genomic Southern blots of DNA from the bermudagrass parents being used in this study. The specific parents used in crossing have been clonally propagated, so that we can greatly increase our supply of DNA and blots, and accelerate accumulation of data.

The data accumulated to date suggests that we will be able to not only meet, but also significantly exceed the proposed goal of 300 mapped loci. The comparative mapping of bermudagrass will draw heavily upon a prior map of sorghum that now includes more than 2,000 DNA loci, and a new map of buffelgrass (Jessup et al., in preparation) that now includes about 400 loci.

Plans for Continuation. The focus of year two will be the scale up of identifying DNA polymorphism, and the beginning of genetic linkage mapping. New lab facilities and personnel will facilitate this. We are anticipating that individual seedlings from most, if not all, of the required genetic populations will be large enough to begin sampling of tissue for DNA during year two. Full-scale genetic mapping will be done in year three. By the end of year three, we expect to meet the formal goals proposed for the full five years (data analysis may continue into year four). We will then apply the map to identify quantitative trait loci (QTLs), identify DNA markers of agriculturally important traits, and develop a small bacterial artificial chromosomes (BAC) library for bermudagrass.

Once the accumulation of genetic differences and DNA markers is proceeding smoothly, as time permits we will begin to explore the development of large-DNA clones of bermuda in BACs. Our prior successes with sorghum (Lin et al, submitted), papaya (Ming et al, in preparation), cotton (Abbey et al, in preparation; Rana et al., in preparation), and peanut (Burow et al., unpubl. results) have led to optimization of BAC technology that should be easily transferable to bermuda.

Leveraging Opportunities Realized. Plant genomics in the United States was recently stimulated by the infusion of nearly $85 million in federal grants through the National Science Foundation. The US Golf Association designated Dr. Paterson's turfgrass genome project to be *matching support of a comparative grass genomics initiative* that Dr. Paterson proposed, together with seven colleagues at three universities. Dr. Paterson's proposal was funded at a level of $3.2 million. This award will provide molecular conduits that will enable improvement of bermudagrass and other turfgrasses to benefit from the rapid progress that is anticipated for grass genomics as a result of the USGA-sponsored project.

Other Significant Events, and their Consequences. Dr. Paterson has recently accepted a Senior Professorship in Plant Biotechnology and Genomics, at the University of Georgia's main campus in Athens, GA. He has the *right of first refusal* to be named the director of the AGTEC Plant Division, to be created in 1999. This will result in a major scale-up of genomics activities in Georgia, and will be a significant expansion of the capabilities that Dr. Paterson's lab can bring to bear on bermudagrass. In the first year (before AGTEC is created), Dr Paterson will occupy about 4,800 square feet of renovated space, fully and newly-equipped for genomics research. When the AGTEC Center is completed in early 2000, around 2,600 square feet of additional lab space, as well as shared core facilities of 5,000 square feet for genomics. About $2.1 million is available for equipping the genomics core facility.

While this move has caused some delays, specifically preventing Dr. Paterson from hiring a person dedicated solely to the bermudagrass project during the first year, by leveraging the activities of other people in the lab they have stayed on schedule. The expanded space and equipment available will greatly accelerate our rate of progress, and we emphasize that we expect to exceed the proposed objectives. Texas A&M has agreed to release Dr. Paterson's extramural grants and funds remaining on these accounts to the University of Georgia. The University of Georgia has agreed to honor the terms of existing contracts.

One advantage of Dr. Paterson's move is that he will be at the same university where Dr. Wayne Hanna is a faculty member. Drs. Paterson and Hanna have already jointly offered an assistantship to Mr. Russell Jessup to focus on the bermudagrass project. Mr. Jessup is presently completing M.S. studies with Dr. Paterson and Dr. Mark Hussey at TAMU, working on *Pennisetum*. The offer remains pending, and contingent on the student's formal acceptance into the University of Georgia graduate school. Consequently, the short-term delays resulting from this move are expected to yield great rewards in long-term progress and capabilities.

Development of Improved Bentgrass Cultivars with Herbicide Resistance, Enhanced Disease Resistance and Abiotic Stress Tolerance through Biotechnology

Rutgers University/Cook College

Faith Belanger

Start Date: 1998
Number of Years: 5
Total Funding: $250,000

Objectives:

This project seeks to conserve golf course natural resources while providing quality playing surfaces by improving creeping bentgrass through transformation. We have concentrated on important bentgrass varieties and selections developed for Northeast golf greens.

