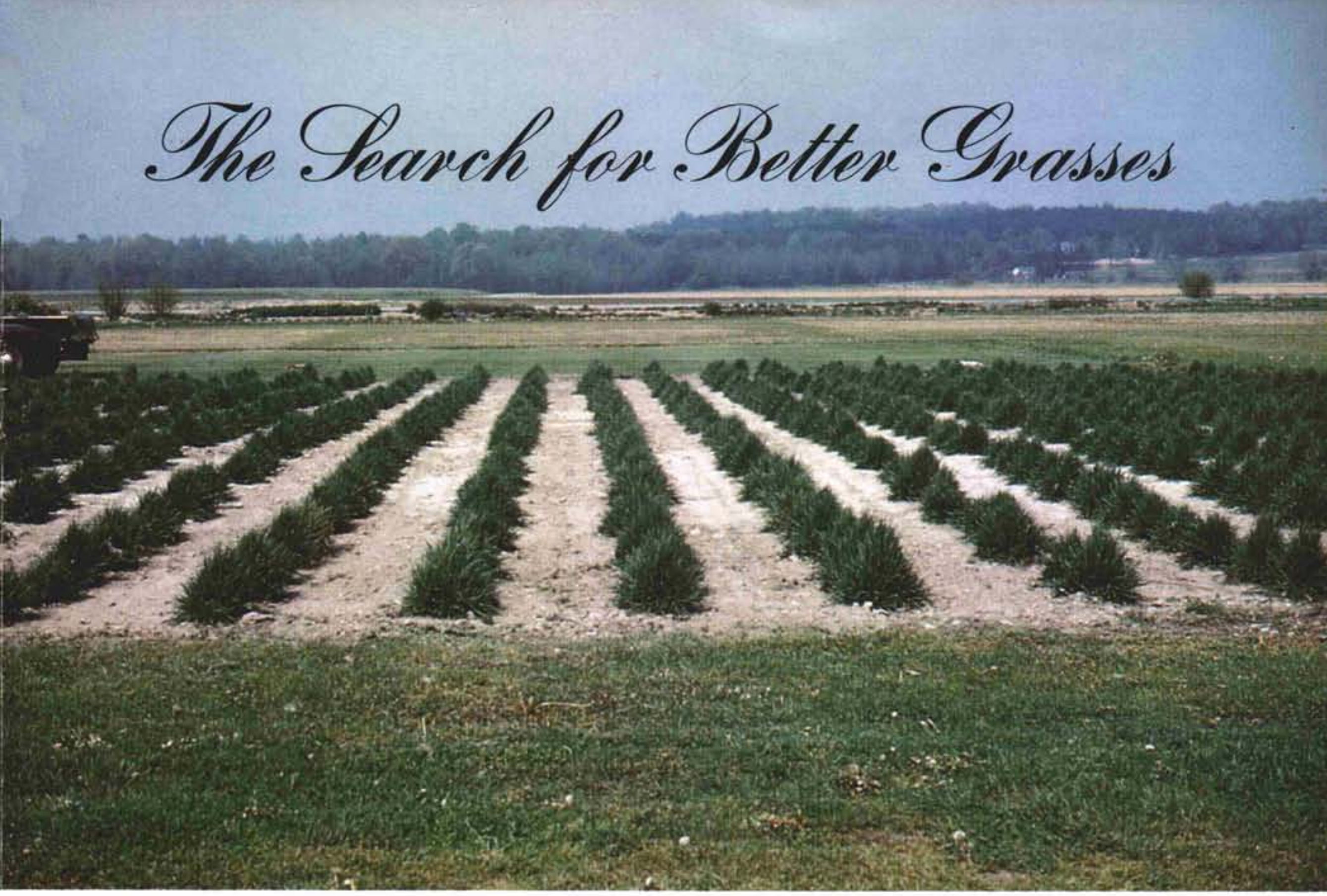
The Search for Better Grasses



Breeding turfgrasses for drought tolerance and low nitrogen requirement is high on the researcher's priority list.

