USGA RESEARCH PROGRESS REPORT 1998

Executive Summary

Project title: Cultivar development of greens-type *Poa annua* L.

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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, 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/dm^2 or 7 to 24 times higher than that of bentgrass), an upright growth habit that lacks grain, and aggressively inhabit golf greens maintained at extremely close (≤1/8 inch) mowing heights. 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. PROGRESS, RESULTS, AND OBSERVATIONS

Germplasm Collection and Evaluation: To date this project has collected over 2,500 samples of greens-type *Poa annua* from regions including the northeast US (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/fall'98 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 has not been chemically 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 begin to be placed on extensive regional testing. In order to enhance and expand this project's 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' x 20'), in Sep98, 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: *Poa annua*'s evolutionary history (allopolyploidy) suggests that observed sexual sterility of particular strains is likely due to the genetic state of these accessions being sterile polyhaploids (plants derived from an unfertilized, reduced egg). We have begun a set of experiements in an attempt to restore fertitlity to several sexually-sterile accessions

II. PROJECT PUBLICATIONS

Huff, D.R. 1998. The case for *Poa annua* on golf course greens. Golf Course Management October issue. pp. 54-56.

Tredway, L.P. and D.R. Huff. 1998. Genome size variation among annual bluegrass selections from golf course green. Agronomy Abstracts pg 137.

Huff, D.R. 1999. For richer, for Poa. USGA Greens Section. In press.

Huff, D.R. 1999. Managing *Poa annua* for golf course greens. Grounds Maintenance January issue. In press.

III. PROJECT PRESENTATIONS

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Huff, D.R. 1998. Penn State's *Poa annua.* breeding program for use on golf course greens. To be presented at the Minnesota Turfgrass Conference, Minneapolis, December.

IV. PROJECT INTERVIEWS AND FEATURE ARTICLES

National Public Radio. Science correspondent Joe Palka. Penn State's *Poa annua.* breeding program for use on golf course greens. Aired June, 1998.

GCSAA Newsline. Poa in Space. July, 1998.

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Annual bluegrass (*Poa annua* L.) makes up a large portion of the putting surfaces in many regions of the US and Canada. Over the past one hundred years, *P. annua* has evolved perennial strains that not only persist but eventually come to dominate many golf course greens in the northeastern and Pacific northwest US, along the US/Canadian border, and in eastern 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.

Poa annua is an extremely diverse species of grass containing wild and weedy types that behave as annuals; short-lived stoloniferous turf-types found in lawns and fairways; and perennial, stoloniferous greens-types adapted to extremely close mowing heights. Greens-type *P. annua* actually has many characteristics that make them enviable as a putting surface. They typically have high shoot densities (Fig. 1.) (9,000/dm^2 or 7 to 24 times higher than that of bentgrass), an upright growth habit that lacks grain, and aggressively inhabit golf greens maintained at extremely close (≤1/8 inch) mowing heights.

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. One of the main problems with *P. annua* greens is that it normally exists as a patch-work of different strains. This patch-work results in a non-uniform putting surface due to differences among the strains in texture, seed head production, and vertical leaf extension rates after mowing. Differences in pest and environmental stress tolerance among the various strains also complicate the management of such a diverse population of plants. The main focus of this project is to develop commercial seed sources of uniform and stable cultivars of greens-type *P. annua*. Such products would allow superintendents and architects an opportunity to utilize *P. annua* putting surfaces rather than having to wait out the natural evolution of greens-types from the wild and weedy invasive annuals.

