

BREEDING COOL SEASON GRASSES FOR DISEASE AND PEST RESISTANCE

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There has been a great increase in breeding work on cool season turfgrass cultivars since the Plant Variety Protection (P.V.P.) Act was signed into law in December, 1970. This law, which is similar to the Plant Patent Law except that it covers sexual and asexual species, permits the developer of a new cultivar to exclude others from any unauthorized reproduction or marketing. This does not exclude others from using protected cultivars in further breeding work.

Presently there are approximately five U.S. universities, fourteen U.S. companies and ten foreign companies involved in the development of cool season turfgrasses. Kentucky bluegrass (Poa pratensis L.), perennial ryegrass (Lolium perenne L.), tall fescue (Festuca arundinacea Schreb.), Chewings fescue (F. rubra L. subsp. commutata Guad.), slender creeping fescue (F. rubra L. subsp. trichophylla Guad.), creeping or spreading fescue (F. rubra L. rubra Guad.), hard fescue (F. longifolia Thuill.), Sheeps fescue (F. ovina L.) and creeping bentgrass (Agrostis palustris Huds.) are the most important northern turfgrasses. All of these species reproduce sexually and are cross pollinated except for Kentucky bluegrass, which reproduces mainly by means of apomixis.

A new turfgrass cultivar must be distinct, uniform and stable during its reproduction process in order to be protected under the P.V.P. Act. The plant breeder is responsible to describe all of the performance and morphological characteristics of a new variety compared to the standard varieties. All of this information is considered by P.V.P. officials in determining the distinctness of a new cultivar. From a practical standpoint, a new cultivar must be easy to establish and an economically efficient seed yielder.

HISTORY OF KENTUCKY BLUEGRASS

Kentucky bluegrass is the most important turfgrass in the northern half of the U.S. All of the cultivars used prior to 1970 were derived from composites collected from naturalized stands in the midwest or individual apomictic clones found in old turf areas. Merion Kentucky bluegrass originated from a single plant collected in 1936 from Ardmore, PA (8). This was the first cultivar with a real turf-type growth habit and improved resistance to leaf spot caused by Drechslera poae (Baudys.) Shoem. and Bipolaris sorokiniana (Sacc. in Sorok.) Shoem. (1, 4, 11). All other cultivars available until the late 1960's were highly susceptible to leaf spot when maintained at close mowing and high fertility.

HYBRIDIZATION OF KENTUCKY BLUEGRASS

Kentucky bluegrasses produce seed both sexually and asexually by a process called apomixis. Seed formed by apomictic reproduction is genetically identical to the mother plant. Apomixis is therefore an excellent means of maintaining the genetic purity of a cultivar from one generation to the next. It also makes the crossing and subsequent selection of Kentucky bluegrasses a difficult process.

Clones of Kentucky bluegrass vary as to their level of apomixis. Merion has a level of apomixis of 96% or more, and A-20 has an apomixis level of around 25% or less. This high level of apomixis of Merion made the stable reproduction of this cultivar possible. A-20 has been increased mainly by vegetative means because of its high level of sexuality (8).

The greatest breakthrough in the breeding of Kentucky bluegrass occurred at Rutgers University in the late 1960's (6). Dr. C. Reed Funk and his associates developed a greenhouse crossing technique using clones with various levels of sexuality which resulted in the many F₁ hybrids. Fortunately 14% of these F₁ hybrids had recovered the apomictic mode of reproduction. They also found that approximately 16% of the clones collected from old turf areas were considered highly apomictic (6).

IMPROVED TURF-TYPE KENTUCKY BLUEGRASSES

The cultivars Adelphi, Able I, Bonnieblue, Challenger, Majestic, Nassau, Eclipse, Midnight, Bristol, and America have resulted from the hybridization work at Rutgers Univ. Touchdown, Columbia, Glade, Plush, Ram I and Mystic are cultivars developed cooperatively by Rutgers University and other organizations. Nugget, A-34, Baron, Blacksburg, Victa, Cheri, Birka, Georgetown, Parade, Haga, Fylking, Sydsport, Wabash, and Shasta were also collections from old turf areas developed by other U.S. and European organizations.

All of the above mentioned cultivars are low growing cultivars with resistance to leaf spot comparable to Merion and more resistant to stripe smut caused by Ustilago striiformis (West.) Niessl than Merion, which is highly susceptible (8). The cultivars Baron, Cheri and Victa were originally thought to have good resistance to stripe smut in New Jersey tests and were later found, after years testing, to be moderately susceptible (8). Determining the level of stripe smut resistance of a new Kentucky bluegrass cultivar adds 3-4 additional years to the development time needed for new cultivar.