by **DR. VICTOR B. YOUNGNER,** Professor of Agronomy,
Department of Plant Sciences, University of California

PRIOR TO 1950 few well-supported breeding programs directed specifically toward improvement of turfgrasses existed either in the United States or, for that matter, in the world. Since then the number of public and private turfgrass breeding programs has increased greatly. The result is that we have many new cultivars. Only a few of these have been of sufficient merit to remain in use year after year. The potential for further improvement, however, is greater than ever because of both an expanding knowledge of genetics and the development of new breeding techniques. Behind every introduction of a new cultivar may be found the efforts of many scientists who have provided the basic genetic and cytologic information, collected new germ plasm sources and devised better breeding methods.

Nevertheless, the plant breeder works within the rather well-defined limits of the germ plasm available in a species and in its close relatives, the gene pool. The continuing effort to identify, collect and preserve new germ plasm sources is therefore of highest importance. Plant breeders are concerned because much valuable germ plasm is lost forever when wild plants are destroyed through agricultural expansion, urbanization and recreational activities.

In simple terms, plant breeding consists of the selection of plants with specific desirable genes, which are then recombined through hybridization. This is often followed by inbreeding and further selection until a pure line with the desirable traits is obtained. Induction of mutations by radiation or chemicals has had limited success; in general, if genes for a desired trait do not exist in nature, not much can be done about it.

Many new turfgrass cultivars have resulted from simple selection of desirable types from segregating populations or from old, established turfgrass areas. In the case of selections from established areas, highly successful genotypes may have survived selection pressures of a specific environment, and they could be well adapted to some similar environments, but not adapt to some others. The plant breeder uses many variations of the basic techniques, as are determined by the plant material and by the specific breeding objectives.

Genetic engineering, which might be called gene transfer in the test tube, has attracted attention recently because it may make it possible for completely unrelated species to exchange desirable characteristics. Although the basic research is now being done, practical breeding by this method is a prospect for the distant future.

TURFGRASS BREEDING OBJECTIVES

Many broad breeding objectives are more or less common to most programs, no matter what methods or techniques are used, because all turf of any species or for any specific use must meet certain requirements.

Pest tolerance or resistance. Diseases, insects, nematodes and weeds limit the usefulness and increase the maintenance costs of all turf. Improved tolerance to a number of turfgrass diseases is appearing now in some recently released cultivars. We are just beginning to make progress in this area, however. The need is greatest in the creeping bentgrasses for putting greens and the Kentucky bluegrasses, colonial bentgrasses and fine-leaved fescues for fairways. Breeding for disease tolerance is especially difficult and precarious because the breeder is working with two organisms: the fungus disease organism and the host turfgrass. Resistance may be lost through mutation or genetic segregation in either organism.

Progress in insect resistance breeding has been limited. Few sources of germ plasm for resistance to the common turfgrass insects have been identified. We need to learn much more about the nature of insect resistance in plants in general and in grasses in particular. If we knew what characteristics would make a grass plant less desirable as food to an insect, we could begin a serious search for resistant germ plasm.

To minimize weed problems, a turfgrass must have the vigor and density to resist invasion. A grass that is dormant or is weak in growth at a time when a serious weed pest is in its phase of rapid establishment and growth is highly vulnerable. We have a number of turfgrasses today that are good weed competitors, but, unfortunately, excessive thatch often goes along with their high vigor and density. Mechanical dethatching which opens up the turf is frequently required, providing an opportunity for weed invasion. Breeders are now looking for strains which are not high thatch producers but are still sufficiently vigorous and dense to minimize weed problems.

