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

Pennsylvania State University

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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 US 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, and maintaining *P. annua* golf greens. Greens-type *P. annua* actually has many characteristics that make it enviable as a putting surface. Typically, greens-type Poa has high shoot densities, an upright growth habit that lacks grain, and aggressively inhabits golf greens maintained at extremely close (≤1/8 inch) mowing heights. A severe agronomic disadvantage of *Poa annua* L. is its susceptibility to extreme temperature stress. This project will seek to develop techniques to screen large numbers of germplasm accessions for tolerances to extreme temperatures and coverage by sheets of ice, and thereby attempt to aid the breeding program to improve the adaptation of greens-type *Poa annua* cultivars within regions of intended use. The purpose of this research is not to replace creeping bentgrass as a putting surface, but rather to offer an alternative to those golf courses where *P. annua* is simply a better choice.

I. Breeding and Cultivar Development: Progress, Results, and Observations

Germplasm Collection and Evaluation. The germplasm collections from southern California (Industry Hills GC) and northern California (California Club GC, San Francisco Club GC, and Olympic Club) were entirely destroyed by an unidentified disease in our greenhouse this summer. My plans are to recollect from these regions as I believe this event was a greenhouse problem and might not have necessarily manifested itself under field grown conditions. Last year's germplasm collection from Oregon and Washington (a total of 279 selections) were established as solid sod in the our experimental Poa green at the Valentine Research Facility. Color, density, overall quality, and dollar spot disease ratings were collected from these strains this fall.

Additional evaluation plots were seeded in the fall of 1999. To date, most of our evaluation plots have been established as solid sod grown in the greenhouse. This seeded trial is the project's first fully seeded trial and the first established on a USGA spec green. This fall-1999 evaluation trial consists of 16 entries with three replications. Plots size is approximately 4x6 feet.

An interesting observation was made concerning nematode resistance in the field while collecting at the California Club GC. The nematode *Anguina pacificae* creates a very serious problem for Poa greens in northern California. At two major infestations, I noticed where the nematodes were apparently avoiding particular strains. I collected samples from each of two of these strains; however, these strains were lost along with the rest of the California collection. I'm looking forward to revisiting these and other sites during the spring of 2000 when this Pacific coast shoot gall nematode disease is active to further investigate the potential of biological control. I have assembled a team of researchers to aid me in the investigation of alternative control strategies of the Pacific coast shoot gall nematode. Dr. Mary Ann Bruns is a soil microbial ecologist and Norm Conrad is an extension specialist who teaches short-courses in nematology. Our intention is to assay various commercial products for biological control and to determine if any mechanism of resistance or differential tolerance exists in any of the local strains of *Poa annua*. To aid us in this work, we are currently preparing a grant proposal for consideration by the Northern California Golf Association and/or the Northern California Golf Course Superintendents Association.

Regional Testing. It is my intention to place increased emphasis on regional testing. Numerous individuals have made offers to establish and maintain golf green plots of this project's selected strains of Poa annua. This past summer, seed of three selections were sent to Jim Ross at Olds College for a Fall-1999 establishment. As additional seed becomes available from these and other promising selections, I will begin to work with more and more cooperators for testing and evaluations. In the future, representative cooperators will be identified within specific regions across the USA and Canada who are willing to evaluate our elite strains of greens-type *Poa annua*.

Seed Production and Increase. Much of our work this fall was focused on generating seed increase for future regional testing and evaluation purposes. The spring 1999 seed harvest of selected strains was relatively good despite having a major snow mold infection of our seed production plots. In September 1999, seed of three selected accessions were sown into seed production plots approximating 1,200-sq. ft. each. In addition, four accessions were sown into plots approximately 400 sq. ft. each, three accessions were sown into plots 60 sq. ft., and six accessions were into 30 sq. ft. plots. Although seed yield is strongly dependent on the accession, we expect the larger plots to yield between six and eight pounds. Spring 2000 will be our largest scale seed harvest to date. We are still considering additional options for the best method of harvesting greens-type Poa seed. In any event, we should have plenty of seed for regional testing purposes for several of the selected accessions. One regional test generally requires about 60 grams of seed for three plots of size 4 x 6 feet.

