A DIGEST OF APPLIED TURFGRASS SCIENCE

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IN THIS ISSUE

The Past, Present and Future of Turfgrass Improvement

by Kevin N. Morris

The genetic improvement and development of turfgrasses has always been a preferred avenue in solving turfgrass problems. In the past, almost all commercially available turfgrasses were *ecotype selections.* Ecotype selections are found on golf courses, parks, cemeteries, etc. and have performed well in that particular situation over a long period. In other words, nature was the mechanism for selecting the best turfgrass. Some of the most famous, landmark turfgrass varieties, including 'Merion' Kentucky bluegrass (commercialized in 1947) and 'Kentucky-31' tall fescue (commercialized in 1931), are ecotype selections. Both of these grasses were released to the general public when very few other varieties were available. Merion was considered the "Cadillac" of grasses for many years because of its appearance and superior disease resistance, when compared to the other varieties available at that time. Kentucky-31 was developed for use in pastures, but was soon recognized as a hardy turfgrass for areas with hot, humid summers and moderately cold winters.

Kentucky bluegrass

(Figure taken from Decker/Decker, LAWNCARE: A HANDBOOK FOR PROFESSIONALS, ®1989, Figure 3-11 p. 63. Reprinted by Permission of Prentice-Hall, Inc., Upper Saddle River, NJ 07458)

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Turfgrass improvement and evaluation

Even though the natural selection of superior ecotypes is still probably the most reliable method used to improve turfgrasses, nature does take considerable time to do its job. With the increased demand for turfgrasses suitable for recreational areas, housing and commercial development, as well as the greater environmental awareness of the general public, faster breeding methods are often needed to produce improved grasses. The role of plant breeders, therefore, is to genetically manipulate plants to produce improved grasses in a timely fashion.

The improvement and development of new cultivars in the United States, although initially slow, has increased dramatically over the last twenty years. This increase is due primarily to the enactment of the Plant Variety Protection Act (PVP) by Congress in 1970. PVP allows for the protection of unique seed-propagated crop plants, thereby protecting a plant breeder's time and monetary investment in developing new germplasm and cultivars.

Evaluation of commercially available cultivars and promising experimental selections is essential to the various turfgrass consumer groups (golf course superintendents, athletic field managers, sod producers, lawn care operators, park and grounds managers, roadside vegetation managers and homeowners) in the United States and involves considerable time and resources to accomplish. Because of the need for a coordinated national approach to cultivar evaluation, the National Turfgrass Evaluation Program (NTEP) was initiated in 1980 (Murray, 1982). The NTEP is a cooperative program between the United States Department of Agriculture (USDA), the Agricultural Research Service, Beltsville, Maryland and the National Turfgrass Federation, Inc. (NTF).

Kentucky bluegrass

Since Kentucky bluegrass (*Poa pratensis* L.) is the most widely-used turfgrass species in the United States, the first NTEP test involved Kentucky bluegrass in 1980 (84 entries, 50 locations), followed by a perennial ryegrass (*Lolium perenne* L.) test in 1982 (47 entries, 40 locations). Since then, Kentucky bluegrass has been tested in 1985 (72 entries, 50 locations), in 1990 with two tests–medium-high maintenance (125 entries, 29 locations) and low maintenance (62 entries, 26 locations), and with a new seeding in the fall of 1995. Perennial ryegrass has also been tested in 1986 (65 entries, 40 locations), 1990 (123 entries, 40 locations) and 1994 (96 entries, 30 locations). Other species currently in tests include tall fescue (*Festuca arundinacea schrebi*; two tests were initiated in 1983 and 1987, with the current test established in 1992), fineleaf fescue (*Festuca* spp.; with two completed tests, and one current test), bentgrass (*Agrostis* spp.; with one completed test and one current test), bermudagrass (*Cynodon* spp.; with one completed test and one current test), St. Augustinegrass [*Stenotaphrum secundatum* (Walt.) Kuntze], buffalograss [*Buchloe dactyloides* (Nutt) Engelm] and zoysiagrass (*Zoysia* spp.).