COMMON TYPES OF KENTUCKY BLUEGRASS

Park, Arboretum, Argyle, Palouse, S-21, Geary, Kenblue, Delta, Common, Delft, Troy, South Dakota and Piedmont are erect cultivars with a rapid

vertical growth rate and high susceptibility to leaf spot. Newport, Prato and Cougar are moderately low growing cultivars susceptible to leaf spot (8). All of the above cultivars perform better when mowed at 6 cm or higher. When common bluegrass is purchased on the market it usually consists of one of the above cultivars.

Park and Kenblue are the most genetically diverse cultivars and will perform better under low maintenance conditions than other common types or new turf-type cultivars.

FUSARIUM BLIGHT OF KENTUCKY BLUEGRASS

Fusarium blight caused by F. roseum f. sp. cerealis or F. tricinctum f. sp. poae (2) can cause severe damage to Kentucky bluegrass cultivars that are resistant or susceptible to leaf spot and stripe smut. Work by Smiley (19) has shown that other soil borne fungi are involved in the Fusarium Blight Syndrome. When these organisms are present, Smiley has re-named the diseases summer patch and necrotic ring spot. This disease is most serious under conditions of drought stress, high nitrogen fertility and heavy thatch accumulation.

The cultivars showing the best resistance to this disease tend to be those cultivars that are less aggressive sod formers. In tests in Southern California and New Jersey (7), the cultivars Adelphi, Columbia, Parade, Rugby, Banff, Glade, and Sydsport have shown improved resistance, while Park, Fylking, and Pennstar have been most susceptible.

In our development system the most promising cultivars are seeded in Southern California where Fusarium blight is usually an annual occurrence. The reaction to Fusarium blight can be observed within 8 months of planting.

LOW MAINTENANCE KENTUCKY BLUEGRASSES

All of the rust diseases and dollar spot (Sclerotinia homeocarpa T. Bennett) are the most serious low maintenance diseases of Kentucky bluegrass. Nugget is very susceptible to dollar spot, while Merion, Glade, Sydsport, Touchdown, Baron, Victa, Cheri, Ram I and Plush have shown moderate susceptibility (8). The other turf-type cultivars have shown moderate or better resistance to dollar spot. This disease could become quite serious on susceptible cultivars in the future if the cost of nitrogen fertilizer continues to rise.

In Midwest and Northeastern U.S. and Southern California stem rust (Puccinia graminis) can seriously damage Merion, Birka, Touchdown, and Baron under low fertility (4,8). Adelphi, Majestic, Columbia, Bristol, Ram I, and Midnight have shown improved stem rust resistance (8).

In the Pacific Northwest and Northern California stripe rust is the most serious disease of Kentucky bluegrass in seed production fields and low maintenance turf. Shasta is the most resistant and Touchdown is the most susceptible cultivar.

SPECIALTY USES OF KENTUCKY BLUEGRASS

Many of the turf areas in the northern U.S. are partially shaded. Powdery mildew (Erisiphe graminis DC) and leaf spot are the most serious diseases in shade (1). A-34, Bristol, Glade, Nugget, Touchdown, Able I and Birka have shown good resistance to some of the races of powdery mildew (8) and perform better in the shade than other cultivars.

When Kentucky bluegrasses are maintained at short cutting heights and managed as a golf course tee or fairway under intense management, they are usually unable to compete with Poa annua. Touchdown and A-34 were two cultivars able to compete with Poa annua under this type of management in an Illinois study (16). These are very aggressive cultivars with high competitive abilities. They can dominate other cultivars in blends and if they are managed at higher, non-demanding cutting heights they can develop thatch at a rapid rate.

TURF-TYPE PERENNIAL RYEGRASSES

All of the perennial ryegrasses available prior to 1960 were developed for forage rather than turf. In 1967 Manhattan perennial ryegrass was released as the first improved turf-type cultivar. It is fine textured, leafy and persistent in turf, with improved mowability. Pennfine was released later and had better summer performance than Manhattan, but was less cold hardy (9).

Through the 1970's many new commercial varieties of turf-type ryegrass have been developed. The list includes Citation, Omega, Derby, Diplomat, Yorktown II, Birdie, Regal, Fiesta, Dasher, Blazer, Loretta, Belle, Pennant, Premier, Barry and Elka (5).

More recently further development work has resulted in the release of some new varieties that have improved performance. The varieties Prelude, Palmer, Gator, Allstar, Tara, Manhattan II, Citation II, Repell, Omega II, Birdie II and Cowboy are some examples (5,18).

These turf-type ryegrasses have performed well over a wide range of soil conditions. They have excellent wear tolerance and the ability to survive in compacted soil situations better than other turfgrass species. Their excellent seedling vigor and persistence and ability to tolerate close mowing and weed competition make them valuable components in mixtures with Kentucky bluegrass for athletic situations.

