from the golf course, and the water captured from the adjacent urban road, commercial, and residential areas.

We have completed installation of sampling equipment (flow meters, samplers, and infield chemical detection systems) at five of the six sites established as part of this project on the constructed wetland. The samplers began running in September of 1998. However, we have not had a significant enough storm to allow for water collection. It is fully anticipated that most of our run off collections will be starting within the next five weeks.

Description of sample sites:

Site 1. Evaluation of the *typical* water flowing from a mature residential and light industrial setting to the golf course.

Site 2. By subtraction (site 1 from 2), water quality and quantity from a greens-fairway complex.

Site 3. The treatment ability of a single wetland cell for municipal water as well as golf course materials (site 2 from 3).

Site 4. Water quantity and quality as affected by treatment in cell series (site 1 from 4).

Site 5. Water volume and quantity for untreated conditions. By subtraction (site 4 from 5), the impact of a wetland series on the quality of discharge waters.

We are presently employing a technician on the project. To date, the funds for the technician have come from matching monies on the project. We are presently search for a student to be employed on the project. We have several excellent applications and hope to have someone in place by January of 1999.

The Effects of Turfgrass Root Architecture on Nitrate Leaching and Nitrogen Use Efficiency

North Carolina State University

Daniel C. Bowman

Start Date: 1998
Number of Years: 5
Total Funding: $97,830

Objectives:

1. *Extend our current column lysimeter study comparing six different warm-season turfgrasses for NO3 leaching and nitrogen efficiency.*
2. *Measure root architecture (depth, density, dynamics) and other root characteristics (cation exchange capacity, carbohydrate release, microbial association, viability) for the six species.*
3. *Measure the kinetic parameters of nitrogenuptake for each species.*
4. *Determine whether root architecture or uptake kinetics explains the differences between the species.*
5. *Use a state-of-the-art-flow-through nutrient solution culture system to screen germplasm for nitrogen uptake efficiency and to simultaneously determine rooting depth of the genotypes.*
6. *Use genotypes identified in objective five to validate the conclusions regarding rooting architecture vs.uptake kinetics as a primary determinant of nitrogen efficiency.*

As part of the initial phase of this study, several model systems/methodologies have been developed and tested. Large column lysimeters were 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 nitrogen 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 nitrogen from the controls amounted to 23, 28, 9 and 7 percent of the applied nitrogen 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 to 65 percent compared to controls (Figure 11), 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 the research project is to compare the nitrogen uptake kinetics of several warm-season turfgrass species. We have previously characterized uptake by cool-season turfgrasses using the Classen-Barber depletion technique to quantify the kinetic parameters V_{max} and K_m. 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.

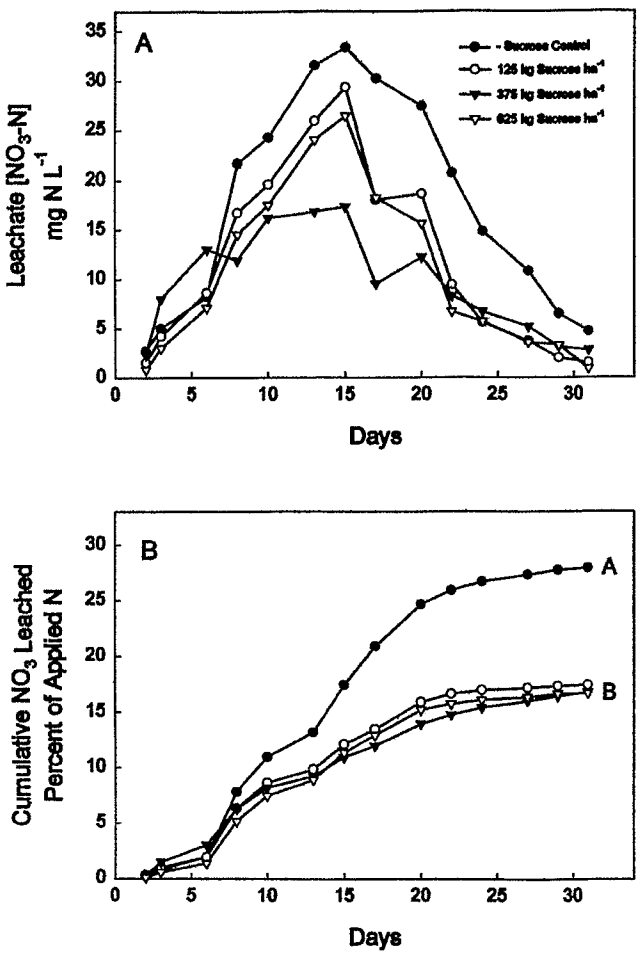

Figure 11. Nitrate-N concentration in leachate (A) and mass emission of nitrogen (B) with time.

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 nitrogen uptake efficiency using ^{15}N. Seventeen genotypes of Kentucky bluegrass were grown in large flow-through solution culture systems. Nitrogen was maintained in the solution at either constant low-nitrogen 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 (K_m) while screening at the high concentration selects for uptake capacity (V_{max}). ^{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.

Comparing Nutrient Losses Via Runoff from a New Golf Course and the Golf Course Site's Previous Native Condition.

Kansas State University

Steve Starrett

Start Date: 1998
Number of Years: 5
Total Funding: $118,155

Objectives:

1. *Compare the nutrient loading, by way of surface water runoff, from a new golf course, and the site's previous native prairie condition.*
2. *Investigate the new golf course's impact on surface water quality during construction and during golf course operation.*

The objective of this research is to compare the nutrient loading, by way of surface water runoff from a new golf course (Colbert Hills Golf Course), and the site's previous native prairie condition. The nutrient loading from the golf course site into the main surface water stream (Little Kitten Creek) will be determined during construction and during operation. Surface water samples are being collected during runoff events from at three locations on Little Kitten Creek. Currently, automated samplers are installed where Little Kitten enters the golf course property, where a small tributary enters the property and where Little Kitten Creek exits the property. About 300 water samples have been collected since February. Water samples will be tested for nutrient concentrations and other physical and chemical parameters. Surface water runoff amounts will be determined so those mass amounts of nutrients contained in the runoff can be calculated.

Kansas State University in cooperation with Jim Colbert, PGA TOUR, GCSAA, and various alumni are building Colbert Hills Golf Course, a 27-hole championship course, near Manhattan, Kansas. Colbert Hills is being built on land that has a prairie-woodland mix that is typical of the Flint Hills Region. The only previous land use was occasional grazing for beef cattle. Data on water quality from the nearby Konza Prairie research area (NSF Long-Term Ecological Site and USGS Benchmark site) has been collected for close to 20 years and comparisons in water quality from Colbert Hills and the Konza Prairie will be made.