EXECUTIVE SUMMARY

Objectives of the Oklahoma State University bermudagrass breeding program are to develop: (1) seed-propagated, cold-tolerant, fine-textured varieties for the transition zone; and (2) improved varieties for golf course putting greens, with emphasis on adaptation to southern coastal states.

Beginning in the mid 1980's cold tolerant bermudagrass germplasm populations with moderate seed production potential were subjected to recurrent selection for increased basic fertility (seed set). Three selection cycles resulted in a threefold increase in fertility. Four seeded experimental varieties synthesized from these populations in 1989 and planted in field tests in 1990 survived the 1990-91 winter without significant injury at Ft. Collins, CO; Columbia, MO; and Stillwater, OK. All of the varieties suffered severe injury at Ames, IA where cold injury to plants was above average. These varieties appear to have good cold tolerance, but are coarser in texture than desired. In the past two years, the breeding populations from which these varieties were synthesized have undergone intense selection for characters affecting turf quality and seed production. New experimental varieties were synthesized in 1991 from these populations for comprehensive and intensive evaluation as potential new varieties. One or more experimental seeded varieties will be entered in the National Turf Evaluation Program bermudagrass test scheduled for 1992.

A laboratory procedure for mass-screening bermudagrass plants for cold-tolerance has been developed. The procedure has been used during the past two years to screen plant populations (totalling ca 3,000 plants) with excellent seed production capability and good turf quality, but poor cold-tolerance. Selected plants have been polycrossed for progeny testing and renewed selection. A summer 1991 experiment in which previously selected plants were cloned and retested along with unselected progeny plants from the same source population provided evidence that the mass screening procedure effectively selects for greater cold-tolerance rather than experimental variation.

Thirty-three hundred C. transvaalensis progeny plants are being evaluated in nurseries at Stillwater, OK. Five hundred eighty-nine of the 3,300 plants are established in nurseries on country club golf courses in Georgia and Florida under putting green management. Superior plants from these nurseries will be selected over the next few months as they begin to "sort out." Wide variation among the C. transvaalensis progenies for important turf performance traits has been demonstrated which points to significant potential for improved cultivar development within the species.

Several vegetatively-propagated C. transvaalensis intraspecific, and C. transvaalensis x C. dactylon interspecific, hybrids first tested during 1991 performed well in comparison to check varieties. Additional intra- and inter-specific crosses were made among selected parental plants in 1991. Resulting hybrid progenies will be field-planted in spring 1992.

Evaluation of 11 seeded and 16 vegetatively-propagated experimental bermudagrasses by Dr. Ronnie Duncan, Georgia Experiment Station, Griffin, GA, showed several to have excellent tolerance to low soil pH.

I. INTRODUCTION

The turf bermudagrass breeding program was initiated in 1986 under the joint sponsorship of the United States Golf Association and the Oklahoma Agricultural Experiment Station. The initial basic objective was to develop fine-textured, winter hardy, seed-propagated varieties for the U.S. transition zone. The program was expanded in 1990 to include the development of superior vegetatively-propagated varieties for use on putting greens in the deep south where bentgrass is poorly adapted.

Important ongoing activities supporting the breeding effort include the development/improvement/use of techniques to measure physiological and morphological parameters related to environmental stresses; the procurement, evaluation, and use of new turf bermudagrass germplasm in the breeding effort; use of tissue culture in generating genetic variation and screening for desirable traits at the cellular level; and evaluation of bermudagrass varieties and breeding lines for turf performance.

This report summarizes activities and progress through October, 1991 and research plans for the coming year.

II. RESEARCH PROGRESS

Breeding Seed-Propagated Varieties. Beginning in 1986 with cold-tolerant, relatively coarse-textured bermudagrass populations, we conducted three cycles of phenotypic recurrent selection for increased basic fertility (% of florets setting seed) which resulted in a 3-fold increase. These plant populations have sufficient basic fertility for economic seed yields, but need improvement in other seed yield components, mainly earlier flowering date and heading prolificacy.

