Increasing the Nitrogen Use Efficiency of Cool-Season Turfgrasses by Regulating Nitrate Metabolism

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Objectives:

1. To quantify each step in nitrate metabolism for ten Kentucky bluegrass, nine perennial ryegrass, and five creeping bentgrass genotypes.
2. To determine which of thse steps correlates best with nitrogen use efficiency under field conditions.
3. To assess the potential for increasing nitrogen use efficieincy by optimizing the activity and locaiton of those steps which are limiting.

Start Date: 1998
Project Duration: 3 years
Total Funding: $75,000

Among the objectives of the USGA's research grants program is the development of turfgrasses and a strategy for managing them that will significantly reduce the amount of fertilizer required to maintain high quality turf under golf course conditions.

We have attempted to understand the factors contributing to nitrogen use efficiency in turfgrasses and manipulate these factors in such a way that the need of turf for nitrogen fertilizers will be reduced. A turfgrass that can allocate more of its photosynthetic resources toward root growth will have a larger root system that will be better able to absorb nutrients and water from a larger soil volume. Such turfgrasses will be better able to tolerate drought conditions and derive a larger portion of their nitrogen requirements from that provided by organic matter cycling within the soil.

Nitrogen is available to turfgrass roots primarily in the form of nitrate. Nitrate is produced in the soil when organic matter is metabolized by microbes, releasing its nitrogen as ammonium that is oxidized by other microbes to nitrate. Nitrate is highly mobile and can leach with water out of the soil and potentially contaminate ground water. The best protection of ground water quality is a dense root system that will absorb nitrate to supply the needs of the grass for nitrogen and sustain those roots throughout the year for continued nitrate uptake.

We are examining the capacity of nine cultivars each of perennial ryegrass and creeping bentgrass to absorb nitrate and metabolize it. We are testing the hypothesis that quality turf is most likely to occur when turfgrasses metabolize nitrate primarily in roots with relatively little nitrate transported to and metabolized in the shoots. Our research has shown that cultivars of perennial ryegrass and creeping bentgrass allocate most of their photosynthetic resources to shoot growth and little to roots. These same grasses also metabolize most of the nitrate they absorb from the soil in their shoots which may explain their priority of shoot growth over root production.

At University of Rhode Island, Dr. Richard Hull and graduate student John Bushoven discuss nitrogen use efficiency in cool-season grass species.

Generally, creeping bentgrass metabolizes more nitrate in its roots and also partitions a greater portion of its total biomass to root growth than does perennial ryegrasses. We also have observed that perennial ryegrass absorbs nitrate more rapidly from the soil than does creeping bentgrass, but much of this nitrate is transport ed to be metabolized in leaves.

In perennial ryegrass, we also have observed a positive and significant relationship between nitrate metabolism in roots and the amount of roots produced. This may explain how bentgrasses, that absorb nitrate more slowly and metabolize more of it in the roots thereby promoting greater root growth, can sustain themselves when maintained as a very closely mowed turf. Research proposed for the future of this project will concentrate on further testing our hypothesis and formulating turf management strategies that can use these findings to make present turfgrasses more efficient in their use of soil nitrogen.

Summary Points

- Perennial ryegrass and creeping bentgrass allocate most of their photosynthetic resources to shoot growth and little to root growth
- Both grasses metabolize most nitrate they absorb from the soil in their shoots.
- Creeping bentgrass metabolizes more nitrate in its roots and partitions a greater portion of its biomass to root growth than perennial ryegrass.