continue exploring the molecular differences between and within these species. Wisconsin isolates will be tested for mating reactions by di-mon pairings with tester isolates from Japan, Russia, Norway, Canada and the United States of America. The percent similarities of the CITS regions will then be compared with the di-mon pairings.

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

University of Rhode Island

Richard J. Hull

Start Date: 1998
Number of Years: 3
Total Funding: $75,000

Objectives:

1. *To quantify each step in nitrate metabolism for ten Kentucky bluegrass (Poa pratensis L.) and five creeping bentgrass (Agrostis palustris Huds.) genotypes.*
2. *To determine which of these steps correlates best with nitrogen use efficiency under field conditions.*
3. *To assess the potential for increasing nitrogen use efficiency by optimizing the activity and location of those steps which are limiting.*

A long-standing paradox confronting turfgrass managers is the simple fact that high quality turf cannot be maintained without annual applications of nitrogen even when clippings are retained on the turf and no nitrogen is removed. This paradox is made all the more intriguing by recent research that shows very little nitrogen is lost from turf through nitrate leaching, ammonia volatilization or denitrification (usually less than 15% of that applied as fertilizer). Our research has shown that more than 2000 lbs. of nitrogen per acre can be recovered within the turf-soil ecosystem of long established turf. With that much nitrogen present in the turf environment, it would appear unlikely that additional applications are unnecessary.

The answer to this paradox lies in the fact that in the spring when nitrogen is most needed by turfgrasses, soils are too cold to mineralize much of the organic nitrogen available. During the summer, when the soil is warm and nitrogen becomes available, turfgrass roots are starved for energy because of high respiratory demands by the shoots due to elevated air temperatures. Warm-season turfgrasses do not experience this problem because their leaf respiration does not increase as much during hot weather.

This research project is intended to find means for making cool-season turf more efficient in recovering soil nitrogen. One obvious approach would be to promote greater root development and less shoot growth. This would make the grass better able to absorb nitrate from a larger volume of soil while less energy is committed to rapid shoot growth. Plant growth regulators have been used to achieve this goal but their action is not long lasting and while they inhibit shoot growth they often fail to stimulate root development. We believe the location of nitrogen metabolism in turfgrasses may be the key to this problem.

Most soil nitrogen is available to turfgrass roots as nitrate and is readily absorbed in that form. However, before nitrate-nitrogen can be assimilated into amino acids and proteins it first must be reduced to ammonium. This reduction of nitrate occurs in two steps or reactions: nitrate reduction (NR) and nitrite reduction (NiR). In roots, the eight electrons (e^-) required for these two reactions come from the reduction of sugars produced during photosynthesis and translocated to the roots. In leaves, most of the eight electrons come directly from photosynthetic reactions. The ammonium (NH_4^+) is assimilated directly into the amide-nitrogen of glutamine, which is a five carbon amino acid.

$$N0_3^- + 2H^+ + 2e^- \text{----------NR---------->} N0_2^- + H_20$$
$$N0_2^- + 8H^+ + 6e^- \text{----------NiR----------->} NH_4^- + 2H_20$$

The first reaction in this process is catalyzed by the enzyme nitrate reductase and this has been determined to be the rate limiting step in the chain of reactions leading to nitrogen assimilation. If nitrate is reduced in the roots, amino acids are produced there and root growth is promoted. If roots are unable to reduce nitrate as rapidly as it is absorbed from the soil, the nitrate can be transported to leaves where it will be reduced, assimilated into amino acids and stimulate shoot growth. When nitrate is reduced in leaves, photosynthetic products are diverted to shoot growth and away from roots. This lowered carbon flow to roots makes them even less able to reduce nitrate so more is transported to leaves and shoot growth is further stimulated and roots are not. This is what normally happens when turf receives nitrate from the soil or fertilizers.

The research conducted in this project will determine if the nitrate stimulation of shoot growth can be minimized by promoting nitrate reductase activity (NRA) within roots. We have found that in all Kentucky bluegrass cultivars studied, NRA is often ten times more active in the leaves than it is in roots. However, some cultivars (*LIBERTY*) did exhibit significantly greater NRA in their roots. We will determine if such cultivars produce greater root growth and if this contributes to more efficient nitrogen use. Currently we are extending this investigation to include diverse cultivars of perennial ryegrass and creeping bentgrass. Similar comparisons will be made and we will determine if greater root NRA correlates well with increased nitrogen use efficiency and field performance. We are also examining management practices that promote greater root growth (higher mowing heights, lower nitrogen fertilization, infrequent but thorough irrigation, etc.) to determine if they contribute to greater root NRA.

If this relationship between NRA in turfgrass roots and increased root growth is substantiated, efforts will be made to alter turfgrasses genetically to produce cultivars that have a more active nitrate reductase enzyme in their roots. This may produce turfgrasses that will utilize soil nitrate so efficiently that little if any fertilizer nitrogen will be required. This would all but eliminate nitrate leaching from turf and produce turf with a larger, stronger root system that would be more tolerant of drought, and root-feeding insects. This research could greatly increase the over-all efficiency of turfgrass management.

