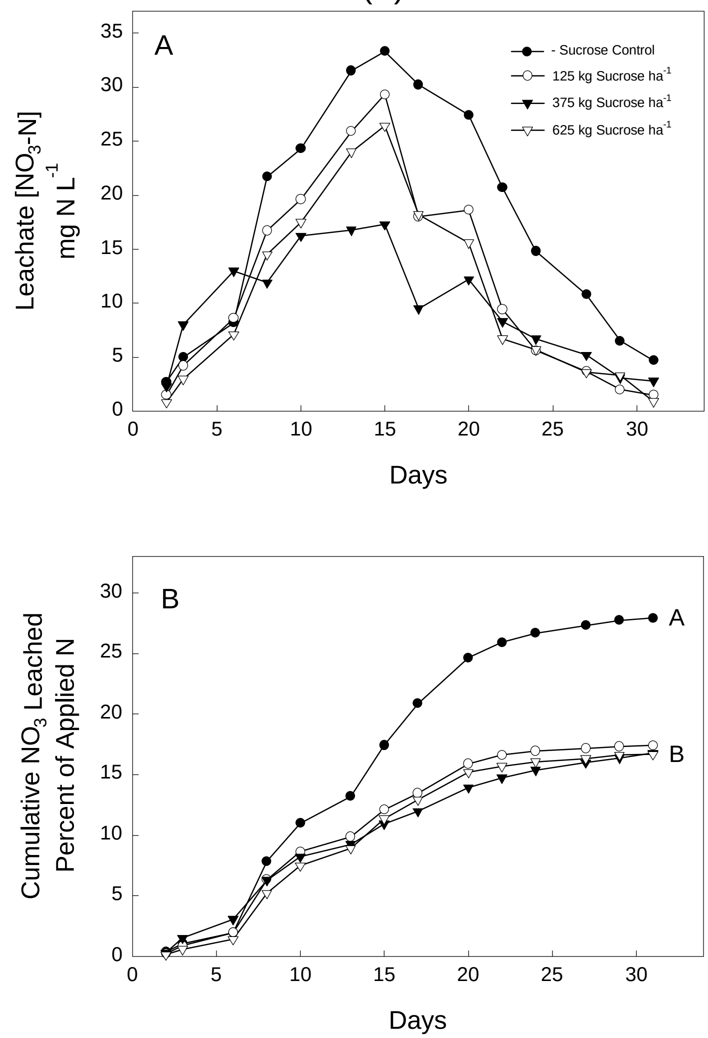
As part of the initial phase of this study, several model systems/methodologies have been developed and tested. Large column lysimeters have been constructed and installed at the NCSU Phytotron. Each is equipped with sampling hardware to permit recovery of all leachate. A preliminary study to evaluate lysimeter performance was conducted using hybrid bermudagrass sod. We hypothesized that supplementing the fertilizer with soluble carbohydrate could reduce nitrate leaching during turf establishment. This would stimulate microbial immobilization of the fertilizer, and tie the N up in the rootzone rather than having it leach. Ammonium nitrate was applied approximately monthly for four months at a rate of 50 kg N $ha^{-1}$, with sucrose added at rates of 0, 50, 150 and 250 kg C $ha^{-1}$. Irrigation was applied to maintain a high leaching fraction and maximize leaching potential. Mass emission of N from the controls amounted to 23%, 28%, 9% and 7% of the applied N for months one through four, respectively. The reduction in loss with time corresponds to root development. Sucrose addition reduced both $NO_3$ concentration and mass emission 40-65% compared to controls (Figure 1), suggesting significant increases in microbial immobilization. Sucrose addition did not affect root distribution, which also supports the role of microbial activity in reducing leaching. These data indicate the need to better understand turfgrass soil microbiology, especially regarding nitrogen nutrition. The experiment also validated the performance of the lysimeters, which will be used to monitor root development during year two of the project.

A second objective of this research program is to compare the nitrogen uptake kinetics of several warm-season turfgrass species. We have previously characterized uptake by cool-season turfgrasses using the Claassen-Barber depletion technique to quantify the kinetic parameters Vmax and Km. The method requires a flowing solution culture system to minimize diffusion limitations. The most common system design uses hydraulic pumps, which are expensive and often troublesome. We have designed a simplified flow-through system using the air-lift principle, which reduces both cost and complexity while maintaining rapid solution flow. Sod will be grown in culture rings until a healthy root system has developed. Kinetic parameters will then be determined. This work is scheduled for summer of 1999, once sod becomes available. We are also evaluating the possibility of screening germplasm for N uptake efficiency using $^{15}N$. Seventeen genotypes of Kentucky bluegrass were grown in large

Figure 1. Nitrate-N concentration in the leachate (A) and mass emission of N (B) with time.




flow-through solution culture systems. Nitrogen was maintained in the solution at either constant low N concentration with continuous addition via a peristaltic pump, or at high (1 mM) concentration with periodic addition. Screening at low concentration should select for differences in uptake affinity (Km) while screening at the high concentration selects for uptake capacity (Vmax). $^{15}$N-labeled fertilizer was added transiently to label the plant material. Plants were harvested, separated into roots and shoots, dried, weighed, and ground. The tissue is currently being analyzed by commercial mass spectrometry. Uptake will be expressed on a root weight basis. We will be looking for genotypes that vary significantly in uptake affinity and capacity. Uptake kinetics of selected genotypes will then be verified using the flow-through system.

A second experiment was conducted in the Phytotron to investigate the effects of trinexapac-ethyl (Primo ®) on nitrate leaching potential and N budget in 'Tifway' bermudagrass. The turf was established in column lysimeters filled with sand as described above. TE was applied twice at four-week intervals at 0.11 kg a.i. $ha^{-1}$, and ammonium nitrate (AN) was applied at 49 kg N $ha^{-1}$ two weeks after each TE application, and again six weeks after the second TE application. Separate sets of columns received $^{15}N$-labeled AN for each of the first two N applications. Irrigation was scheduled three times per week to provide a 50% leaching fraction. TE reduced clipping production by 30-40% compared to the control. There was no effect of TE on nitrate leaching following the first two N applications. Following the third AN application, approximately 50% less nitrate leached from the TE treated columns compared to the control, even though growth effects from TE had mostly disappeared. It is possible that the post inhibition growth response increased demand for N during this period, resulting in less N being available in the rootzone for leaching. Data on tissue allocation of N are currently being analyzed. The results indicate that growth regulators can be used without increasing the potential for nitrate leaching.

Finally, we have been able to hire Dr. Chunhua Liu to conduct this project's research. He is currently initiating two experiments. This first will examine nitrate leaching as a function of root development in several warm-season grasses. The second will characterize nutrient uptake kinetics for the same species. Considerable progress on these topics is anticipated in the next six months.