BREEDING FOR BROWN PATCH AND NET BLOTCH RESISTANCE IN PERENNIAL RYEGRASS

Since perennial ryegrasses are a cross pollinated species, recurrent selection can be used to improve disease resistance. In our breeding program in cooperation with Rutgers University, we have been able to use recurrent selection in conjunction with single plant turf progeny tests to improve the levels of both net blotch, caused by D. siccans (Drechs.) Shoem, and brown patch (Rhizoctonia solani Kuhn) resistance in ryegrass populations (5,18).

Some of the new varieties from this program and other breeding programs with improved resistance to both of these diseases are Prelude, Palmer, Premier, Citation II, Tara, Omega II, Allstar, Repell, Birdie II, Manhattan II, and Cowboy (5,18).

LOW MAINTENANCE DISEASES OF PERENNIAL RYEGRASSES

Dollar spot, crown rust (Puccinia coronata Cda.), red thread caused by Laetisaria fuciformis (McAlp.) Burdsall, and stem rust (Puccinia graminis Pers.) can severely damage perennial ryegrasses grown under low fertility.

The varieties Citation, Regal, Premier, Repell, Birdie II, Citation II, Palmer, and Prelude are examples of varieties that have shown improved resistance to certain strains of red thread and dollar spot (5,8,18). The inoculation of mowed clonal space plants of ryegrass with red thread in Oregon has shown a wide variation in the reactions of plants to the indigenous strains of red thread. Hopefully this technique of screening clones will result in the development of synthetic varieties with high levels of resistance to this disease.

The varieties Elka, Birdie II, Citation II, Prelude, Palmer, Cowboy, Blazer, Premier, Repell, Manhattan II and Pennant have shown improvements in resistance to crown rust (18). This is another disease that has been reported to have many different races which could effect variety performance.

Stem rust is also a serious disease in the seed production fields in western Oregon causing yield reductions of up to 93%. A breeding program was started in 1975 to incorporate three sources of stem rust resistance found in germplasm collected in old turf areas into some of the improved turf-type perennial ryegrass varieties (15). The varieties Manhattan II, Citation II, Birdie II, Omega II and Cowboy were developed as a result of this program and have shown good resistance to stem rust in seed production fields and turf (17,18).

OTHER DISEASES AND PESTS OF PERENNIAL RYEGRASS

Pythium blight is still a serious disease of perennial ryegrasses, especially under poor drainage conditions. No resistance to this disease has been reported for perennial ryegrass. Fortunately, the new turf-type cultivars have the ability to rapidly recover from the disease.

The turf-type perennial ryegrasses are unique in that they have never been reported to form thatch. They are also useful in mixtures with Kentucky bluegrass to reduce the incidence of Fusarium blight. In our tests in Southern California the addition of 15-20% turf-type perennial ryegrass in a Kentucky bluegrass mixture was an effective control for Fusarium blight.

Recently reports have shown that some of the present perennial ryegrass varieties are systemically infected with the endophyte fungus Epichloe typhina (Fr.) Tul. (12). The varieties Repell, Regal, Citation II and Pennant were found to contain over 80% endophyte content from analysis of seed. The varieties Birdie II, Cowboy, Allstar and Prelude were found to have over 55% endophyte content. This fungus is transmitted from one generation to the next by seed and is found widely in plants surviving in nature. This endophyte enhanced pest resistance should become an important practical method of biological control for insects and other pests of new varieties in the future (12).

FINE FESCUES

The Chewings, slender creeping, creeping or spreading, hard, and sheeps fescues are the predominant species included in the open-pollinated fine fescue group. They form a fine, dense turf and will maintain this density at low fertility. They will tolerate infertile, droughty, and acid soil conditions, moderate shade and tree root competition. They will not tolerate wet soils or perform well in open sun at high nitrogen fertility and irrigation because of severe leaf spot damage caused by B. sorokiniana and D. dictyoides (1,10).

CHEWINGS FESCUE

This is a very low growing species producing only basal tillers and no rhizomes. They perform best in cooler regions of the U.S. and will tolerate close mowing. Jamestown and Banner are improved cultivars with better heat tolerance than older cultivars (10). These cultivars can be damaged by powdery mildew in the shade. Shadow is a new cultivar with improved resistance to powdery mildew. All of the new cultivars need better resistance to red thread and dollar spot. They are very dense, aggressive turf formers, which can be a disadvantage when they are used in mixtures with Kentucky bluegrass by being too competitive and by rapid thatch accumulation. They combine better in mixtures with turf-type perennial ryegrasses, which are more competitive and help to keep a balance of species.

SLENDER CREEPING FESCUE

Dawson is the popular example of this group. It forms short, thin rhizomes and looks like a Chewings fescue. Dawson is more susceptible to dollar spot and more resistant to leaf spot than most other fine fescues. It has performed better than other fine fescues for the overseeding of dormant bermudagrass with a very good establishment rate.

