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TURFGRASS TRENDS

TURF VARIETIES

Breeders Refine Fine Fescue's Disease Resistance

By Leah A. Brilman

Tall fescue, usually classified as *Festuca arundinacea* but now classified as *Lolium arundinaceum* by some taxonomists, originated in Europe, possibly near Morocco. It has been used extensively as a forage grass due to high dry-matter production combined with excellent drought avoidance.

Over the years, millions of pounds of tall fescue seed designated as Kentucky-31 were also planted as a drought-resistant, low-maintenance turfgrass. Improvement of tall fescue for turfgrass traces its origin to plants selected from old turfs of the United States in a germplasm collection program initiated in 1962 by C. Reed Funk of Rutgers University in New Jersey. The first improved tall fescue developed from this program was Rebel (Funk et al., 1981), which also had some plants from trihybrid crosses between tall fescue, meadow fescue and perennial ryegrass used in its development.

Typically, the plants selected for improved turf quality have increased density and finer leaf texture, yet these same qualities may be increasing brown patch.

Attractive clones were selected from old turfs in Birmingham, Ala.; Athens, Ga., Atlanta, and Millegeville, Ga; Preston, Idaho; Baltimore; Bayonne, N.J., Jersey City, N.J., Elizabeth, N.J., Princeton, N.J., and Cape May, N.J.; eastern North Carolina; Philadelphia; Nashville; Lexington, Ky.; Cincinnati; Dallas; and northern Mississippi.

The tall fescue plants selected from old turfs were of unknown origin. All were large patches of turf surviving in stressful environments, indicating that they had persisted and developed over a period of many years. A few hundred attractive, turf-type plants were collected and established in spaced-plant nurseries and/or frequently mowed clonal evaluation trials at Rutgers University. All but a few dozen of the most promising plants were quickly discarded.

The best selections were different from any tall fescue variety in existence at the time. They produced lower-growing turfs with finer leaves, greater density, darker color, and greater tolerance of close mowing. This material developed by Funk, plus additional material collected by other breeders usually in other high-stress locations, forms the basis of most turf-type tall fescue varieties currently available.

If you glance at brochures for tall fescue varieties, you will see descriptions of them as low-growing, dwarf, semidwarf, dark green, fine-textured and dense. These descriptions show where the major improvements have been in this species. If you walk through plots of the newest tall fescues during spring and fall, you will notice the newest material has all of those

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characteristics and forms high-quality turf.

In much of the Eastern and Midwestern United States, you will find significant amounts of brown patch if you walk through these same plots in the summer, however. It's usually caused by *Rhizoctonia solani* and appears on these same dense, dark-green varieties that had excellent quality earlier in the year. Table 1 shows a comparison of the NTEP data from the 1992 trial and the 1996 trial. Although small improvements have been made, which may be more evident in individual trials, similar varieties ranked toward the top of both trials, probably because of small advances in resistance to this disease.

Turf-type tall fescue breeders have been trying since the original turf selections to improve resistance to this disease. But the genetics of tall fescue, the complex of brown patch varieties or the types of plants selected to increase turf quality make this disease devastating under the proper environmental conditions. Typically the plants selected for improved turf quality have increased density and finer leaf texture, yet these same qualities may be increasing brown patch. Studies by Giesler et al. (1996 a,b) showed that brown patch severity in tall fescues was highly correlated with blade density because a denser canopy promoted a higher relative humidity and a longer leaf wetness duration.

Funk has often observed that tall fescue cultivars that are thinned by brown patch early in the season have little or less severe brown patch later in the year, probably due to reduced density. Recently, Rutgers University selected populations that are dwarf and dark green but with reduced density to see if these show improved long-term brown patch resistance (Watkins et al. 2000). Pure Seed Testing has an additional research farm in Rolesville, N.C,. to select for varieties with better brown patch resistance combined with tolerance of heat and humidity.

Jacklin Seed Co. has used screening in Maryland and Seed Research of Oregon has utilized screening in New Jersey, Virginia and Missouri to help identify resistance.