Over the past fifteen years, NTEP tests have produced data that reveals definite trends in variety performance. In testing Kentucky bluegrass, we have seen varying cultivar performance in response to management level and different environments (Morris and Murray, 1986-1993). During the period of 1981-85, some cultivars, such as 'Aspen' and 'Merit', performed well only under high maintenance (2+ lbs. of nitrogen per 1000 ft^2/year and frequent irrigation) while others, such as 'Monopoly' and 'Vantage', performed well only under low maintenance (<2 lbs. of nitrogen per 1000 ft^2/year and no irrigation). During this same period, 'Enmundi' performed well under both maintenance regimes, while 'I-13' performed well under both maintenance levels at Beltsville, Maryland, but not at Ames, Iowa. In addition, some cultivars, (i.e. 'Ram-1', 'PSU-173'), performed well under low maintenance, without heavy traffic, but faltered under the traffic and compaction stress in Washington, DC. In recent, more extensive testing of various maintenance regimes, 'BAR VB 852' and 'Midnight' performed very well under high and low maintenance while 'Ram-1' and 'Caliber' performed well only under the low maintenance regime.

Using NTEP data, Kentucky bluegrasses can be identified that have either improved spring, summer or fall performance. This performance variability is due to differences in spring greenup (leading to lower early spring turfgrass quality scores), disease tolerance or susceptibility, amount of seedhead production (leading to "stemmy" growth and, therefore, lower quality), color retention and survivability during drought conditions, and fall color retention. The cultivar 'Midnight' was found to greenup slowly in spring, but performed well during summer. The common-type bluegrasses such as 'Kenblue' and 'South Dakota Certified' performed well under non-irrigated conditions such as those found in Ames, Iowa, but not in Beltsville, Maryland where they are susceptible to the leafspot (*Drechslera* and *Bipolaris* spp.) diseases common to the area.

It is most interesting to note that when comparing the overall performance of entries in the 1980 National Kentucky Bluegrass Test, 1985 National Kentucky Bluegrass Test and the 1990 National Kentucky Bluegrass Tests, several grasses performed consistently well over the fourteen years these tests were conducted (Morris and Murray, 1986-1993). The following table (Table 1) displays rankings of turfgrass quality for selected entries from each of the Kentucky bluegrass tests NTEP has conducted.

For various reasons, varieties such as Midnight, Eclipse and Glade have been consistent performers over the last fifteen years. While each cultivar has its different strengths, they all have some critical similarities. All possess good summer survival and leafspot resistance, a medium-dark to dark green color, medium to high density, good sod strength and medium to low seedhead production. While a pleasing green color and good density are obviously desired by most people and help a particular variety gain acceptance in the marketplace, summer survival and disease resistance (leafspot, in this case) are more important.

Table 1. Ranking of mean turfgrass quality ratings of selected Kentucky bluegrasses.

Entry	1980 Test [1]	1985 Test [2]	1990 Test [3]
		Rank	
Midnight	1	2	2
Bristol	3	23	NIT
Classic	5	15	61
Eclipse	6	11	6
Aspen	8	12	13
Glade	11	14	16

1 Eighty-four entries; data from 1981-85
2 - Seventy-two entries; data from 1986-90
3 - One hundred twenty-five entries; data from 1994
NIT Not in test

Another important component of turfgrass quality in Kentucky bluegrass is the amount of seedhead production. Excessive seedhead production in turf (which happens to Kentucky bluegrass in late spring) causes grass plants to expend considerable energy on reproduction (preparing for seed production) and not on root, shoot or rhizome production. Thus, these plants are weakened and are more susceptible to damage from disease and drought. Grasses that do not expend as much energy on reproduction can, therefore, maintain higher quality turf in summer; however, these same grasses do not produce high seed yields. Low seed yields lead to inconsistent supply and very high prices. Many varieties such as Enmundi have either faltered in the marketplace or have never been commercialized because of seed yield limitations.

There are a few Kentucky bluegrass cultivars that actually performed better over time. For example, 'A-34' was ranked fifty-ninth out of eighty-four entries for turfgrass quality during the 1980-85 testing, but improved to a ranking of nineteenth out of seventy-two entries in the 1985 test. 'Wabash' was ranked thirty-eighth in the 1980 test, but climbed to a ranking of eighteenth in the 1985 test. Explaining this phenomenon is difficult, but it could be due to the fact that both A-34 and Wabash were originally selected and tested by facilities in the Midwest U. S. and that, possibly, more data from that area were collected during the 1985 test than during the 1980 test.