Management Practices for Golf Course Roughs, Fairways, and Tees using Buffalograss

University of Nebraska

Terrance Riordan

Start Date: 1998
Number of Years: 3
Total Funding: $75,000

Objectives:

1. *Develop fertilization, mowing, irrigation, and pesticide recommendations for new buffalograsses.*
2. *Evaluate effect of cultivation on buffalograss.*
3. *Evaluate management for wear and divot recovery on buffalograss.*
4. *Use quantitative measures of turfgrass quality and recovery.*
5. *Study population changes in seeded cultivars due to management changes.*

Evaluation for Low-mowing and Wear tolerance. Under low mowing and no wear the female clone *92-135*, which outperformed all other entries in 1997, performed very well again in 1998 along with the female clone *92-31*. However, two male clones, *92-141* and *92-116*, had the best overall performance in 1998. All seed established experimentals exhibited average color and quality characteristics. The trial had a number of promising male and female clones. Wear results indicated that male and monoecious clones exhibited the most damage, while wear tolerance of female cultivars was significantly better than males, but not as good as for mixed seeded types.

Fertility and Mowing Effects on Buffalograss. At the Nebraska site, *NE 91-118* and *378* had the highest quality ratings at the 2.5 cm mowing heights for years 1996-1998. *CODY* and *TEXOKA* had poor quality ratings at the 2.5 cm mowing height for all years. In 1998, *NE 91-118*, *378*, and *CODY* had the highest quality ratings at the 5.1 cm mowing height. At the 7.6 cm mowing height, *CODY* and *TEXOKA* had the highest quality rating in 1997 but *CODY* and 378 had the highest quality ratings in 1998.

From 1997 to 1998, several trends were evident. First, turfgrass quality decreased from 1997 to 1998 for all cultivars at the 0, 2.4, and 5.0 g N m^{-2} rates. At 10 g N m^{-2}, *NE 91-118* and *378* had higher quality in 1998 than in 1997. All cultivars had improved quality ratings in 1998 at the 20 g N m^{-2} rate. Quality ratings in 1998 were poor (< 6) for all cultivars at 0, 2.4, and 5.0 g N m^{-2} rates. At 10 g N m^{-2} *NE 91-118*, *378*, and *CODY* had good turfgrass quality. Management recommendations for 378 and *NE 91-118* are 2.5 or 5.1 cm mowing heights and a nitrogen rate of 10 g N m^{-2} $year^{-1}$. Recommendations for *CODY* and *TEXOKA* are 5.1 or 7.6 cm mowing heights and a nitrogen rate of 10 g N m^{-2} $year^{-1}$.

Nitrogen Partitioning in Turfgrasses. Field experiments to determine the fate of nitrogen fertilizer applied to three turfgrass species were initiated in 1997 at the John Seaton Anderson Turfgrass Research Facility near Mead, Nebraska. Fate of fertilizer nitrogen will be followed in buffalograss, Kentucky bluegrass, and tall fescue. Established turfgrass plots of two cultivars of buffalograss, *NE 91-118* and *NE 86-120*, a blend of Kentucky bluegrass, and a blend of tall fescue. The total amount of actual nitrogen that will be applied each year to a 9 m^2 plot is 0, 10, and 20 g N m^{-2}. For Kentucky bluegrass and tall fescue 80 percent of evapotranspiration will be returned every four days and for buffalograss 60 percent of evapotranspiration will be returned weekly. Plots will be randomly sampled prior to each fertilizer application to analyze for nitrogen content in plant and soil fractions. A Giddeon Soil Probe will be used to extract six cores (5 cm diameter) to a depth of 62 cm. Cores will be divided into thatch, verdure, roots, and soil components. The soil cores will be partitioned to four depths: 0 to 8, 8 to 16, 16 to 32, and 32 to 62 cm. After partitioning the cores by depth, the six samples will be composited, mixed thoroughly, and analyzed for total N, NH_4^+-N, NO_3^--N, and N-isotope ratio.

Buffalograss Resistance to Chinch Bugs. The initial phase of this research involved developing screening methods and evaluating selected buffalograss germplasm for resistance to *Blissus occiduus*. Eleven buffalograss cultivars/selections (*CODY, BONNIE BRAE, TATANKA, TEXOKA, NE 91-118, NE 86-120, NE 86-61, 315, 378, 609*, and *NE 84-45-3*) were screened for resistance to *B. occiduus* in two greenhouse trials. Using chinch bug numbers and plant damage ratings to assess levels of resistance, the 11 buffalograss cultivars/selections were separated into categories of resistance. *CODY* and *TATANKA* consistently exhibited high levels of resistance to chinch bug feeding, while *BONNIE BRAE* and *NE 91-118* showed high to moderate levels of resistance. Other cultivars/selections, including *378, 315, NE 84-45-3*, and *NE 86-61*, were moderately to highly susceptible. *CODY* and *TATANKA* maintained acceptable turf quality although both became heavily infested with chinch bugs. This suggests tolerance may be a mechanism of the resistance. Studies designed to characterize the mechanisms of resistance are currently underway. Antixenosis experiments have revealed chinch bug preference for *TEXOKA, NE 86-120*, and *BONNIE BRAE*. Other cultivars/selections such as, *609* and *NE 91-118* are rarely preferred.