I. RESEARCH INITIATED IN 1998

- Germplasm Collection and Evaluation
- Regional Testing
- Seed Production and Increase
- Genetic Identification and Manipulation of Polyhaploids

II. PROGRESS, RESULTS, AND OBSERVATIONS

Germplasm Collection and Evaluation:

To date this project has collected over 2,500 samples of greens-type *Poa annua* from regions including the northeast US (Pennsylvania, New Jersey, Long Island NY) the mid-Atlantic (Delaware, Maryland, Virginia), and the Pacific northwest (Oregon, Washington) (Table 1). Samples of greens-type *Poa annua* are collected from old, closely mown golf greens within the various regions of major use areas. Collected samples are those that possess traits immediately identifiable as being agronomically important, such as but not limited to: high shoot density, dark green color, high seed yield and/or high stolon yield potential, limited seed head production under close mowing, tolerance to extreme temperatures, deep or extensive root systems, and naturally occurring environmental stress tolerances and field resistance to various disease and insect pests. Approximately 15 to 30 samples are collected per green with usually 4 to 6 greens sampled per course. Samples (accessions), are collected as 3/4 inch cores, wrapped in moist paper towels, taken back to Penn State where they are individually transplanted into 4 inch pots containing 80/20 greens mix, and maintained in the greenhouse throughout the remaining summer and fall months. During late fall through winter, selected accessions are tillered out into 1' x 2' flats of 80/20 mix and allowed to vegetatively fill-in to ensure that each accession derives from a single genotype. The following spring, selected accessions are transplanted as solid sod onto our experimental golf green located at the Valentine Research, maintained at 1/8 " mowing height, and evaluated for turfgrass quality and persistence. Criteria for evaluating turf quality include: overall quality, density, seed head production under close mowing heights, rate of spread, color, and rooting depth.

The project continues to amass a large collection of unique accessions. During spring'98, an additional 306 evaluation plots were established in the experimental Poa green. 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/fall'98 in one particular accession collected from Westchester CC, Long Island. 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 has not been chemically 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. Initiating extensive breeding efforts before such elite strains are identified would result in wasted time and effort.

Regional Testing

Our attempt to establish a set of comparative plots (eight) using University of Minnesota's strain of creeping bluegrass (DW184) was disappointing. Initially, all plots of DW184 became established as solid sod, but began to thin-out as close mowing was initiated. To date, there is none of this original strain left in any of the eight plots. In a similar attempt of regional testing evaluation, we propagated one of our Penn State accessions, Oakmont 18G-3A, and planted it at two additional regional locations, Purdue University and Columbia Edgewater Country Club, Vancouver, Washington . To date, the Pacific northwest Washington sample has become established and is beginning to spread. At the Purdue location, however, the Oakmont 18G-3A plots began to deteriorate following the spring of its initial establishment. Little, if any, of the Oakmont 18G-3A survived the summer at Purdue.

My initial hypothesis was that selection for adaptation to extreme-close mowing heights should outweigh most other environmental selection pressures. However, this viewpoint needs to be revised. Based on the regional performances of DW184 and Oakmont 18G-3A, a renewed emphasis must to placed on extensive regional testing. In order to enhance and expand this project's regional testing efforts, we have begun to identify cooperators willing to evaluate our experimental strains in golf green plots. Currently, I have identified two cooperators: Drs. Gwyne Stanchke (Washington State University) and Clarke Throssell (Purdue). As our seed stock of selected accessions continues to increase, we will bring more regionally diversified cooperators on board.

Initially, ecotypic and mass selection of elite germplasm was this project's original strategy for the development of commercial cultivars. While this strategy remains a viable approach, the observation of the importance of regional adaptation has suggested that hybridization between regional types might provide cultivars with broader adaptation. As this program identifies regionally elite lines, these lines will begin to serve as parental source for the development (through cross-hybridization) of a broad-based genetic pool, from which, single line selections will be produced for evaluating the feasibility of developing broadly-adapted cultivars.

Seed Production and Increase

Plots of the selected accessions derived from the 1997 mid-Atlantic States (Delaware, Virginia, and Maryland) collection were not mowed during the entire spring of 1998 and allowed to set seed. Florets from all plots were harvested, dried, and evaluated for seed set. Approximately 40% (8 out of 20) of all selected accessions proved to be sexually sterile. Viable seed of all remaining accessions (a total of 12) were sown into seed production plots (approximately 5' x 20'), in Sep98, for further seed yield evaluation and for generating seed increase for further regional testing. Due to the low seeding rate of these plots (approximately 1/10 to 1/4 lb per 1,000), any substantial seed harvest was expected to be delayed until the summer of 2000 to enable the plots to fill-in. However, 1.5 months after planting, all but one accession have already filled-in the plot area. Thus, we are expecting a reasonable, though limited, seed harvest for the summer of 1999.