Table 2. Ranking of mean turfgrass quality ratings of perennial ryegrass cultivars over all locations tested.

Entry	1982 Test[1]	1986 Test[2]	1990 Test[3]
		Rank	
Gator	1	23	64
Repell	6	9	61
Citation II	8	20	86
Pennant	15	6	80
Pennfine	25	44	115

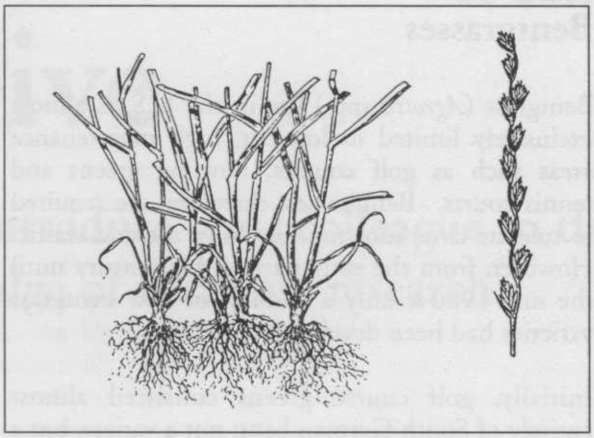
1 - Forty-seven entries; data collected in 1983-86
2 - Sixty-five entries; data collected in 1987-90
3 - One hundred twenty-three entries; data collected in 1991-94

Perennial ryegrass

Perennial ryegrass, used extensively in the northern U. S. for permanent turf stands and in the southern U. S. for overseeding dormant warm-season turfgrasses, has been steadily improved, over the last fifteen years, through plant breeding. The highest ranking cultivars for turfgrass quality in one test rank consistently lower in subsequent tests (Table 2) as improvements in genetic color, density and disease tolerance are expressed in newer cultivars (Morris and Murray, 1986-1993).

Much of the improvement in perennial ryegrass quality appears to be in genetic color. Two of the highest rated cultivars for genetic color in the 1986 test, 'Dimension' and 'Competitor', consistently ranked statistically lower than twenty-seventh and forty-eighth, respectively, in data collected during the four years of the 1990 test. Although most were not statistically significant, the density ratings collected on the 1990 test were, for many cultivars, also higher than Dimension and Competitor.

Resistance to the two major disease problems of perennial ryegrass in the U. S., brown patch (*Rhizoctonia solani* Kuhn) and red thread [*Laetisaria fuciformis* (McAlpine) Burdsall], have been increased, but at a much slower rate. In the 1982 National Perennial Ryegrass Test, 'Regal', 'Pennfine' and 'Pennant' were amoung the higher rated cultivars for red thread resistance. In the 1986 test, Regal had the highest red thread resistance rating over four years and was the only cultivar statistically better than Pennfine and Pennant. In the 1990 National Perennial Ryegrass Test, no cultivars performed significantly better than Pennfine and Regal for red thread resistance, while only seven performed significantly better than Pennant. A similar situation exists with brown patch resistance. The cultivars 'Premier' and 'Repell' performed at or near the top for brown patch resistance in the 1982 test, with one entry and ten entries, respectively, performing significantly better than Premier and Repell in the 1990 test.



