A GREEN SECTION SUPPORTED RESEARCH PROJECT

Better Bermudagrasses for Golf[1]

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"Why keep on trying to breed better bermudagrasses for golf? The Tif-bermudas will do the job if properly managed."

This statement from a leading turf specialist in the South made me stop and think. Our best turf bermudas for golf—Tifgreen, Tifway, and Tifdwarf—do have a pretty good performance record. They are certainly an improvement over the common bermudagrass they replaced.

Several years ago, a superintendent of a Florida golf course that had Tifdwarf on the greens and Tifway on the fairways and tees told me that Ben Hogan said it was the finest turf he had ever played on. But it was well managed. Northern golfers playing Tifdwarf greens in Birmingham, Ala., thought they were playing on bentgrass greens. Again, the greens were properly managed.

The Tif-bermudas were bred to give good turf with less fertilizer, insecticides, and fungicides than many other grasses. Tifdwarf and Tifway are darker green than most other grasses and require less nitrogen fertilizer to give the desired dark green color. They also require less fertilizer than other bermudas to create the sod density necessary to crowd out weeds. Tifway is resistant to the bermudagrass mite, a pest that otherwise would have to be controlled with chemicals. Tifway, Tifgreen, and Tifdwarf are immune to rust and fairly resistant to several other diseases. Put very simply, it costs less to maintain good turf with the Tif-bermudas than with most other grasses. Springhill Country Club, Tifton, Ga., with Tifdwarf on the greens and Tifway on the fairways, tees, and rough, has demonstrated that these grasses can be kept in excellent playing condition on a limited budget.

"Too much thatch," a criticism of Tifway, is evidence of too much fertilizer and water and sometimes too little mowing. Cutting Tifdwarf daily at a height of 3/16 inch, fertilizing moderately and topdressing as needed could overcome most of the criticism we have heard of this grass. Yes, with proper management, the Tif-bermudas would do a pretty good job—a much better job than they are doing on some golf courses today. But they are not perfect.

None of the Tif-bermudas is resistant to nematodes. If we could increase their nematode resistance, golf courses could save many thousands of dollars spent for nematicides. If we could increase their winterhardiness and make them resistant to spring dead spot, they would be much more useful in the northern part of the bermudagrass belt. Tifdwarf turns purplish brown when temperatures approach 32 degrees Fahrenheit. To overcome this unsightly color, greens must be either overseeded with cool season grasses or sprayed with gibberellin. These expensive operations in the lower part of the bermudagrass belt could be eliminated with a golf green bermuda that would not turn purple and brown when it gets cold. These are but a few of the reasons why we keep on trying to breed better bermudagrasses for golf. We made progress with the development of the Tif-bermudas and we believe we can continue to do so.

Hybridization

When plant breeders try to develop better varieties, they find parents that have the desired traits and hybridize them. If the desired combination of traits is not found in the F_1 (first generation)

Rhizomes of Tifgreen bermudagrass prepared for irradiation.

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Bermudagrass mutants and new hybrids under evaluation at Beltsville, Md., for winter-hardiness.

hybrids, it can usually be found in the F_2 (second generation) grown from these hybrids. It is often necessary to look at thousands of F_2 plants. We cannot use this procedure as we try to improve Tifgreen, Tifway, and Tifdwarf, because they are sterile triploids. They are hybrids between two species, the tetraploid *C. dactylon* and the diploid *C. transvaalensis*. Because they are sterile, we can have no seed for an F_2 generation. If we do not find the desired combination of traits in the F_1 hybrids, we must make more F_1 hybrids and hope to find them there. Because Tifgreen, Tifway, and Tifdwarf are sterile, they cannot be used as parents to add, for example, nematode resistance to them. We must make more species hybrids and hope to find in them all the desirable traits in the Tif-bermudas plus the new ones sought. Just how difficult this is will be apparent if we review the combination of traits the game of golf demands.

Golf Course Demands

For top-quality golf greens, a grass must be able to withstand daily defoliation to a height of 3/16 inch and maintain a smooth, uniform surface that will keep the ball on a true course. Its leaves must be fine, soft, and closely spaced to meet this requirement. It must also have a uniform dark green color. For tees, a variety must be tough to stand the punishment doled out by the golfer and his clubs. It must have dense, stiff leaves to hold the ball well above the soil, and it must heal rapidly to fill in divot holes left by the players. For fairways, a variety must make an attractive, uniform carpet, dense enough to give a good lie to the ball. It must be able to heal divots rapidly and must tolerate considerable traffic. It must do all of this over a great variety of microenvironments with less water and care than greens and tees.

In addition to these specific demands, there are a number of general characteristics that we would like to incorporate into new golf course varieties for the South. First and most important is dependability. These varieties (except for overseeded winter grasses) should be perennial regardless of the weather. They should maintain a green color throughout their growing period (hopefully to be extended by increasing frost resistance). Low maintenance costs and, of lesser importance, low establishment costs should receive major attention in the development of every new variety. Adding resistance to drought, cold, disease, insects, nematodes, and weeds will lower maintenance costs. Wear resistance, shade tolerance and low weed potential are other important traits that should be added.

Tifdwarf, the last improved grass to come from our turf breeding project at Tifton, was released in 1965. From 1965 to 1970, we made and evaluated a number of new sterile triploid hybrids. Some were good but none was better than Tifway, Tifgreen, Tifdwarf already in use on golf courses. The best of these are being kept in our nursery as insurance against a possible disaster, such as the 1970 corn blight disease which greatly reduced corn yields.

