Better Grasses by Breeding: Section I

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Introduction

Grasses originated long ago, probably about 70 million years ago during the Age of Dinosaurs in the Cretaceous and Tertiary periods (Harlan, 1956). Most of our cool season turfgrasses evolved much later under consistent grazing pressure at the margins of forests in Europe/Eurasia during the Pliocene and Pleistocene epochs (Beard, 1973). The only turfgrass species native to the Americas is buffalograss (Buchloë dactyloides), a native of the shortgrass prairie, which evolved under grazing pressure from the American bison (Bison bison).

The turfgrasses used at present are vastly different than those available sixty, thirty, and even ten years ago. During the past half century tremendous strides have been made by relatively few breeders: their programs result in continuously new cultivars and have even added new species to the list of acceptable turfgrasses within the last 20 years (e.g., perennial ryegrass, tall fescue, rough bluegrass).

Why Breed?

Humans have a penchant for consistently demanding superior products. Products considered wonderfully advanced yesterday become archaic the next, thus, people want ryegrasses with continuously better color, tall fescues with continuously finer texture, etc. In addition, new races of pathogens constantly evolve and can overcome the resistance of an improved cultivar over time.

The earliest selections of superior turfgrass strains were performed by J.B. Olcott in Connecticut and W.W. Beal at Michigan State Ag. Exp. Station (now Michigan State University) towards the end of the 19th century. The first real breeding efforts, though, were not instigated until several golf course superintendents pushed for the establishment of a turfgrass research program at Pennsylvania State College (now University) in 1928. The program was initially headed by H.B. Musser, a former legume breeder. Musser was followed by Dr. Joe Duich in 1959 who has made invaluable contributions of new turfgrass cultivars, especially bentgrasses. In the south, Glen Burton at the University of Georgia began breeding warm season turfgrasses in the late 1940's. In the early 1950's Dr. Burton produced the first hybrid bermudagrasses (Cynodon dactylon x C. transvaalensis), 'Tiflawn' and 'Tiffine' (Burton, 1992).

How Varieties are Developed

"Fortune favors those prepared" is seldom truer than when turfgrass breeding is involved. Although the commercial release of a new cultivar involves years of painstaking evaluating, backcrossing, sorting, and seed production, most new cultivars started out as a single plant which was outperforming its neighbors in a turf stand. In 1936, Joe Valentine of the Merion Golf Club in Pennsylvania, noticed a Kentucky bluegrass plant which did not seem to be affected by leafspot disease (Drecshlera poae) (Burton, 1992). By 1950 the first improved variety of Kentucky bluegrass was available, and to date over 70 million lb of 'Merion' have been sold due to its leafspot resistance. Prior to 'Merion', leafspot was THE major disease of Kentucky bluegrass. Unfortunately, 'Merion' is susceptible to stripe smut and the patch diseases so is no longer a prime cultivar. Nonetheless, some degree of leafspot resistance has now been bred into many of the Kentucky bluegrass cultivars now available.

Development of a new cultivar requires time, patience, money, and more time! The release of a new cultivar may take up to 10 years from the time the original germplasm is collected. Once unique plants are collected from the field (often from old cemeteries or golf courses), they are

"increased" by growing them in the greenhouse. They are then cross-pollinated with plants having other desirable traits (e.g., fine leaf texture). The resulting seed is then grown, and the progeny ("children"; sometimes called the F1 generation) is evaluated. Promising F1 plants may then be backcrossed (cross-pollination with the parents) to produce the F2 generation to ensure genetic stability. Several more generations may be produced by additional backcrossing or outcrossing with yet more plants. At some point, the best plants are selected for field evaluations. After several seasons of field evaluations, the best plants may be allowed to grow to maturity and produce Breeders Seed. This becomes the original seed source for all future development. Some of the Breeders Seed is planted to produce Foundation Seed the next year; the remainder will stay with the breeder. The Foundation Seed is always bagged with a white certification tag and is then planted by seed producers to grow seed for sale. If the amount of Foundation Seed is small, the crop produced by the Foundation Seed may be tagged as Registered Seed. The Registered Seed (purple certification tag) will then be used to increase the seed quantity sufficient for commercial purposes. Otherwise, seed produced from Foundation Seed can be sold to consumers as Certified Seed (as long as the production fields and seed lots pass inspection by the seed certification commission of the state) (Figure 1). Certified seed labels are often blue or white, however, not all seed is certified. Non-certified seed may have a low germination rate or too many weed seeds to allow certification.