Genetic Identification and Manipulation of Polyhaploids

Poa annua's evolutionary history (allopolyploidy) suggests that the sexual sterility of particular strains is likely due to the genetic state of these accessions being sterile polyhaploids (plants derived from an unfertilized, reduced egg). While smaller is likely more adaptive on closely-mowed golf greens, polyhapliody provides an avenue (reverse-gigas) for morphological characters to become smaller, finer, denser. Having gone through this intense selection process, it is of interest to double their chromosomes, thereby restoring sexual fertility, and then compare their morphological traits and performance to those accessions that have retained the original allopolyploidy genomic state.

During the fall of 1998, four of the above sexually-sterile accessions were treated with colchicine, a chemical known to inhibit spindle formation during mitosis and thereby capable of doubling chromosome number. Preliminary results suggest that the range of colchicine concentrations (control, 0.1%, 0.2%, and 0.5%) and exposure times (4hr, 6hr, 12hr, 24hr, 123hr) employed were appropriate to yield a range of survivability among the accessions (Fig 2.; Not for publication). Generally, successful colchicine treatments in other crops occurs at approximately the lethal dose (near-death-experience) of the crop.

III. UPCOMING RESEARCH FOR 1999

- In spring'99, I anticipate the completion of a 15,000 sq ft experimental research green. This new research green facility will provide the additional plot space necessary for the continued expansion of the germplasm collection, evaluation, and selection trials, and will allow the project an opportunity to begin to perform needed management research on close-cut *Poa annua* greens.
- Collection trips currently in the planning stage for spring'99 include: a midwestern trip (Ohio, Indiana, Michigan) and additional mid-Atlantic sites (New Jersey).
- Continue to enhance this project's regional testing capabilities by identifying additional cooperators willing to evaluate our experimental strains on university or industry golf greens.
- Genetic analysis (morphological, molecular, and cytological) and evaluation of the colchicine treated, sexually-sterile, accessions will occur in winter'98 and spring'99.
- Initiate discussions with commercial companies for their interest in assisting in seed increase of selected strains and the eventual production and release of cultivars.

IV. PROJECT PUBLICATIONS

Huff, D.R. 1998. The case for *Poa annua* on golf course greens. Golf Course Management October issue. pp. 54-56.

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VII. COLLABORATIONS

This project will continue its efforts to work collaboratively with turfgrass scientists who are interested in investigating various aspects of greens-type *Poa annua* growth and development, management, and pest resistance and susceptibility. We have begun to select for anthracnose resistance in collaboration with Dr. Pete Landschoot (Penn State) and continue to plan to begin screening for differential tolerances to the annual bluegrass Hyperodes weevil with Drs. Paul Heller (Penn State) and Pat Vittam (UMass). We are also participating in turfgrass management research with other Penn State faculty including Drs. Charley Mancino, Al Turgeon, and Tom Watschke. Such collaborations, on these and future projects, will play a vitally important role as this project bring commercial products to market.