Wear resistance. Any turf used for recreation should be able to withstand the kind and degree of traffic characteristics of that use. Traffic wear may be a scuffing, tearing, twisting or pounding action which damages leaf, stem and root tissue. Nearly 20 years ago we built the first accelerated-wear machine for turf studies. Since then other turf researchers have made machines. Studies with these machines had shown pronounced differences among species and among the cultivars of a species in resistance to the different types of wear. The plant characteristics providing wear resistance are

Zoysia is one of our most winter hardy and drought tolerant warm season grasses. It deserves a prominent place in the breeding program for southern and transition zone golf courses.

not well understood, but the amount and location of fibers are important. As we learn more about these characteristics we will be better able to include wearability as a breeding objective.

Rapid recovery rate. When turfgrasses are injured, ability to recover quickly is important. Tee and fairway grasses must heal over divots in a short time. This means that they should be either rhizomatous or stoloniferous — preferably, both. In bermudagrass country we are fortunate to have several species and cultivars which are excellent in this respect during the summer. Where play is year around, however, these grasses are inadequate during the cool seasons.

In our bermudagrass- and zoysia-breeding programs, better growth during the cool season has been a selection criterion of long standing. We are also attempting to develop zoysiagrasses with a more rapid rate of stolon and rhizome growth.

Tall fescue has had a limited use on the golf course, but if finer textured rhizomatous strains could be developed, this species might become a good fairway grass. At the University of California we have a tall fescue breeding program with these characteristics as primary objectives. Although they have few disease or insect problems, present tall fescue cultivars are too coarse and bunchy for golf course use.

Tolerance of close mowing. Frequent and rather close mowing differentiates a turf from a meadow. In recent years the trend has been to closer mowing on golf course turfs — greens, tees and fairways. This trend has eliminated many cultivars from fairways, especially among the Kentucky bluegrasses and fine fescues.

Tolerance of close mowing is primarily a function of growth habit. If the grass is prostrate with many leaves at the crown of the plant, more leaf surface will remain after close mowing than on plants that grow upright. This larger amount of leaf surface will permit prostrate strains to continue to produce carbohydrates at a sufficiently high rate to maintain good vigor and growth.

Drought resistance. Water shortages and droughts occur in one place or another every year. Our recent experience with these problems has emphasized the importance of using grasses that have a high level of drought resistance and maintaining them to realize their full drought potential.

Drought resistance may be of several types, all of which may not be valuable in turfgrasses. The ability to extract water efficiently from the soil is of great value and can be selected for in a turfgrass breeding program. This ability is the result of root development — the number, depth and extent of branching of the root system.

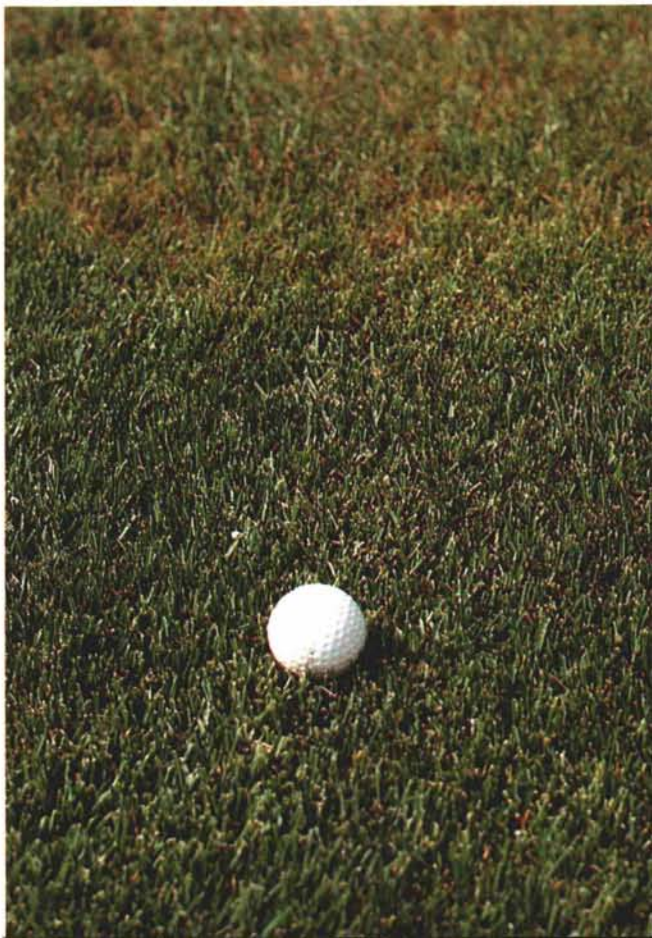
Some species, notably bermuda, zoysia, red fescue and tall fescue are inherently drought tolerant and should be used wherever other considerations permit. Breeding to improve these grasses in other respects while retaining their drought tolerance will extend their usefulness. At the University of California, for example, efforts are underway to develop zoysiagrasses with less thatch, more rapid establishment, better growth in cool weather and other characteristics which will increase their usefulness on golf courses and other turf areas.

