from North America and Australia. The population of *O. herpotricha* at a given location appears to be a mixture of many different individuals. In contrast, just a few distinct clones dominate the population of *O. korrae* in a location.

Field and greenhouse studies are conducted to evaluate the resistance of seed and vegetatively propagated bermudagrass selections to spring dead spot. Field trials in Oklahoma indicated that several bermudagrass entries including GUYMON, SUNDEVIL, MIDLAWN, MIDFIELD, FT. RENO, and MIRAGE and OKS 91-11 were more resistant to spring dead spot. We are currently developing greenhouse and laboratory methods to more rapidly screen bermudagrass selections for disease resistance. Furthermore, we are determining whether there are differences in pathogenicity to bermudagrass selections among the three SDS pathogens. Preliminary evidence suggests that *O. herpotricha* results in larger dead spots and more shoot kill within the spots than the other spring dead spot pathogens.

Various cultural and chemical control strategies were proposed to control spring dead spot. We established a trial 1998 to evaluate the effects of some of these control recommendations, alone and in combination, for suppression of SDS. Preliminary results indicate that aggressive summer aerification accompanied by fungicide and growth regulator treatments will reduce, but not eliminate symptoms of spring dead spot.

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.*

The purpose of this research is to understand the factors contributing to nitrogen use efficiency in turfgrasses and manipulate them in such a way that the need of turf for nitrogen fertilizers will be reduced. We have concentrated on the physiology of biomass partitioning between roots and shoots. A turfgrass that can allocate more of its photosynthetic product toward root growth will have a larger root system that will be better able to absorb nitrate 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 the soil.

Nitrogen is available to turfgrass roots primarily in the form of nitrate (NO_3-). Nitrate is produced in the soil when organic matter is metabolized by microbes, releasing its nitrogen as ammonium (NH_4+) that in turn is oxidized by other microbes to NO_3-. This NO_3- is highly mobile and can leach with rainwater out of the soil and potentially contaminate ground water. The best protection of ground water quality is a dense grass root system that will absorb NO_3- to supply its need for nitrogen and sustain a root-mass capable of continued NO_3- uptake.

In this research project, we are examining the capacity of nine cultivars each of perennial ryegrass and creeping bentgrass to absorb NO_3- and metabolize it within the grass plant. The respective cultivars should accomplish this in such a way that root growth is maintained and the turf remains vigorous and of high quality. We are testing the hypothesis that quality turf is most likely maintained when turfgrasses metabolize NO_3- primarily in their roots with relatively little NO_3- transported to and metabolized in the shoots. If NO_3- is metabolized into amino acids (the building blocks of proteins) in the roots, there will be a stimulation of root growth with less nitrogen transported to the shoots to promote clipping growth. If NO_3- is not metabolized in the roots but transported to the shoots, it will be metabolized into amino acids there and promote shoot growth at the expense of root production. This situation can be aggravated further under high temperature conditions that stimulate respiration more than photosynthesis making less carbon and energy available for transport to roots. It is recognized that this reduced energy supply during hot weather is a major contributor to summer turf decline. This theory also explains why heavily fertilized turf is often more vulnerable to summer turf decline than less intensively managed turf.

Our research has shown that cultivars of perennial ryegrass and creeping bentgrass allocate more of their photosynthetic resources to shoot growth than to roots. These same grasses also metabolize most of the NO_3- they absorb from the soil in their shoots, which may explain this priority for shoot growth over root production. Generally, creeping bentgrass cultivars metabolize more NO_3- in their roots than do perennial ryegrasses, which may explain in part how bentgrasses can sustain themselves when maintained as a very closely mowed turf. In perennial ryegrass, we also have demonstrated a positive and significant relationship between NO_3- metabolism in roots and the amount of roots produced. Our findings with these two turfgrasses have so far supported our proposed linkage between root centered NO_3- metabolism and greater root growth with less shoot production. Research proposed for the remaining year 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. Preliminary studies designed to alter the genetics of turfgrasses to optimize root metabolism of NO_3- will be initiated so that more nitrogen efficient turfgrasses will be available in the near future.

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.*

Sprig Establishment. Establishment of buffalograss has always been a major objective of the project. Great strides were made with buffalograss establishment since the project was first initiated. Initial studies in the 1980's indicated that pre-rooted plugs had an advantage in establishment over seeded varieties. However, present studies have shown that seeded varieties now establish as rapidly as vegetative plugs. These improvements are due to improved selections with faster germination and improved seedling vigor, and because of better production of seed by producers. Sprigging of buffalograss has also shown potential to provide very rapid establishment rates. The research project will focus on improving sprigging characteristics in addition to seed production.

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 through 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.

Several trends are evident for the study conducted from 1997 through 1998. 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 (i.e., < 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.

Buffalograss Resistance to Chinch Bugs. The development of turfgrasses with insect resistance offers an attractive approach for managing pests associated with buffalograss because it is sustainable, environmentally responsible, and fits well with its low maintenance, reduced pesticide-input philosophy. Greenhouse experiments were conducted to determine the categories of resistance of 10 buffalograss cultivars or selections (*CODY*, *TATANKA*, '609', '315', '378', *TEXOKA*, NE84-45-3, NE91-118, NE86-120, NE86-61) screened previously for resistance to the chinch bug, *Blissus occiduus*. From these initial greenhouse screenings, *CODY*, *TATANKA*, and NE91-118 are resistant to *B. occiduus*. NE84-45-3 and '378' were designated susceptible. Although three selections are identified as chinch bug resistant, further evaluation is needed to determine the categories of their resistance (i.e., antixenosis, antibiosis, and/or tolerance)

Integrating Natural Enemies, Cultural Control, and Plant Resistance for Sustainable Management of Insect Pests on Golf Courses

University of Kentucky

Daniel A. Potter

Start Date: 1998
Number of Years: 3
Total Funding: $105,000

Objectives:

1. *Evaluate the role of ants as beneficial predators in golf turf: determine the predominant species inhabiting golf courses; and develop tactics for managing mound-building pest ants on putting greens with reduced environmental risk or impact on beneficial species.*
2. *Investigate synergism between endophyte-enhanced, resistant turfgrasses and bio-rational insecticides for improved management of white grubs and black cutworms.*
3. *Examine the main and interacting effects of cultural practices (mowing height, irrigation, and N fertilization) on nutritional and defensive characteristics of creeping bentgrass on relative susceptibility to white grubs and black cutworms.*

Ants are important predators on eggs and larvae of cutworms, grubs, and other pests, but on golf courses, these positive aspects must be weighed against the fact that some ant species build mounds on putting greens and tees. Surveys of ants