Breeding and Genetics of Turfgrasses at the University of Wisconsin-Madison
A New Research Initiative

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Introduction: Background and Rationale

The turfgrass seed industry averages approximately $600 million in gross sales each year. Nearly all of this seed trade is based on improved cultivars developed by breeding programs in the USA, with a small amount coming from Canadian and European cultivars. For cool-season turfgrasses, the majority of the breeding work has been conducted by private companies in the Willamette Valley of Oregon. They are located there because of a climate that provides the most favorable conditions for cool-season grass seed production in the USA.

That general location facilitates breeding for resistance to some diseases and for seed production traits. Similarly, plot trials in Oregon and making collections from old turfs in other locations allows selection for turf traits. However, centering breeding efforts in Oregon does not allow specific selection pressure for tolerance to many stresses that are not present in Oregon. For example, screening for drought and heat tolerance, cold or freezing tolerance, snow mold resistance, and resistance to many other pests is not generally possible in Oregon programs.

Alternative to the Oregon-based programs, some companies have expanded their post-synthesis testing programs to include many sites across the northern USA. However, post-synthesis testing, the testing of synthetic populations which are candidate cultivars, is an inefficient way of finding or improving stress tolerance, particularly if multiple stress tolerances are important. It relies heavily on statistical probabilities and the serendipitous discovery of superior levels of unselected traits. For example, recent studies have shown some small differences among creeping bentgrass (*Agrostis stolonifera* L.) cultivars for snow mold (*Typhyla* spp. and *Microdochium nivale*) resistance and, independently, *Poa annua* L. colonization, neither of which has been a specific, conscious selection criterion in a breeding program. The differences observed in these studies are completely serendipitous, but clearly indicate that larger differences could be obtained with conscientious breeding efforts in an appropriate environment with appropriate procedures.

"WELL, BOSS SAYS HE'S GOING TO CHECK THE SPRINKLERS ON 17, BUT REALLY HE JUST LIKES TO DRIVE THE CART."

In addition to the private Oregon-based breeding programs, there are four public breeding programs that focus on cool-season turfgrasses in the northern USA. These are located at the Pennsylvania State University, Rutgers University (New Jersey), University of Minnesota and University of Rhode Island. The eastern environments are all much milder than that typically found in Wisconsin and neighboring states. Winter temperatures, snow mold fungi, and the potential for severe summer drought stress are all more severe in the north central USA than in the northeastern USA. Furthermore, only the Penn State and Rutgers programs are of any size to have a significant impact on the turf seed industry.

Thus, there is a large vacuum of both focus and activity for turfgrass cultivar development in the north central USA. While the National Turfgrass Evaluation Program (NTEP) routinely runs tests in Minnesota, Wisconsin and Michigan, their tests are typically focused on the visual appearance of cultivars. The emphasis is on turf quality, leaf texture, and genetic color. Ratings for disease resistance are typically made only if natural inoculum allows expression of cultivar differences. Similarly, tolerance to other stresses such as winter temperatures can only be assessed if conditions are sufficient for differential genetic expression. Furthermore, because NTEP trials of a single species are typically repeated only every 5 to 6 hears, there is only a small chance to expose each cultivar to the wide array of stresses that it must eventually survive in a commercial turf.

A directed and focused breeding and genetics program at the University of Wisconsin-Madison will help remedy some of these inadequacies. Our location includes all the important elements of such a program: highly stressful environments; an adequate research infrastructure; turf management and turf pathology programs; and interested, willing, and able collaborators in the commercial turf sector.

Program Objectives and Approaches

Overall: To increase our understanding of turfgrass genetics and breeding principles related to improved functionality for the turfgrass industry in the north central USA.

Objective 1: To develop an improved creeping bentgrass with combined resistance to snow mold fungi and *Poa* colonization.

Winter diseases of turfgrass, collectively referred to as snow molds, are a major problem on all turf areas in Wisconsin and similar regions. Golf course greens, fairways, and tees are of primary concern because of the high dollar value associated with these areas. Fungicides currently provide the only means of snow mold control. Often the fungicides are used in various combinations and multiple applications in an attempt to obtain good control of the diseases. The most effective fungicides are mercury-based compounds, which are now illegal in the USA. All legal fungicides are less effective and some fungal pathogens have begun to show resistance to some of these fungicides. In addition, there is considerable public opinion to reduce the amount of fungicide use on golf courses.