Low nitrogen requirement. Because supplies of natural gas and other energy sources are becoming tighter and their costs higher, nitrogen fertilizer costs will continue to increase and occasional shortages may occur. Significant savings may be realized if grasses with lower nitrogen requirements can be substituted for any high nitrogen consuming varieties now in use.

Tall fescue, red fescue, centipedegrass, zoysiagrass and carpetgrass are species which will make turfs of acceptable quality at relatively low nitrogen levels. Kentucky bluegrass, bermudagrass, and creeping bentgrass need much higher levels. The development of high quality cultivars with reduced nitrogen requirements should be a primary goal of turfgrass breeders.

This goal may be approached in either of two ways. First, there is evidence that germ plasm for lower nitrogen requirements can be found in bermudagrasses and Kentucky bluegrasses. It should be possible, although difficult, to introduce this characteristic into otherwise desirable geno-

Improved Kentucky bluegrass varieties may one day replace bentgrasses for fairways, especially as water use becomes more critical.



types. The second approach, which may be easier to achieve, is to improve the quality and usefulness of those species that already have low nitrogen requirements. As with drought resistance, this is one of the basic concepts in our tall fescue and zoysia breeding programs.

High quality playing surface. This goal needs little explanation. Any golfer knows that unless a cultivar provides an acceptable playing surface it is of little value no matter how good it may be in other respects. Breeders should be familiar with the features of a good green, tee or fairway and should search for the grass characteristics most useful in producing these qualities.

Climatic adaptation. From the seed, sod or stolon producer's viewpoint, a cultivar with adaptation to a wide range of climates has obvious advantages. However, the user may prefer to have one with excellent adaptation to his specific climate. Certainly the latter may often be the easier to achieve.

Climatic adaptation of a turfgrass is primarily possession of characteristics which permit it to grow, or at least to survive, under the temperature extremes of a given climate. It is also the ability to produce a good turf under prevailing temperature conditions. Reproduction, i.e., flowering and fruiting, is not a concern; in fact, it is undesirable where the grass is used as turf.

Selection of strains or clones that have survived for many years in a particular environment have produced some cultivars well adapted to that or similar climates. The introduction of selections from around the world has provided germ plasm for wider climatic adaptation of many grasses.

Salinity tolerance. Irrigation water of relatively poor quality must be used in many parts of the West. An increasing number of golf courses are using sewage effluent water for part or all of their irrigation needs. Salt levels of these waters may run 900 ppm, or much more. Salts from these waters may accumulate in the soil until they become toxic. Our studies have shown that turfgrasses vary greatly in salt tolerance and that it is possible to select more salt tolerant types. Salt tolerance is a selection criterion in most of our breeding work.