CREEPING OR SPREADING FESCUES

These fescues have wider leaves than other fine fescues and produce long rhizomes. They will not tolerate a close cut, but have very good seedling vigor. Fortress, Ruby and Ensylva are creeping types with less leaf spot, red thread, and dollar spot resistance than the best fine fescues (10). Flyer is a new creeping fescue variety with improvements in heat and disease tolerance. These cultivars have a more open growth habit than the other fine fescues and are more compatible in mixtures with Kentucky bluegrass than the other fine fescues.

HARD FESCUES

Biljart (C-26), Reliant, Spartan, Scaldis, Aurora and Waldina are improved hard fescues. They are similar in appearance to the better Chewings fescues, but have a slower rate of vertical growth and improved heat tolerance. They have good resistance to red thread and leaf spot and improved tolerance to dollar spot. Their rate of establishment is slower than the other fine fescues. The limited commercial availability of hard fescues has been caused by their lack of burning tolerance in seed production, which limits the productive life of fields to 2 or 3 years. Breeding work has been done to select clones for use in synthetics that can sustain good seed head formation over a longer period of time in the absence of field burning. Aurora is a new variety that has been developed with improved seed production capabilities.

SHEEPS FESCUE

Sheeps fescue has had a minor usage as a turfgrass. This has mainly been due to the very limited availability of commercial varieties. It is a very durable turfgrass that can be found in shade and growing in very poor soils. Many of the common strains have a wiry-grainy appearance and a blue-gray color. The variety Bighorn is a new sheeps fescue with improved turf forming ability. It has better establishment characteristics than hard fescues, especially under wet conditions and also improved leaf spot and red thread resistance.

TALL FESCUES FOR TURF

Tall fescue is a cool season grass best adapted to the transition zone of the U.S. This species can also do well in the great plains and Rocky Mountains when irrigated and is well adapted to the Pacific Northwest and California. The tall fescues require less irrigation to maintain active growth than the Kentucky bluegrasses and perennial ryegrasses.

Alta and Kentucky 31 were the first cultivars developed for forage and turf

uses (13). They both form a coarse, moderately open turf with a rapid rate of leaf elongation. Fawn was a later forage development producing poorer turf quality than the above cultivars. Kentucky 31 has shown better tolerance of brown patch and D. dictyoides than Alta and Fawn, which are quite susceptible.

Rebel, Falcon and Olympic were the first new, moderately low growing, leafy cultivars developed for turf purposes (17). They have softer leaves and produce a denser more persistent turf than the older cultivars. They have shown improved resistance to brown patch and a more rapid recovery rate from disease damage. Olympic has displayed better resistance to leaf spot during establishment than other cultivars (14). Olympic and Falcon were screened for resistance to crown rust prior to the final selection of parents in the breeder seed production field in Western Oregon. Since tall fescue is another cross pollinated species, recurrent selection has been used successfully to improve levels of disease resistance in populations.

Other more recent varieties with improved resistance to both brown patch and leaf spot are Jaguar, Adventure, Bonanza, Apache, Finelawn I, Arid, Mustang, and Hounddog. The varieties Apache and Bonanza have a darker green color than any tall fescues previously developed.

CREEPING BENTGRASS

Penneagle creeping bentgrass was released in 1978 by the Pennsylvania Agricultural Experiment Station (3). This cultivar was developed after testing parental material for 15 years. The objective in developing this new putting green bentgrass was to have a broad genetic base without gross segregation of off-types, improved putting green quality, enough vigor to compete with Poa annua invasion and good disease resistance. In tests compared with Penncross, Seaside and Emerald, this looks like an improved disease resistant putting green grass for the northern U.S. Another new creeping bentgrass variety being tested as PSU 126 was developed by Duich in Pennsylvania. This variety forms a very dense, fine putting surface when compared to other varieties.

FUTURE NEEDS

There is an increasing demand for turfgrasses that require less energy and other natural resources for maintenance. This includes reduced mowing, irrigation and fertilization. Cultivars are also needed that require less pesticide usage by being at least tolerant to serious diseases and insect problems and competitive with weedy species. There is a great need to eliminate diseases in seed fields through breeding work to improve the economics of seed production.

It is well known that no single cultivar is sufficiently well adapted and disease resistant to be used in homelawn type turf in a monoculture. Blends and mixtures of Kentucky bluegrasses, improved turf-type perennial ryegrasses, and fine and tall fescues are now commonly used for new seedings and sod production. This trend places added demands on the turfgrass breeder to

determine the compatibility of a new cultivar for blending and mixing with other cultivars and species to attain optimum long term turf performance.

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