Brown patch on tall fescue is typically caused by *R. solani* but *R. zeae* has also been shown to cause the disease, and you cannot tell the difference based on visual symptoms. In addition, *R. solani* comes in many different forms, called anastomosis groups, determined by fusing in culture. Different isolates from the same anastomosis group may have varying pathogenicity (Martin et al, 2001). In Maryland, Zhang and Dernoeden (1997) isolated AG-1 IA and AG-2-2 IIB six times each from tall fescue, with the later found two times outside disease patches. In South Carolina, Martin et al (2001) found differences in causal agent in two locations and in different parts of the plants. *R. solani* AG 1-IA was detected principally from leaf tissue and at Florence, S.C., and AG 2-2 IIIB was detected primarily from crown tissue and at Clemson, S.C. *R. zeae* and binucleate rhizoctonia were also found more frequently in crown tissue and more frequently from asymptomatic plants.

The complexity of the disease and the lack of information about the causative organism in many ratings has made breeding for resistance difficult. Breeders have observed varieties and experimental lines that appear to have improved resistance in one location but fail to exhibit it in another. Often a variety may exhibit resistance early in the summer, only to succumb to a later infection at the same location. This may be due to density factors outlined above, or it may be the result of changes in AG type or species causing the brown patch.

Long-term stable resistance against the many forms of rhizoctonia will continue to be a focus of breeding programs.

Further understanding of the causes of variability in resistance to brown patch will depend on quick, reliable tests for type or species of rhizoctonia involved. Current ELISA tests, which are simple tests to check for organisms based on an immunological reaction, do not distinguish between species or types of rhizoctonia, although in some locations they have helped in disease monitoring along with environmental models. DNA sequences of the ITS region were able to separate Rhizoctonia solani into anastomosis groups (Hsiang and Dean, 2001) and may prove useful in developing tests that do not rely on maintenance of live tester strains, so more accurate identification may be possible.

Identification of genes for resistance to brown patch would help in the improvement of tall fescues. The problems mentioned above in disease identification plus the complex genetics of tall

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TABLE 1

Entry	1993-95 Quality	1993-95 Brown Patch	1997-00 Quality	1997-00 Brown Patch
Rembrandt			6.3	6.6
Plantation			6.2	6.3
Millenium			6.2	6.3
Dynasty			6.1	6.3
Shenandoah II			6.0	6.3
Masterpiece			6.0	6.3
Scorpio			6.0	6.3
Crossfire II	5.9	6.1	6.0	6.6
Coyote	5.9	5.9	6.0	6.1
Arid 3			5.9	6.4
Jaguar 3	6.0	6.9	5.9	6.7
Olympic Gold			5.9	6.6
Mustang II			5.9	6.4
Tarheel			5.9	6.6
Southern Choice	5.9	6.1	5.8	6.1
Durana			5.8	6.5
Wolfpack			5.8	6.5
Genesis	5.9	6.3	5.8	6.1
Empress	5.8	6.1	5.8	6.0
Renegade	5.8	6.2	5.7	6.2
Coronado	5.8	5.8	5.7	5.8
Tulsa	5.8	5.9	5.7	6.0
Shenandoah	5.6	6.3	5.7	6.2
Duster	5.8	5.8	5.7	5.9
Safari	5.7	6.4	5.7	5.7
Sunpro	5.7	5.4	5.7	5.7
Regiment	5.7	6.2	5.7	5.7
Falcon II	6.0	6.3	5.6	6.2
Finelawn Petite	5.9	6.2	5.6	6.0
Marksman	5.8	5.9	5.5	6.1
Shortstop II	5.7	5.8	5.5	5.2
Titan II	5.7	6.1	5.5	6.1
Leprechaun	5.6	6.1	5.5	5.9
Bonsai	5.5	5,1	5.3	5.6
Arid	5.3	6.2	5.0	6.3
KY-31 w/E	4.4	6.5	3.9	6.3
LSD*is 5%	0.1	0.5	0.1	0.6

*(LSD stands for Lowest Statistical Difference)

Top-ranked and varieties common to both trials shown. Overall means are shown but varietal performance varies by location, year and management. This data should only be used for comparison between the trials not for varietal recommendations in specific locations. Quality for 1997-2000 trial is from 28 locations and from 48 locations in 1993-1995. Brown patch '93-95 from 16 locations and 15 locations in '97-00. The comparison of tall fescue cultivar quality and brown patch were done on varieties rated in the 1992 and 1996 NTEP trials.