The goals of this project are to produce improved creeping bentgrass cultivars through a combination of genetic engineering and breeding. Our aim is to provide golf course managers with more effective and selective weed control with herbicides by developing herbicide resistant cultivars. We are also attempting to produce cultivars with improved disease resistance and abiotic stress tolerance that can be maintained in a more environmentatly-sound and cost-effective manner.

The effectiveness of genetically-engineered herbicide resistance in creeping bentgrass has been demonstrated in multiple field tests. This trait is now ready to be incorporated into a commercial cultivar.

We currently have fifty independent transgenic lines of creeping bentgrass expressing one of five potential disease-resistance genes. We have established randomized replicated field trials of these plants that will be evaluated in the summer of 1999.

We also have transgenic plants from bombardments with HVA1, a potential drought and salinity tolerance gene. Plants found to be expressing HVA1 will be screened for effectiveness of the gene.

Cultivar Development and Extreme Temperature Tolerance of Greens-type Poa annua

Pennsylvania State University

David R. Huff

Start Date: 1998
Number of Years: 5
Total Funding: $175,000

Objectives:

1. *Collect, select, breed, and develop genetically stable and phenotypically uniform cultivars of greens-type Poa annua for commercial production.*
2. *Develop techniques to screen large numbers of germplasm accessions for tolerance to extreme temperatures and coverage by sheets of ice.*
3. *Identify genetic markers associated with genetic loci (genes) controlling agronomically important traits and specific stress tolerances in order to aid in the breeding and development of improved cultivar of greens-type Poa annua.*

Annual bluegrass *(Poa annua* L.) makes up a large portion of the putting surfaces in many regions of the United States and Canada. Given its wide-spread occurrence in the golf industry, there is currently a need for high quality, commercially available sources of greens-type *P. annua* for use in constructing, renovating, or maintaining *P. annua* golf greens. Greens-type P. *annua* actually has many characteristics that make them enviable as a putting surface. They typically have high shoot densities (9,000 shoots dm^{-2} or 7 to 24 times higher than that of bentgrass), an upright growth habit, and aggressively inhabit golf greens maintained at extremely close ($\leq$ 0.125 inches) mowing heights. The purpose of this research is not to replace creeping bentgrass as a putting surface, but simply offer an alternative for those golf courses where *P. annua* is simply a better choice.

Germplasm Collection and Evaluation: To date, this project has collected over 2,500 samples of greens-type *Poa annua* from regions including the northeast United States (Pennsylvania, New Jersey, Long Island NY) the mid-Atlantic (Delaware, Maryland, Virginia), and the Pacific northwest (Oregon, Washington). The performance and morphological features of field plot accessions are beginning to demonstrate that there is a tremendous amount of naturally occurring variation between regions, among golf courses within regions, and even among samples within a golf green.

Field resistance to dollar spot disease was observed during summer and fall of 1998 in one particular accession collected from Long Island, NY. This particular accession was completely free of dollar spot disease while all other surrounding plots were moderately to heavily diseased. This disease occurred naturally and was not treated with fungicides.

Currently, our collections of greens-type *Poa annua* exist as a collection of naturally occurring ecotypes and, as such, display a wide range of variation in many, many agronomically important traits. This variation is partitioned among individual plants due to its self-pollinated breeding system and thus, is readily accessible through selection as distinct, uniform, and stable inbred lines. Initially, ecotypic and mass selection of elite germplasm will be used for the development of cultivars. As regional testing and evaluation begins to identify genetically superior strains, these elite strains will begin to serve as parental sources for the cross-hybridization and subsequent single line selection that will eventually result in improved commercial cultivars.

Regional Testing: Based on the 1998-season plot evaluations, a renewed emphasis must be placed on extensive regional testing. In order to enhance and expand regional testing efforts, we have begun to identify cooperators willing to evaluate our experimental strains in golf green plots.

Seed Production and Increase: Seed of the selected accessions were sown into seed production plots (approximately 5 ft. x 20 ft.), in September 1998, for further seed yield evaluation and for generating seed increase for further regional testing. We are expecting a reasonable, though limited, seed harvest for the summer of 1999.

Genetic Identification and Manipulation of Polyhaploids. The evolutionary history of *Poa annua* (allopolyploidy) suggests that observed sexual sterility of particular strains is likely. This may be due to the genetic state of these accessions being sterile polyhaploids (plants derived from an unfertilized, reduced egg). We have begun a set of experiments in an attempt to restore fertility to several sexually sterile accessions.