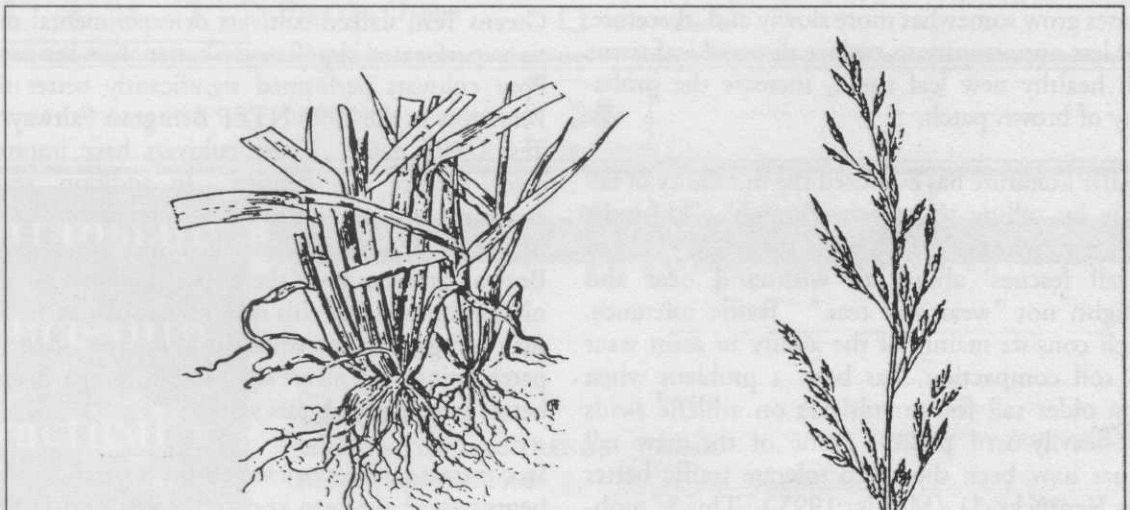
Perennial ryegrass

(This and following figures taken from Roberts/Roberts, *The Lawnscape... Our Most Intimate Experience With Ecology.* Reprinted by permission of The Lawn Institute.)

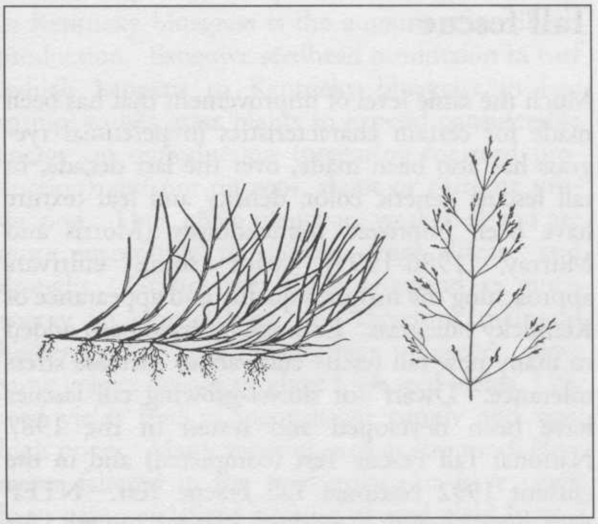
Insect resistance and stress tolerance have been improved with the addition of a fungal endophyte (*Acremonium* spp.) to many perennial ryegrass cultivars. This endophyte enables the plant to repel certain chewing and sucking insect pests (i.e. chinch bugs, sod webworms) and helps the plant to survive during severe summer stress periods. The consistent performance of 'Repell' and 'Pennant', in the 1982 and 1986 NTEP perennial ryegrass tests was most likely due to their high levels of endophyte infection.

Tall fescue

Much the same level of improvement that has been made for certain characteristics in perennial ryegrass has also been made, over the last decade, in tall fescue; genetic color, density and leaf texture have been improved tremendously (Morris and Murray, 1986-1993), with some cultivars approaching the turfgrass quality and appearance of Kentucky bluegrass. Endophytes have been added to many new tall fescue cultivars to increase stress tolerance. "Dwarf" or slower-growing tall fescues have been developed and tested in the 1987 National Tall Fescue Test (completed) and in the current 1992 National Tall Fescue Test. NTEP data have shown a reduced vertical growth, for some cultivars, when compared with older, taller (at plant maturity) varieties. In other instances, there is no significant difference between many "dwarf" cultivars and the older cultivars (Morris and Murray, 1986-1993). Marketing to consumer groups has increased greatly since the slower growing nature of these grasses enables them to be promoted primarily as labor-saving (requiring less frequent mowing) cultivars; however, these slower-growing cultivars are also generally slower to germinate and develop into mature plants. This particular characteristic often causes problems on sites such as athletic fields and roadsides where quick establishment is necessary.