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fescues and the difficulties in finding resistance genes in many crops to this disease may explain the slow progress in identifying stable, consistent resistance.

Hexaploid species

Tall fescue is a hexaploid species, which means it has three distinct sets of chromosomes, one set similar to that in perennial ryegrass and the other two sets from another related species.

Andy Hamblin of the University of Illinois is currently working on identifying resistance genes for one strain of brown patch using crosses between a resistant X and a susceptible parent. Then the progeny are crossed to each other to create an F2 population. The F2 population was normally distributed with a population mean of 50.4 percent overall disease severity. The range of values within the population was 15 percent to 88 percent disease severity, so it segregated for resistance. From these current results, this population suggests additive inheritance and is likely controlled by several genes.

They will confirm this with work by comparing it with an F2 derived F3 population (Hamblin, 2002). In rice, using a similar population, Prinson (2002) identified 15 genes for Rhizoctonia resistance. Rouf Mian of The Noble Foundation (2002) has been working on developing genetic markers for tall fescues that may enable breeders to use comparative genomics between tall fescue and other grasses and cereals to find resistance genes.

In many species, it has proven difficult to find stable, effective genes for rhizoctonia resistance, so genetic modification by insertion of chitinase, glucanase and ribosome inhibitor protein genes have been attempted (Stricklen,1998, Feng and Li, 2002). Long-term stable resistance against the many forms of this disease will continue to be a focus of breeding programs.

Additional diseases that continue to need improved resistance to are pythium blight, helminthosporium net blotch, gray leaf spot and stem rust in seed production. Pythium blight can be especially devastating to young turf when warm, wet weather occurs and is more severe with high nitrogen and high seeding rates. Older turf can also be damaged under similar conditions. Helminthosporium net blotch can be damaging to young turf when cloudy, cooler weather occurs.

On mature turf, it rarely kills the turf but it

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can weaken it. It is particularly damaging when the turf is growing slowly from spring to fall, especially in mild winter areas. Some of the dwarf types, without winter-active growth, show the most damage from net blotch and it can be the most serious disease in areas of the Western United States.

Other diseases

Gray leaf spot can also devastate young stands of tall fescue in the Southeast. There appear to be more varieties with resistance to this disease than in perennial ryegrass, so this resistance may come from the other genomes. A. Hamblin (2002) is also studying resistance to this disease and trying to identify genes responsible for resistance. Stem rust continues to be a problem in seed production.

It is important to have varieties cycled for improvement in seed production so resistance can be improved with reductions in fungicide use for seed production.

One of the major problems of tall fescues for many uses has been its slow recovery from injury and the tendency to become clumpy or bunchy if not overseeded. Sod-forming grasses that produce rhizomes or stolons often maintain greater density and recover from injury more quickly than bunch-types grasses (Turgeon, 1985).

Traditionally, tall fescues have been considered bunch grasses but as early as 1958 Porter documented rhizomes in tall fescues. Jernsted and Bouton (1985) established that the most common rooted stems in tall fescue are morphologically and anatomically equivalent to rhizomes of Kentucky bluegrass. Development of turf-type tall fescues with the potential to produce rhizomes has received attention from some breeders both in the United States and overseas, and it was noted that certain varieties developed using varying selection pressures produced significant amounts of rhizomes. Grande, for example, shows about 65 percent rhizomes as spaced plants and sod growers note it seems to knit faster.

Alan Stewart of Pyne Gould Guinness in New Zealand developed a highly rhizomatous tall fescue from European material that has principally been used as winter-active forage in the United States. Barenbrug has released a variety also developed from European material called Labarinth for turf usage. The rhizomatous characteristic is only one criteria for selection of varieties and resistance to stresses and diseases commonly found in tall fescue use areas must also be evaluated. Seed Research of Oregon has continued to use rhizomatous material in its breeding program. SR 8600 has 55 percent rhizomatous plants, Crewcut II has 65 percent, and 100 percent of the parental plants of Grande II have rhizomes.

