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

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Objectives:

1. Compare six different warm-season turfgrasses for nitrate leaching and nitrogen efficiency.
2. Measure root architecture (i.e., depth, density, dynamics) and other root characteristics (i.e., cation exhchange capacity, carbohydrate release, microbial association, viability) for the six species.
3. Measure the kinetic parameters of nitrogen uptake for each species.
4. Determine whether root architecture or uptake kinetics explain the difference between species regarding nitrogen uptake.
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. Determine if root architecture or uptake kinetics are primary determinants of nitrogen use efficiency.

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Project Duration: 5 years
Total Funding: $97,830

Use of fertilizers in the urban setting has increased over the last few decades, due in large part to increasing acreage and higher management of turfgrass. Environmental problems associated with nitrate contamination of water supplies have also increased over the same period. This project investigates various factors that may affect nitrogen use efficiency including root architecture, genetics, and the application of carbohydrates and growth retardants.

An initial study demonstrated that nitrate leaching could be reduced during turf establishment by supplementing the fertilizer with sugar, thus stimulating microbial immobilization of the fertilizer.

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 over time corresponds to root development. Sucrose addition reduced both nitrate concentration and mass emission 40-65% compared to controls, suggesting significant increases in microbial immobilization.

A second experiment investigated the effects of trinexapac-ethyl (Primo) on nitrate leaching potential and nitrogen budget in 'Tifway' bermudagrass. Trinexapac-ethyl applications reduced leaf growth by 30-40% compared to the control. There was no effect of trinexapac-ethyl on nitrate leaching following the first two N applications.

A study at North Carolina State University is underway to compare nitrogen use efficiency and root architecture of different bentgrass cultivars.

Following the third ammonium application, however, approximately 50% less nitrate leached from the trinexapac-ethyl treated columns compared to the control, even though growth effects from trinexapac-ethyl had mostly disappeared. The results indicate that growth regulators can be used without increasing the potential for nitrate leaching.

The effect of root distribution on nitrate leaching was investigated using hybrid bermudagrass, zoysiagrass, centipedegrass and St. Augustinegrass. Different root distributions are established by staggering the planting time from one week to four months.

Nitrate leaching was high from the most recently planted sod of both species. As little as one to two months establishment reduced leaching losses considerably, presumably due to root growth (i.e., depth and density).

Bermudagrass established deeper and denser root systems more rapidly than did zoysiagrass, which is reflected in the cumulative leaching profiles. This experiment is currently being repeated using centipedegrass and St. Augustinegrass.

Summary Points

- Nitrate and ammonium leaching from the first nitrogen application to recently sodded turf was high, ranging from 48% to 100% for St. Augustinegrass and zoysiagrass. To minimize leaching losses, fertilization on newly planted sod should be carefully monitored.
- Considerably less nitrate nitrogen and no ammonium nitrogen leached from subsequent nitrogen applications, probably due to more efficient uptake by the developing root system.
- There was consistent genotypic difference in nitrate leaching potential. St. Augustine exhibited the lowest nitrate leaching and 'Meyer' zoysiagrass exhibited the highest nitrate leaching.
- Root architecture was a primary determinant of nitrate leaching and nitrogen use efficiency and highlight the importance of carefully managing both fertility and irrigation when establishing warm-season grasses from sod.