Tall fescue



Colonial bentgrass

Resistance to the most important disease on tall fescue in the U. S., brown patch, has not been shown to have been improved on most newer cultivar releases. Data collected in 1993-1994 on the 1992 National Tall Fescue Test shows that brown patch resistance is not significantly increased over many older entries such as 'Kentucky-31', 'Arid' and 'Falcon'. In fact, many of the older entries exhibit better tolerance to brown patch than many of the newer cultivars. This appears to be due primarily to an increase in density with the new cultivars, which leads to higher canopy temperatures, higher humidity and less air movement. These factors, along with the fact that many of the new releases grow somewhat more slowly and, therefore, have less opportunity to replace diseased leaf tissue with healthy new leaf tissue, increase the probability of brown patch.

Popular literature has espoused the durability of tall fescue by calling the species "tough", "kid-resistant", etc. Most of these claims are actually related to tall fescues' ability to withstand heat and drought, not "wear and tear." Traffic tolerance, which consists mainly of the ability to resist wear and soil compaction, has been a problem when using older tall fescue cultivars on athletic fields and heavily-used parks. Some of the new tall fescues have been shown to tolerate traffic better than Kentucky-31 (Morris, 1995.) This is probably due to the increase in density and tillering of these new cultivars. It appears, however, that even these newer cultivars do not tolerate traffic well when incurred in the fall season.

Bentgrasses

Bentgrass (*Agrostis* spp.) use in the U.S. is almost exclusively limited to low-cut, high maintenance areas such as golf courses, bowling greens and tennis courts. Bentgrasses, therefore, are required to tolerate close mowing, intensive use and traffic. However, from the early part of this century until the mid-1980's, only a handful of new bentgrass varieties had been developed.

Initially, golf course greens consisted almost entirely of South German bent; not a variety, but a mixture of plant types. Improved cultivars such as 'Congressional', 'Cohansey' and 'Arlington' were selected from old greens, most likely South German bent greens. Unfortunately, all of these cultivars required vegetative establishment. In 1954, seed-propagated 'Penncross' creeping bentgrass was released and the bentgrass market worldwide has since been dominated by this variety.

In the last ten years, the development of new creeping and colonial bentgrasses has intensified. According to NTEP data, progress has been made in improving on Penncross. In data collected in 1990-93 from two completed NTEP tests (Modified soil and native soil greens), 'Regent', 'Providence', 'SR 1020' and 'PRO/CUP' had significantly higher quality ratings than Penncross. No cultivar performed significantly better than Penncross in the 1989 NTEP Bentgrass Fairway/Tee Test. However, in 1994 data collected on the 1993 NTEP Bentgrass Greens Test, sixteen cultivars or experimental selections performed significantly better than Penncross. Four cultivars performed significantly better than Penncross in the 1993 NTEP Bentgrass Fairway/Tee Test (1994 data). These cultivars have improved color, texture and density. In addition, several creeping bentgrass cultivars have shown, thus far, significantly improved resistance to brown patch. Brown patch has been the biggest problem on colonial bentgrasses and this is still the case. A few colonial bentgrasses are equal to Penncross in brown patch ratings, but all are significantly poorer than the better creeping bentgrass varieties.