The breeding program at Advanta Seeds Pacific has seen an increase in the number of plants with rhizomes based on selections for survival when grown in a heavy clay acid soil subjected to drought and mowing pressure. Other breeders have been using this screening method and their populations may also see an increase in rhizomatous types. Care must also be taken that the tall fescue plant does not sacrifice turf density in favor of rhizome production. Identification of genes responsible for this important characteristic would make inclusion of it in new varieties easier.

One of the traditional advantages of using tall fescues has been drought and heat tolerance. For tall fescue to demonstrate these characteristics, there must be adequate soil moisture prior to the stress to enable the tall fescue to establish a deep root system, plus adequate soil depth for this root system.

Dwarf varieties

Some of the newer dwarf varieties have been observed to not have the stress tolerance of older material and reduced root systems have been observed in some varieties. Drought avoidance can also be influenced by mowing height, nitrogen rates, soil permeability and any previous stress.

Different techniques are being examined to retain and improve the drought avoidance (and possibly increase true drought resistance) in tall fescues. Huang and Gao (2000) studied root physiological characteristics in six cultivars of tall fescue as they underwent drought stress. Rebel Jr. had increased root mortality and reduced water uptake in both soil layers as the soil dried, while Kentucky-31 had the least root mortality.

Ronny Duncan, professor of plant breeding and biotechnology at the University of Georgia, grew tall fescues in acid, clay soils with cycles of drought and mowing stress to select material with reduced leaf firing and less water use during drought cycles (Duncan and Carrow, 2002). This has led to the development of varieties such as Southeast, Tulsa II and Greystone by Duncan and other breeders through cooperative work.

Further work on the mechanisms associated with improved drought avoidance and true drought resistance may enable reduced water use by tall fescue without a reduction in turf quality.

Winter-active growth is another characteristic that would enable tall fescue to be used more extensively. It would enable it to be used more in the Pacific Northwest, where slow winter growth allows *Poa annua* to invade. Many of the initial dwarf varieties were day-length-dependent dwarfs with reduced growth primarily during times of year when day length was shorter. In other environments, we still need improvements in cold tolerance, especially when the turf is young. Quicker establishment, especially when soil temperatures are lower, would improve the usefulness of the species.

Incorporation of improved endophytes into turf-type tall fescues continues to be important in many breeding programs. In some areas of the country, the endophytes have demonstrated less importance in tall fescue than they have in ryegrasses and fine fescues. The alkaloids produced by the endophytes help in resistance to stem and leaf feeding insects such as chinch bugs, billbugs and cutworms. In certain tall fescue/endophyte combinations, improved nematode resistance has been observed.

Additionally endophytes have been shown to improve stress resistance in many environments, with endophyte-containing plants growing more vigorously during heat and drought stress. In the most stressful environments where breeders collect germplasm, it's almost always infected. The presence of the endophyte in the straw from seed production fields can effect the ability to market this so some growers prefer varieties without endophytes.

Care must be taken that an endophyte-containing turf-type tall fescue is used to plant an area where the family horse may graze. Recently, endophytes that do not contain the alkaloids that cause animal problems but retain other benefits have been incorporated into forage tall fescues.

It may be beneficial in the future to use these types also in turf-type tall fescues. Identification of endophytes that provided resistance against root feeding insects would be a valuable contribution.

In all improvement projects, breeders must balance different goals and different markets. Seed production goals must be balanced against turf goals. Cycles of improvement in one environment for certain characteristics need to be followed by additional cycles in other environments. If you examine a map of where tall fescue is used as a turfgrass in the United States, it's one of the most extensive.

During cycles of heat and drought, the area tends to expand. Different regions and different management will require unique cultivars. It is important to utilize regional data from the National Turfgrass Evaluation Program to help in decision making or data from other local trials.

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