Smog tolerance. Air pollution is a fact of most urban environments and may well continue to be for years to come. Leaf injury of turfgrasses from high levels of ozone, sulfur dioxide, PAN (peroxyacetylnitrate) and other pollutants has been known for many years. When this injury occurs it discolors and weakens the turf. Of greater importance, re-

Breeding for resistance to insects is high on the list of needs for golf course grasses. Chinch bugs wiped out all but a few clones of grasses on this lawn.

Even weeds have great genetic diversity.

sults of some of our recent research showed that grasses may suffer severe reduction in growth at air pollution levels below those which cause leaf injury symptoms. These levels would be those which might prevail for long periods in many urban areas.

Our research and that of others have shown that species and cultivars within species differ in their susceptibility to smog. Breeding for smog resistance, therefore, is possible and may be a desirable goal in many programs. Smog tolerance was one of the selection criteria in the bermudagrass breeding work that led to the Santa Ana cultivar released in 1966.

Tolerance of agricultural chemicals. Herbicides, fungicides, insecticides and other agricultural chemicals are standard turfgrass maintenance tools. A cultivar that is too readily injured by widely used chemicals will not be a satisfactory addition to our list of turfgrasses. It is a common observation that existing cultivars differ widely in tolerance to various chemicals. Screening for tolerance to such widely used chemicals as the phenoxy compounds is a worthwhile part of new cultivar evaluations.

This discussion of breeding goals is not meant to be exhaustive, but only to describe briefly some objectives I consider important. Other turfgrass breeders undoubtedly could add some which they consider to be equally valuable.

THE POTENTIAL IN OTHER GRASSES

Up to this point our discussion has dealt only with those species widely used for turf. Although there may be few if any other species equal to these as turf formers, we should still look at the potential value of many others. Some of these may be considered weeds or poor quality turfs at the present. However, they may often have one or more characteristics that are highly desirable in a turf.

If these grasses are of sufficiently close relationship to the fine turfgrasses to cross with them, they may be used as sources of germ plasm in interspecific or even intergeneric hybridization programs. Some examples of these are the relatives of bermudagrass *(Cynodon)*, bluegrass *(Poa)* and fescue *(Festuca)*

Tifway, Tifgreen and Santa Ana bermudagrasses are hybrids between two *Cynodon* spp. Crosses have been made between *Festuca* and *Lolium* (ryegrass) species, but no hybrids of turf value are as yet available. Kentucky bluegrass *(Poa pratensis)* and Canada bluegrass *(Poa compressa)* have been successfully hybridized. This cross may eventually introduce valuable new genes into Kentucky bluegrass.

In some cases we might consider breeding programs to improve some weedy grasses to make them more acceptable as turf. Annual bluegrass, for example, although unwanted, is a major constituent of putting greens across the country. It is a highly variable species with an extreme range in growth habit and other characteristics. In the past we have conducted selection studies which have indicated that some excellent putting green types may be easily obtained. Although we found no disease tolerance in our selections, we believe that it may be quite possible to find such strains. More work needs to be done.

In the West we have been waging a losing battle against kikuyugrass for years. We have been unable to find a satisfactory control for it on golf courses and other landscaped areas. Still it is not all bad. When properly maintained it makes fairly good fairway turf. It is tolerant of drought, insects, diseases, salinity and smog. It grows well under low nitrogen levels, withstands heavy use and heals rapidly. Its worst faults are its aggressive invasion of greens and other areas, a rapid thatch buildup, fast growth which requires frequent mowing, and a fairly coarse texture. Although it lacks the genetic diversity of annual bluegrass, our studies have shown that considerable variation does exist in our material and more can be found in other parts of the world. We plan to begin some very cautious breeding studies on it soon.

Without going into excessive detail, this describes the search for better grasses for turf which we follow at the University of California. Similar programs are underway throughout the country, but I should point out that improvements do not come overnight. Breeding and selection work reap benefits as a result of the consistently applied efforts of many people over extended periods of time. It takes as well your continuing support, the assistance and backing of everyone interested in turf to make things happen.