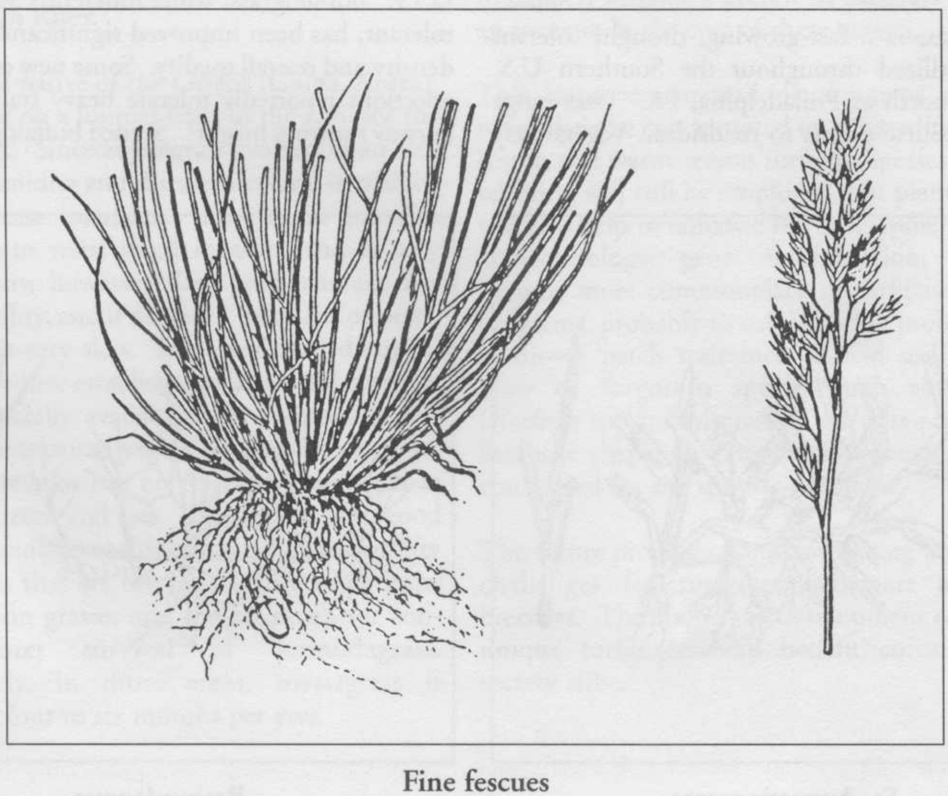
In contrast to the story with brown patch, colonial bentgrasses have been known for their resistance to dollar spot (*Sclerotinia homeocarpa*). A few new creeping bentgrass cultivars (i.e. 'Providence', 'G-6' and 'Cato'), while not significantly more resistant to dollar spot than Penncross, have shown dollar spot resistance statistically similar to the colonial bentgrass in NTEP fairway tests.

Fine fescues

Fine fescues are known for their tolerance of low fertility, acid soils, shade and minimal water. Development of new fine fescue (hard fescue, chewings fescue, creeping red fescue, sheep fescue) cultivars has therefore concentrated on improved survivability during summer stress periods and disease resistance, especially in the warm, humid eastern U. S.

Hard fescue (*Festuca longifolia*) and chewings fescue (*Festuca rubra commutata*) has been greatly improved over the last ten to fifteen years. The better cultivars have improved color, density and persistence. However, we seem to have reached a plateau in these areas with the best cultivars in tests from 1990-93 performing as well as new entries in 1994. More testing is needed as thatch production can severely affect these grasses and cause them to decline over time. Also, summer patch (*Magnaporthe poae*) is a severe problem on hard fescue and does not usually appear until after the turf is two to three years old and some thatch is present.

Creeping red fescue (*Festuca rubra*) is probably the most improved species among the fine fescues. Creeping red fescues are useful in very low maintenance mixes, but do not persist well in most lawns. For many years, 'Pennlawn' was the dominant cultivar in this group and was not improved upon until the mid-1980's with the release of 'Flyer'. Only two experimental selections performed significantly better than Flyer in NTEP tests during the period of 1990-93. In the current NTEP test (1994 data only), six grasses have performed significantly better than Flyer. Another consistent problem with creeping red fescue, leafspot, seems to be less of a problem on the newer, improved releases.



Fine fescues

Warm-season grasses

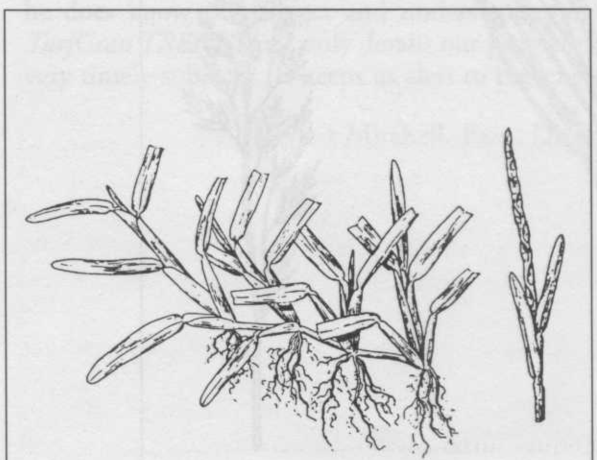
Much less NTEP testing has occurred on the warm-season grasses (St. Augustinegrass, bermudagrass, buffalograss and zoysiagrass) than on the cool-season grasses. This is because the cool-season grasses are more widely used throughout the U.S. and are almost exclusively seed propagated. Grass varieties that are seeded are much easier to improve than vegetatively established types, such as many of the warm-season grass cultivars. Nonetheless, significant breeding work has been done on the warm-season grasses and their usefulness is increasing nationwide.