Numerous small seed production plots were established in Fall 1999 for a large number of additional accessions originating from Long Island, NY. Several of these strains look quite promising including one with excellent field resistant to dollar spot. This is the first

group of accessions entering our modified cultivar development scheme that includes an early phase of seed increase.

Genetic Identification and Manipulation of Polyhaploids. *Poa annua's* evolutionary history (allopolyploidy) suggests that the observed sexual sterility of particular strains is likely due to the genetic state of these accessions being sterile dihaploids (plants derived from an unfertilized, reduced egg). The results of our previous research suggest that we are capable of manipulating the ploidy level of such sterile dihaploids, and in doing so, are able to restore their ability to set viable seed. We are continuing our research efforts into the genetics of our experimental dihaploids as well as to apply our new found knowledge to a wider array of sterile *Poa annuas* exhibiting high quality. I expect our work in the manipulation of polyhaploids to become an integral part of the breeding program. This work will enable us to make greater progress in the understanding the evolutionary events that occur on golf greens involving *Poa annua* and may eventually allow us to better identify and manipulate agronomically important traits in the species.

II. Extreme Temperature Tolerance: Progress, Results, and Observations

Assessing the relative low-temperature tolerance among ecotypes (Laval): This part of the project is performed in collaboration with Julie Dionne, Horticultural Research Center, Laval University and Dr. Yves Castonguay, Agriculture Canada Research Center in Ste-Foy. Previous results from the Laval group demonstrated that differences in low temperature tolerance exist among Poa accessions. In the future, they will begin to examine the molecular basis of cold tolerance differences. I will continue to work with the Laval group and supply them with interesting and contrasting plant materials.

Assessing the relative survival of Poa and bentgrass given a cycling of freeze-thaw conditions. Last year's results suggested that neither Poa nor bentgrass was capable of surviving multiple freeze-thaw cycles. Survival of both species progressively decreased as the number of freeze-thaw cycles increased. Our attempt this year to confirm this result was inconclusive as the experiment failed due to the plants becoming desiccated in the growth chamber. At this point, I am uncertain if this aspect of the project will continue due to limited time and resources.

Determining the artificial conditions for assessing heat tolerance among ecotypes. In September 1999, Rhonda Witmer was hired to assist in the field and greenhouse aspects of the breeding program. In addition, Rhonda has been performing the heat tolerance testing using a linear gradient sand heat bench. She has completed upgrades of the linear gradient, sand heat bench and begun testing various greens-type Poas and bentgrass. I look forward to very interesting data and results in the future.

Determining the artificial conditions necessary for assessing ice coverage tolerance among ecotypes. Our attempts to directly evaluate differential ice coverage tolerance among Poas has not been successful. Mr. George Hamilton has taken on this part of the project as his Ph.D. dissertation. George is focusing on those environmental conditions that induce and reverse the hardening process. He has discovered a critical temperature difference between bentgrass and Poa during the hardening process. This work will continue to evaluate exposure times and response to day length to conclude his hardening experiments. Once completed, George will begin to examine the effects of ice coverage using a variety of hardening and deharding treatments.

Examining the root dynamics of ecotypes throughout the seasons and during periods of extreme temperature stress. Graduate student Eric Lyons, a National

Science Foundation Fellow in Penn State's Root Biology program, has begun to research the root dynamics of greenstype *Poa annua* for his Ph.D. The purpose of his study will be to understand the rooting characteristics of different ecotypes throughout the entire year, while concentrating on times of extreme temperature stress (heat and cold). His study will exam characteristics of *Poa annua* root systems during cold acclimation, throughout the winter, and continue during spring root initiation to determine the ability of the root system to survive cold temperatures. Root mass, depth, viable length, and root fate will be assessed during the fall, winter, spring, and summer seasons in order to fully assess the root dynamics of contrasting Poa ecotypes. We will also attempt to correlate root dynamic parameters with plant survival and performance in times of extreme temperature stress to enable us to more efficiently evaluate our greens-type *Poa annua* germplasm resources. To this end, we built a 5,000-sq. ft. experimental USGA green to specifically study roots. In August, Eric worked with Dr. B. Huang at Kansas State University whose lab group performs similar research on bentgrass.