In 1966, after the Grassland Congress in Finland, I spent three weeks in Europe looking for winter hardy bermudagrasses. I had the help of grass breeders and botanists in Germany, Switzerland, Italy, and France and mailed back rhizomes of a number of bermudagrasses I found there. Agronomists in

several states helped evaluate their winter hardiness. Professor Milo Tesar at Michigan State University had to go to his northernmost planting near Lake City, Michigan to find the two most winter hardy plants. One of these came from a railroad siding in Berlin where Professor Soukoup had seen it growing for 15 years. The other plant I found in the Alps of north Italy. One of my Canadian friends recently reported that the Berlin bermuda was surviving in Canada.

We are using the Berlin bermudagrass as a parental source of winter hardiness and have made several hundred hybrids between it and our best *Cynodon transvaalensis* introduction from South Africa. Dr. Jerrel Powell, ARS, USDA, Beltsville, Md., is helping us evaluate these hybrids for winter hardiness. Because these F_1 hybrids are sterile and will not produce an F_2 generation, we cannot expect to develop hybrids as winter-hardy as their Berlin parent. We do expect some of them to be more winter-hardy than the Tif-bermudas.

Some of the progeny from the Berlin bermudagrass have set seed very well in small plots. In 1974 we isolated three of the best of these and used springs to plant large plots. When we harvested seed from these plots near the end of the season, we found lots of heads but a very poor seed set, due, we think, to self-incompatability. To solve this problem, we interplanted them in 1975 and expect to get a good seed harvest. Our objective is to develop a winter-hardy bermudagrass than can be propagated by seed.

Mutation Breeding

The failure of the triploids made in the late 1960s to excel the Tif-bermudas caused us to turn to mutation breeding as a possible way to improve them. The occurrence of Tifdwarf as a natural mutant in Tifgreen suggested that speeding up this natural mutation process with mutagenic agents might be profitable.

Thus, in the winter of 1969-70, with the help of Dr. Jerrel Powell, we began mutation breeding research to produce mutants of Tifdwarf and Tifgreen. Dormant stolons, washed free of soil and cut into one or two node sections were selected because their buds contain few cells. Actively growing buds contain many cells and a one-celled mutant occurring in such buds will usually be obscured by the development of the normal cells around it. Thus the ideal bud for mutation breeding will have only one cell.

When we treated dormant buds of Tifdwarf and Tifgreen with the chemical mutagen EMS (ethyl methane sulfonate) at rates up to levels that killed many buds, noticeable variants failed to appear. When we exposed dormant sprigs to 7 to 12 kR of gamma irradiation from a cobalt 60 source, however, a number of distinctly different bud mutations occurred. Isolated from normal tissue and grown in two-inch pots in the greenhouse, these 60 mutants differed in leaf size, hairyness, stem diameter, internode length, and basic plant color. In a field planting they differed in herbicide sensitivity, frost tolerance and spreading rate.

In the winter of 1970-71, we exposed dormant stolons of Tifgreen and Tifway to gamma rays and planted them in flats of sterile soil in the greenhouse. In April we space-planted in the field the tiny plants that grew from the irradiated buds and isolated 62 mutants from Tifgreen and 36 from Tifway. These mutants were similar to those obtained earlier. Tifway, however, gave a lower mutation frequency and failed to produce as much variation in plant color.

From these studies we have learned that mutation breeding is a very effective method for creating variation in the sterile triploid bermudagrasses. Our experience indicates that dormant sprigs should be exposed to 7,000 to 9,000 r of gamma irradiation and then planted in sterile soil in the greenhouse. When well established, the plants from irradiated sprigs should be space-planted in the field. A regular daily search for mutant shoots should begin as soon as stolons appear. Color differences are easier to detect on cloudy days. Mutant shoots should be removed immediately and grown in the greenhouse, otherwise they will be overgrown with normal plant material and lost.

Up to 6 per cent of the sprigs of Tifgreen and Tifdwarf that we irradiated produced M_1 mutants. Approximately 70 per cent of these mutants did not sector and gave rise to uniform turf when increased vegetatively. Sectoring mutants were usually stabilized by isolating small sectors from them. Frequency of discernible mutants was lower in Tifway than in Tifgreen and Tifdwarf.

The mutants from our mutation breeding program were set out in plots along with normal material of Tifgreen, Tifway, and Tifdwarf to serve as checks at Tifton, Ga. and Beltsville, Md. For the past three years we have been carefully evaluating these mutants, searching for one or more that may be superior to the normal Tif-bermudas. We have about decided that the dwarfs smaller than Tifdwarf are too small and grow too slowly to be useful on most golf courses. Some mutants that looked good three years ago no longer compare favorably with their normal parent. We learned years ago that it takes at least three years to pick the good ones. Some of the mutant plots have very few nematodes in them; others are heavily infested. Dr. A.W. Johnson, ARS, USDA, nematologist at Tifton, is helping to evaluate these mutants for nematode resistance. Evaluation is difficult because it is hard to get a uniform infestation in the field, and nematodes cannot be cultured in the laboratory as can disease organisms. Dr. Johnson has some of the most promising mutants in the greenhouse and hopes to give us a resistance evaluation of them by next spring. By that time we hope we will have several mutants (at least one from each Tif-bermudagrass parent) to increase and release for evaluation on golf courses.