St. Augustinegrass is grown in the lower southern U.S. states and across through Texas to Southern California. St. Augustinegrasses have been selected that are lower-growing, denser and finer textured than the standard cultivars 'Floralawn' and 'Floratam'. Cultivars such as 'Del Mar', 'Jade', 'Seville' and 'Sunclipse' provide a more attractive turf with good disease and insect resistance. 'FX-10' was developed for improved survival in nonirrigated turf areas. Some research is also being conducted on the development of seeded St. Augustinegrasses.

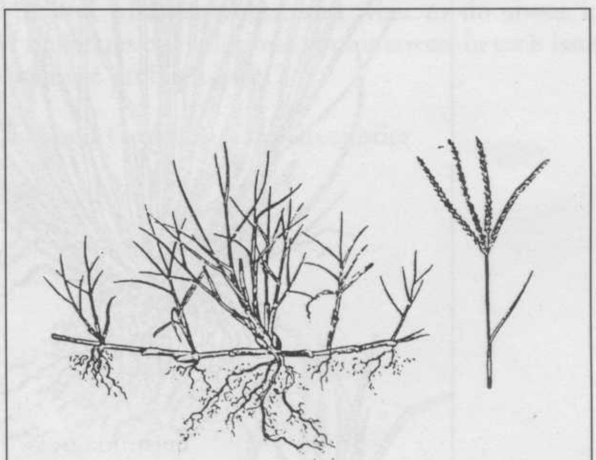
Bermudagrass is a fast-growing, drought tolerant turfgrass utilized throughout the Southern U.S. and as far north as Philadelphia, PA. Uses range from golf course greens to roadsides. Vegetatively propagated varieties such as 'Tifgreen', 'Tifway', 'Midiron' and 'Tufcote' have delivered the highest quality and, consequently, have had the most use. However, seeded cultivars developed in the last ten years are becoming more popular because of their reduced establishment costs. These seeded cultivars are improved over the 'Arizona Common' variety for appearance and winter-hardiness, but still rank below the quality and winter-hardiness of the better vegetative cultivars. Also, there is still much interest in developing vegetative varieties with improved cold tolerance and better disease resistance.

Besides working with the traditional grasses mentioned, plant breeders are actively seeking to improve grasses that have been under-utilized for turf. Two of these species, buffalograss and zoysiagrass, have great potential for providing functional turf on golf course roughs, parks, lawns and roadsides, while requiring less water and pesticides.

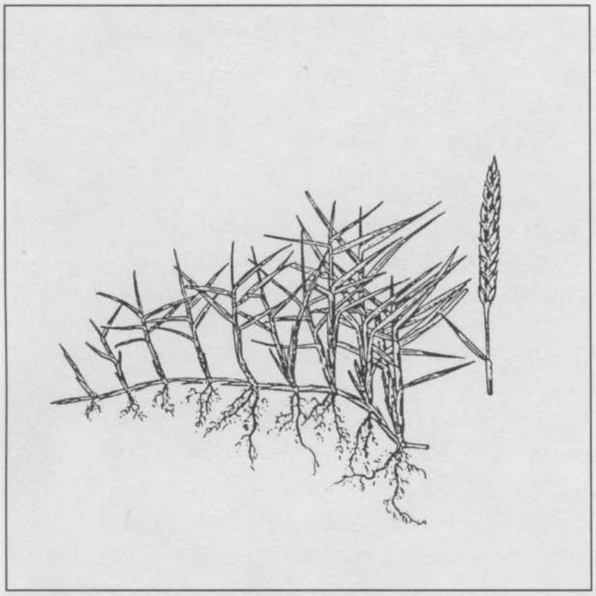
Buffalograss is native to the Great Plains of the U. S. (Montana south to Texas) and evolved mainly in areas of 15 to 25 inches (37.5 to 62.5 cm) of annual rainfall, hot summers with drying winds and, in some areas, winter temperatures of -20° to -25°F. Buffalograss, while inherently very drought tolerant, has been improved significantly for color, density and overall quality. Some new experimental selections reportedly tolerate heavy traffic and low fairway mowing heights. Seeded buffalograsses have



St. Augustinegrass



Bermudagrass



Zoysiagrass

also been developed, thus giving consumers another establishment option. Disease resistance and competition from other grasses and weeds has been a problem when growing buffalograss in the more humid, eastern U.S. Although this grass has been successfully grown on turf sites in such areas, its greatest utility, at this point, is probably west of the Mississippi River.

