USING GAMMA IRRADIATION TO IMPROVE STERILE TURF AND FORAGE BERMUDAGRASSES[1/]

Glenn W. Burton[2/]

ABSTRACT

The widely-used Tif-series of turf bermudagrasses — Tifgreen, Tifway, and Tifdwarf — are vegetatively propagated sterile triploids that cannot be improved by conventional breeding methods. Dormant stolons, washed free of soil and cut into one-or two-node sections were treated with varying dosages of EMS and gamma irradiation ranging from 7 to 12 kR. EMS failed to produce noticeable variants but gamma irradiation from a Cobalt 60 source created 158 mutants. These mutants differed in many characters such as leaf size, hairiness, stem diameter, internode length, basic plant color, herbicide tolerance, spreading rate, and nematode resistance.

Attempts to improve the winterhardiness of tetraploid sterile Coastcross-1 forage bermudagrass by exposing over 1,400,000 sprigs (vegetative stems) to 7 kR of gamma rays gave chlorophyll deficient

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2/ Research Geneticist, Agricultural Research Service, U.S. Department of Agriculture, and the University of Georgia, College of Agriculture Experiment Station, Coastal Plain Station, Tifton, Ga.

mutants but progress in increasing winterhardiness has not been established.

Turf Bermudagrasses

The Tif-turf bermudagrasses — Tifgreen, Tifway, and Tifdwarf — have a good performance record. 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 and Tifway on the fairways, tees, and rough, has demonstrated that these grasses can be kept in excellent playing condition on a limited budget.

The Tif-turf bermudagrasses are not perfect. None of the Tif-turf 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°. 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 turf bermudagrasses.

The Tif-turf bermudagrasses are sterile F_1 hybrids between the tetraploid Cynodon dactylon and the diploid C. transvaalensis. They are triploids and because they are sterile they cannot be used as parents to add, for example, nematode resistance to them. We can only make more species hybrids and hope they will be better than Tifgreen, Tifway, and Tifdwarf. Although we have made and tested many similar hybrids, we have found none better than Tifgreen, Tifway, and Tifdwarf.

The failure of these new triploids to excel the Tif-turf 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% of the sprigs of Tifgreen and Tifdwarf that we irradiated produced M_1 mutants. Approximately 70% 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 few years we have been carefully evaluating these mutants, searching for one or more that may be superior to the normal Tif-turf 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 just completed a greenhouse experiment in which sprigs of six of the most promising mutants (based on field observations) and the parent clones, Tifgreen, Tifway, and Tifdwarf were planted in 15-cm pots of nematode innoculated soil replicated four times. In this test the root knot nematode was unable to reproduce on two of the mutants suggesting that they are immune to this serious pest. Two other mutants, although infested with all of the normally occurring root nematodes, were able to grow as well as plants without nematodes.

Coastcross-1 Forage Bermudagrass

Coastcross-1 is a sterile F_1 hybrid between Coastal bermudagrass and a highly digestible bermudagrass from Kenya. It has a 12% higher *in vitro* dry matter digestibility (IVDMD) than its Coastal bermudagrass parent. In replicated grazing and feeding trials cattle consuming Coastcross-1 have made 33% better average daily gains and 34% more liveweight gain per acre than Coastal bermuda although it produces no more dry matter per acre. Unfortunately, Coastcross-1 lacks winter hardiness and because it is sterile, it cannot be improved by conventional breeding methods.

Coastal bermudagrass produces rhizomes. The Kenya parent of Coastcross-1 produces no rhizomes and is not winterhardy. Coastcross-1 rarely produces rhizomes and those produced are usually very short indicating that the non-rhizomatous character is dominant. If by irradiation we could destroy this dominant gene or genes and make Coastcross-1 rhizomatous, we would greatly increase its winter hardiness. Soils where bermudagrass is adapted rarely freezes as deep as these rhizomes grow.

Radiation breeding of Coastcross-1 was begun June 21, 1971. The main objective was to increase winter hardiness by restoring rhizomes or developing more winter hardy mutants. Some 400,000 freshly cut green stems of Coastcross-1 were packed into 14 x 16 x 36 inch bales with a standard hay baler. These were trucked to the University of Tennessee A.E.C. agricultural laboratory at Oak Ridge, Tennessee where they were exposed to 7,000 R. They were then trucked to the Mountain Experiment Station where they were broadcast and disked into the soil and were

sprayed with 2,4-D to control weeds. Good establishment resulted and 25 chlorophyll deficient stem sectors were observed in the fall. Four tiny plants from irradiated material survived -16°C. All plants from non-irradiated stems winterkilled. The four surviving plants are still being tested in replicated plantings for winter hardiness. Unfortunately we have had unusually mild winters at the Mountain Experiment Station at Blairsville for the past four years and have been unable to get good readings on the winterhardiness of these four surviving plants.

We did observe on one of these plants a rhizome that was over 12 inches long, a much longer rhizome than we have ever observed before in non-irradiated material. We broke up this rhizome and planted it out in the field, hoping that it would give rise to plants that would be more rhizometous than Coastcross-1. Observations in 1974 suggested that this material is not more rhizomatous than the parent clone.

In the spring of 1972 we planted at Blairsville more than 1 million sprigs of Coastcross-1 that had been irradiated at Oak Ridge, Tenn. We planted another million irradiated sprigs in 1973 fully occupying all land available for this study.

The winter of 1975-76 was colder than the previous winters and killed most plants of Coastcross-1 on land sloping to the north. It was not cold enough to kill plants on land sloping to the south. On May 7, 1976, I carefully examined surviving plants trying to find plants that had spread by rhizomes. Not finding any, I removed several of the best plants for further evaluation. The other bermudagrass plants will be destroyed with the chemical Roundup and a new planting of irradiated springs will be made in the spring of 1977. The amount of work

required for this experiment is not great. We still believe if we can screen enough irradiated sprigs of Coastcross-1, we will find a plant with rhizomes. Such a plant (which could be easily propagated vegetatively) would be of great value to the livestock industry.