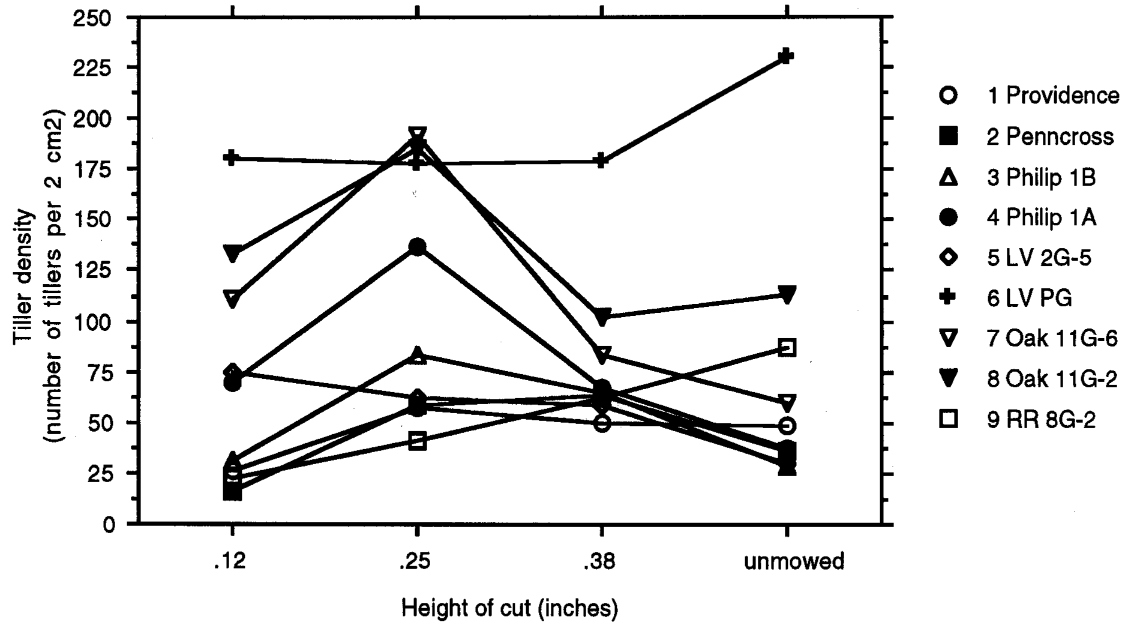

Fig. 1. Average tiller densities of bentgrass and a range of greens-type *Poa annuas* maintained under different mowing heights (results are from a 1996 greenhouse root tube study).

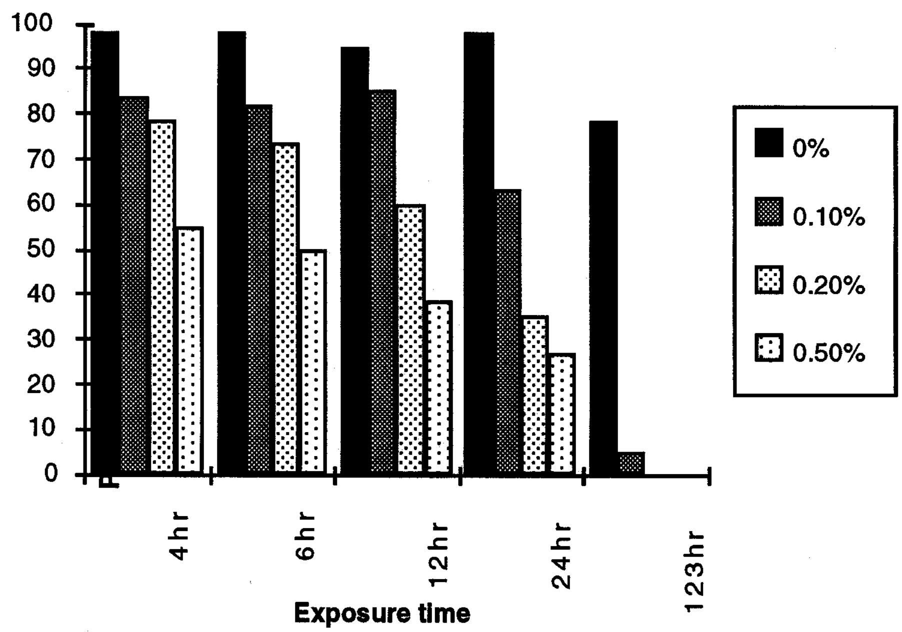

Fig. 2. Percent survival of individual tillers of *Poa annua* treated with different concentrations of colchicine for various exposure times.