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Title: Pre-breeding for bentgrass germplasm improvement

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Objectives:

The goal of this research is to develop genetically narrow but diverse bentgrass families with enhanced abiotic stress tolerance.

Start Date: 2017

Project duration: Three years

Total funding: $51,040

Summary:

There are more than 150 different bentgrass species, but only five that are routinely used in turf applications. Even among the common species, there is significant variation in morphology and turf performance, differences that are exacerbated with a broader representation of species. Many alternative bentgrasses do not have acceptable turf quality, making it difficult for bentgrass breeders to introduce stress tolerance from those sources without also compromising quality of their elite breeding material. This project builds from the previously funded USGA project, *Low input performance of Highland, heat, and drought tolerant bentgrasses*. In the previous study, 69 bentgrass accessions were obtained from the National Plant Germplasm System and evaluated under 5/8 inch and 3 inch mowing heights with minimal supplemental fertility or irrigation inputs following establishment in Mead, Nebraska. Results from the previous study identified accessions with traits that may benefit elite creeping bentgrasses used on golf courses. The current study is focused on preliminary breeding to move desirable traits (drought, heat, low fertility use, late season color retention) into elite bentgrass breeding stocks through introgression breeding to benefit bentgrass breeders.

Two breeding strategies are being implemented. At the University of Nebraska-Lincoln, a population improvement strategy is being applied whereby all of the accessions were allowed to intermate during the 2017 growing season, and viable seed was harvested from 60 of the 69 accessions (Figure 1). With this strategy, the pollen source is not known (open pollinated), but the maternal parent is known and recorded. The seed was started in the greenhouse and multiple plants representing each population are being increased over the winter. In the greenhouse, differences were observed between the progeny for establishment rate, genetic color, texture, and density (Figure 2). The progeny will be evaluated and compared to the original maternal parent to visually identify phenotypically different plants and those with desirable traits under reduced input management. The individuals again will be allowed to intermate, starting an annual recurrent phenotypic selection strategy to improve the population. The other breeding strategy being applied is a more directed approach, whereby a crossing block consisting of 10 colonial bentgrass and 10 creeping bentgrass accessions was established in Beltsville, Maryland.

The plants all flowered at approximately the same time during the 2017 growing season and were allowed to intermate. Seed was harvested as described above. Progeny was started in the greenhouse and DNA was extracted from 2,600 individuals using FTA-cards (Warnke et al., 2017). Molecular markers able to discriminate creeping and colonial bentgrass have already been developed and a subset of markers will be used to confirm species hybrids by high-resolution melt analysis (Warnke et al., 2017). With open pollinated breeding methods, in the absence of distinguishable morphological differences between species, the molecular methods are essential for confirming the formation of hybrids in the bentgrasses. In general, bentgrasses are highly outcrossing but there is still a chance of self-pollination or sib-mating which could slow progress towards advancing desirable stress tolerance traits. Both breeding approaches will be used for at least two generations, and in the third year of the project, selected populations will be compared to creeping bentgrass cultivars under conventional and reduced input management. Resulting from this project, we expect to produce abiotic stress tolerant bentgrass germplasm with acceptable quality, useful for bentgrass breeders to further improve stress tolerance in future cultivars.

Reference:

Warnke, SE, CS Thammina, K Amundsen, P Miljanic, H Hershman. 2017. High-resolution melt analysis of simple sequence repeats for bentgrass species differentiation. Int. Turfgrass Soc. Res. J. 13:1–5. doi: 10.2134/itsrj2016.10.0838

Summary points

1. Genetic markers able to distinguish creeping bentgrass and colonial bentgrass were developed.
2. The markers are being used to confirm hybridization between bentgrass species, currently being tested on 2,600 potential hybrids.
3. Bentgrass seed was harvested from a crossing block consisting of 69 bentgrass accessions and is being evaluated.

Figure 1. Seed from bentgrass accessions at full maturity that were allowed to intermate was collected and is being used in a phenotypic recurrent selection breeding scheme to improve bentgrass abiotic stress tolerance.

Figure 2. Early germinating bentgrass progeny obtained from a bentgrass crossing block consisting of 69 different National Plant Germplasm System accessions.