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.

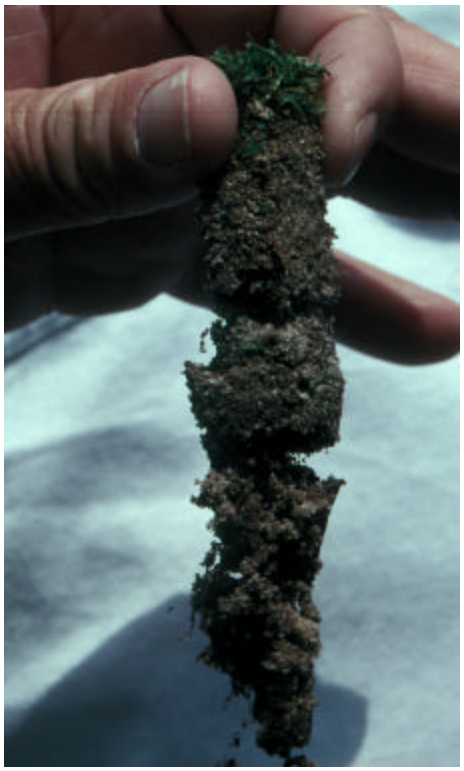
Start Date: 1998
Project Duration: 5 years
Total Funding: $97,830

This study investigated the kinetics of nitrate absorption by four warm-season turfgrasses. Hybrid bermudagrass (*Cynodon dactylon* X *C. transvaalensis*), zoysiagrass (*Zoysia japonica*), St. Augustinegrass (*Stenotaphrum secundatum*), and centipedegrass (*Eremochloa ophiuroides*) were grown in a re-circulating solution-culture system.

Uptake kinetics are typically described using the analagous enzyme kinetic parameters V_{max}, which is the maximum rate of absorption expressed on a root weight, length or area basis, and K_m which is the nutrient concentration at which the uptake rate is half maximum. Higher V_{max} values indicate greater capacity, while lower Km values imply greater efficiency.

The kinetic parameters V_{max} (maximum nitrate uptake rate) and K_m (nitrate concentration at which uptake rate is half maximum) were determined. The V_{max} for nitrate uptake by St. Augustinegrass, bermudagrass, zoysiagrass and centipedegrass was 92, 39, 33, and 22 mmol N g^{-1} DW h^{-1} respectively. The K_m values were 78, 70, 44 and 16 mmol, respectively. The low K_m value for centipedegrass may be related to its ability to grow under conditions of very low N fertility.

Logically, a root system having a high nitrate uptake capacity, a high uptake efficiency, or both would be able to absorb applied fertilizer N most rapidly, and thus minimize the potential for leaching.



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

Nitrate uptake followed classical, saturable kinetics, with St. Augustinegrass having the highest V_{max} and centipedegrass the lowest. The V_{max} of bermudagrass, centipedegrass, St. Augustinegrass, and zoysiagrass was 39, 20, 92, and 33 mmol N g^{-1} DW h^{-1} and the K_m was 70, 16, 78, and 44 micromol, respectively.

Pertinent to this discussion is the typical soil solution nitrate concentration range found under turf, since this will determine which of the two kinetic parameters is the stronger determinant of uptake. Our recent data for fairway bermudagrass turf documents soil solution nitrate concentrations averaging > 3 mg N L^{-1}. This suggests that of the two parameters, V_{max} may be more important in determining relative N efficiency in warm-season turfgrasses under field conditions.

Our previous work on nitrate leaching from these same species identified St. Augustinegrass as having the least, and centipedegrass the most potential for leaching losses. The present data suggests that leaching potential may be related to uptake capacity, since St. Augustinegrass had the highest and centipedegrass the lowest V_{max}. However, there was also a correlation between leaching and rooting patterns, with deeper and more extensive root systems minimizing the leaching potential. Most likely both parameters act as strong determinants of N uptake.

Summary Points

- Nitrate uptake followed classical, saturable kinetics, with St. Augustinegrass having the highest V_{max} and centipedegrass the lowest.
- Of the two parameters, V_{max} may be more important in determining relative N efficiency in warm-season turfgrasses under field conditions.
- The present data suggests that leaching potential may be related to uptake capacity. Most likely both uptake capacity and rooting patterns parameters act as strong determinants of N uptake.