Zoysiagrass, a native of the Orient (China, Korea), has been used on a limited basis in the U.S. for the last fifty years. Since zoysiagrass evolved in an area with high humidity and disease pressure, it exhibits excellent disease tolerance. Zoysiagrass has also been shown to resist weed invasion and is very traffic tolerant; however, slow establishment has limited its utility, and if damaged by traffic or pests, its recovery is very slow. Improved seeded zoysiagrasses that reduce establishment time and costs are now commercially available. In addition, lower-growing, fine-textured vegetative type zoysiagrasses have been bred for use on fine turf areas such as golf course greens and tees. Zoysiagrass, with good to excellent winter-hardiness, has its greatest utility in those areas that are too far south to easily grow the cool-season grasses and too far north for consistent winter survival of bermudagrass. Unfortunately, in those areas, zoysiagrass is dormant for four to six months per year.

Future challenges

As water and pesticide use on turf is increasingly scrutinized by legislators and the general public, more pressure will be placed on turfgrass managers to provide acceptable turf with less inputs. As budgets continue to shrink, turfgrass managers will be asked to do more with less. Even as demand for facilities such as municipal athletic fields and golf courses increase, turfgrass managers will be asked to deliver the same safe, functional playing surfaces they now provide. Homeowners will still be seeking the "Holy Grail" - grasses that grow slowly and, thus, require infrequent mowing, stay beautiful despite heat, drought and cold, and tolerate damage from hordes of feet, paws, cleats, etc.

The perfect grass for every situation will never be found or developed. Yet, plant breeders will have to develop grasses that provide acceptable quality turf during prolonged drought periods with little or no supplemental irrigation. Grasses will need to be bred that better resist disease and insect invasion and, thus, reduce pesticide use. Compaction and traffic-tolerant turfgrasses will need to be identified and commercialized. Dense, weed-resistant grasses will be needed in response to concerns over herbicide use or misuse on turf. And all of this will have to happen without a decline in turfgrass quality or an increase in the cost of these grasses.

This improvement and development effort will most likely be concentrated on the traditional cool-season and warm-season turfgrass species. Ecotype selecting will still be employed, but plant breeding will also help to enhance the development process. Biotechnology, gene manipulation, etc. will become more commonplace in turfgrass breeding programs, probably to solve specific problems such as brown patch resistance or acid soil tolerance. New or forgotten species such as Junegrass (*Koeleria* spp.), Hairgrass (*Deschampsia* spp.) and Seashore paspalum (*Paspalum vaginatum*) will be considered for site specific problems.

The future promises many interesting and exciting challenges for turfgrass managers and plant breeders. The continued development of new and unique turfgrasses will benefit consumers and society alike.

MR. KEVIN N. MORRIS is the National Program Coordinator for the National Turfgrass Evaluation Program (NTEP). He received his degree in agriculture from the University of Maryland in 1981. Upon receiving his degree, he was employed by the Maryland Environmental Service for one year and then started with the NTEP, Beltsville, MD in 1982 as Technical Coordinator. He was named National Program Coordinator of the NTEP in 1988. His duties include administration and coordination of national tests for seventeen grass species at approximately sixty test sites across the United States and Canada. In addition, he coordinates research involving NTEP tests, low or reduced input management of turf and evaluation of promising new species at the USDA, Beltsville, MD. He also provides consultation to turfgrass managers at facilities such as Laurel and Pimlico Race courses. He also has eight years experience as co-owner of a lawn service company. His most recent contribution to *TurfGrass TRENDS* appeared in the September 1992 issue.

Terms to Know

Ecotype Selection - an plant found growing in nature that has survived and thrived despite long periods of exposure to stress, i.e. cold, heat, drought, traffic, disease, etc.

Endophyte - an organism that lives/grows within another plant; it is often, but not necessarily, parasitic.

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