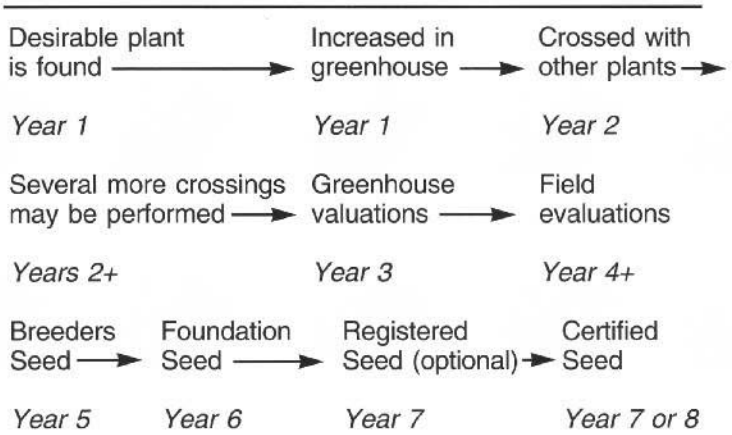

Figure 1. The long path to commercialization of a new cultivar.

Currently there is interest and even preliminary trials using biotechnology to add specific genes to turfgrass plants to achieve certain characteristics (e.g., glyphosate resistance). More will be written about these techniques and developments in a future installment of the turfgrass breeding series.

The Link to Forages

Many of our cool season turfgrass varieties were developed from forage grass varieties. Tall fescue (Festuca arundinacea) is a classic example. The first varieties released for turf use were 'Alta' (1940) and 'Kentucky 31' (1943) (Hanson, 1965). Prior to this, tall fescues were considered too coarse for use as a turf. Today, 'K-31' is considered ancient, and is undesirable as new, finer textured cultivars of tall fescue are available. The severity of droughts in the midwest during the late '80's and the early 1990's, along with increased concern over irrigation, gave tall fescue breeding a jumpstart. Ten years ago there were few tall fescue varieties available. In the latest National Turfgrass Evaluation Program (NTEP) trials, there were over 100 entries submitted by most of the major seed companies! Some of the newest advances have been made in darker green color, low growing height (the dwarf types), and endophyte enhancement (Acremonium spp.) for insect/disease resistance.

Perennial ryegrass (Lolium perenne) is another latecomer to the turfgrass world, also developed from forage varieties. In the past, tough fibers in perennial ryegrass leaves made mowing difficult and often resulted in a shaggy appearance to the turf. While this problem is still present, it is greatly reduced compared to the forage types. In Britain, where it has been used for forage for over 300 years, various strains range from short-lived stemmy types to long-lived, leafy types (Meyer and Funk, 1989). Although the stemmy types are excellent seed producers (e.g., 'Linn', 'Victoria'), the perennial leafy types were first noted for their ability produce good athletic turf surfaces. The development of 'NK-100' by Howard Kaerwer at Northrup King in the mid 1960's signaled the beginning of the widespread use of perennial ryegrass for overseeding warm-season turf in the U.S. (Meyer and Funk, 1989). Its rapid germination helped its popularity in many turf situations. In 1967, Dr. Reed Funk released 'Manhattan' perennial ryegrass for cool season turf use. Developed from a plant Dr. Funk found in Central Park, 'Manhattan' has been the most popular perennial ryegrass cultivar to date. New crosses of 'Manhattan' have resulted in 'Manhattan II' and 'Manhattan 3'. Like tall fescue, newer cultivars boast finer leaf texture and darker color. Many cultivars are suited for mixtures with Kentucky bluegrass where they help improve wear tolerance of the turf. Certain cultivars accept low mowing heights of 0.5 inches and are used as fairway turf. Unfortunately, because most breeding efforts have been focused on improving the agronomic qualities of perennial ryegrass, diseases are still a major limitation to

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their use in many instances, particularly brown patch (Rhizoctonia solani), Pythium blight (Pythium aphanidermatum), and crown rust (Puccinia coronata). Breeding endophytes into perennial ryegrasses is being attempted.

Breeding Programs

At the University of Wisconsin we are devoted to improving turf quality for all turf managers and users. One of the exciting new projects we are embarking upon is the development of a turfgrass breeding program. Most turfgrass breeding is performed by private companies, generally in the Pacific Northwest. A few universities in the U.S. also have turf breeding programs, some of exceptional quality due to numerous varietal releases over the years (e.g., Rutgers University, Pennsylvania State University, University of Georgia, Texas A & M, and the University of Nebraska). Breeding of cultivars under one set of environmental conditions, however, does little to ensure success of the cultivar in other regions. One of the reasons for establishing a breeding program at the UW is to develop varieties particularly suited for the Wisconsin climate and soils. Initially, the program will focus on fine fescues, annual bluegrass for putting greens, and creeping bentgrass. The program at the UW will be headed by Dr. Michael Casler from the Agronomy department. Dr. Casler has been a forage grass breeder at the UW for 17 years and has successfully released several varieties, notably bromegrasses with recent work also on meadow fescues (another potential turf species).

Future installments of this series will focus on breeding of creeping bentgrasses and biotechnology in turf breeding.

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