Poa annua is the most troublesome weed on golf courses in

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Wisconsin and other northern states. There are both annual and perennial types. Annual types produce seed heads under close mowing, including heights cut on golf greens. This seed production leads to replenishment of seed banks in the soil, allowing annual re-establishment. Perennial types are capable of profuse tillering and survival under the most severe winter conditions. They are extremely competitive against commercial turfgrass cultivars. The only effective way to control *Poa annua* in established turf is by visual identification and physical removal, a practice that is not economical in any commercial tuff application.

There is preliminary data that suggests creeping bentgrass cultivars differ in both the level of snow mold infection and resistance to *Poa* colonization. Genetic resistance to these two pests would be an extremely valuable contribution to the turfgrass seed industry. The preliminary data and our own observations indicate that both resistances can be achieved by traditional plant breeding techniques. We have already made numerous collections and will continue making collections on golf courses that show apparent genetic segregation. In addition, we will use small-plot trials to do further selection for both resistances.

There are distinct advantages to this approach. Combining the selection work with some genetic studies of inheritance will allow us to identify the most resistant plants and to ensure that the resistance of those plants is controlled by multiple genes. Multiple-gene resistances to both pests have a distinct advantage over single-gene resistance, because the pest cannot easily overcome the resistance by mutations. Single-gene resistance to diseases can be overcome by pathogens rather quickly, because they only need one virulence gene mutation to overcome the host plant resistance. Similarly for Roundup resistant creeping bentgrass, past history suggest that there are *Poa* plants that are already resistant to Roundup and they will rapidly increase in frequency on greens seeded to Roundup resistant bentgrass that are routinely sprayed with Roundup. Our multiple-gene approach will make it much less likely that these pest can mutate to overcome our accumulated resistances.

Our plans will be to conduct much of our screening and plot research at the O.J. Noer Research Facility, but also to rely heavily on cooperation from golf course superintendents. We will use molecular genetic approaches to identify the number of genes involved in these resistances, but traditional breeding approaches to develop germplasm. We anticipate the development of a creeping bentgrass cultivar that is resistant to all common strains of snow mold fungi and is capable of establishing itself and persisting on *Poa*-dominated golf course greens. Ultimately, we think it is possible to develop a creeping bentgrass cultivar for golf course greens that does not require application of snow mold fungicides.

Objective 2: To develop fine fescues suitable for use in golf course fairway construction and/or overseeding.

As a group, these species tend to have extremely fine leaf texture, good drought tolerance, and excellent shade tolerance. They are generally used in low maintenance turfs or as mixture components in shady environments. There have been a number of recent attempts to utilize fine fescues under more intensive mowing managements, such as occur on golf courses. There are large differences among cultivars in tolerance to various intensive mowing managements, indicating that there may be considerable genetic variation for such tolerances. This indicates that there is potential to develop cultivars that are more adapted to golf course managements. Combining this with the excellent inherent drought and shade tolerance of most of the fine fescues would provide additional flexibility and options for golf course superintendents and possibly other turf managers.

We plan to rely heavily on both local and distant collections of fine fescues from stressful environments, including sandy soils, soils with clay pans, and closely mowed sites. Collections of fine fescue plants will be screened for turf quality and adaptation in collaboration with golf course superintendents. Initial survey of existing cultivars and fine fescue plants found in many Wisconsin turf sites indicates that there is greater potential for improvement.

Objective 3: To determine the potential of meadow fescue as a high-quality, traffic-tolerant turfgrass.

Meadow fescue is a close relative of tall fescue. It has a lower growth habit, with reduced above-ground biomass production, finer leaves, softer leaves, and greater tiller density than tall fescue. Clumpiness (unevenness of stand as the turf ages) and leaf coarseness are two of the major problems with the use of tall fescue in turf applications in the north central USA. As such, there is relatively little tall fescue used in the north central USA. It is primarily recommended on sandy, drought-prone soils. Because of its excellent traffic tolerance, a solution to these problems might be useful to turf managers.

My initial screening of the USDA collection of meadow fescue indicated that some lines have potential turf applications. I have found good-looking, narrow-leaf, low-growing plants with good ground cover. The next step will be to increase these collections and put them into turf plots for initial evaluation and additional selection and breeding. These trials will be done in collaboration with athletic field managers in the Madison vicinity to assist in creating a realistic stress that we can readily evaluate. They will also be evaluated in mixtures with Kentucky bluegrass and compared to dwarf-type tall fescues to determine their potential value.