In 1988 and 1989, selected plants from these populations were used to produce experimental synthetic varieties which were included in turf evaluation tests established in 1989 and 1990, respectively, at the Turf Research Center (TRC), Stillwater, OK (Tables 1-4, Fig. 1). Four of the experimental synthetic varieties plus NuMex Sahara were established in tests in 1990 at Ames, IA, Ft. Collins, CO, and Columbia, MO. All of the synthetic varieties survived the winter of 1990-91 with little injury in all tests except the one at Ames, IA in which they were badly injured. The winter at Ames was unusually severe according to Dr. Nick Christians. Both common and Numex Sahara were either completely killed or severely injured in all tests except the one at Stillwater. In Test 89-1 at Stillwater, both common and Numex Sahara were severely injured during the 89-90 severe winter while the experimental synthetics suffered little or no injury. Turf quality ratings in Table 1 indicate little difference between the synthetics and common or NuMex Sahara. Data in Table 3, however, indicate that the turf quality of the seeded synthetic experimentals is not as good as that of many vegetatively propagated commercial and experimental varieties. Performance data from the Colorado and Missouri tests will be available at the end of the 1991 growing season.

Steady progress continued during the past year in refining the texture and seed yield components (primarily date and prolificacy of seed head production) in the populations. During the past 24 months, two greenhouse selection cycles were completed for fine texture involving ca 20,000 plants. Three hundred and twenty-nine selected plants from the C_2 population were established in a polycross nursery at the Stillwater TRC Sept. 10, 1990 (Figs. 1 and 2). The excellent winterhardiness of these materials was verified by the fact that every plant survived the winter despite the late planting. Seed from these plants were harvested this past summer for inclusion in turf evaluation tests and to provide progeny for a third cycle of selection. The two completed cycles of selection have dramatically refined the texture of the breeding populations relative to the C_0. Textural refinement has been attained via reduction in leaf width, stem diameter, and stem internode length. Although further significant textural refinement is possible via recurrent selection, we will evaluate the presently available materials for possible release as commercial varieties. Evaluations will be conducted for seed production and overall turf quality.

In early September, 1991 we selected 29 of the above-mentioned 329 progeny plants on the basis of turf quality and seed yield potential. The 29 selected plants were planted in an isolated polycross nursery on the OSU Agronomy Farm Sept. 9, 1991. The same 29 plants plus an additional 22 selected plants were planted on the Yuma Valley Agricultural Research Center October 11, 1991. The plants will be evaluated for seed yield and seed yield components during summer 1992.

In 1989, we began selecting for increased cold-tolerance in cold-sensitive common bermudagrass germplasm using a mass screening technique described later. Over 2,000 individual plants have been screened and about 50 have been selected for use in breeding. Selection was made on the basis of survival at following exposure to a single low temperature and the earliness and vigor of their regrowth. The selected plants were established in a polycross in summer 1991. The objective of this effort is to increase the cold-tolerance in germplasm already having good seed yield potential and relatively good turf quality.

In summary, we are at the point in our seeded turf bermudagrass breeding program in which we will concentrate on evaluation of presently available experimental varieties for potential release as commercial varieties while continuing to further improve the germplasm populations with which we are working. We hope to release one or more varieties within the next 3 years contingent on evaluation results.

Breeding Vegetatively-Propagated Varieties. Mean performance ratings for 19 vegetatively-propagated turf bermudagrasses including 13 experimentals from our breeding program are given in Tables 3-4. The experimentals are either *C. transvaalensis* progeny plants or *C. transvaalensis* x *C. dactylon* interspecific hybrids. Several have performed very well in comparison to check varieties and will continue to be evaluated. Entry 13, a selection sent to us from the Country Club of Virginia, Richmond, was the only entry failing to survive the winter. It was reestablished in the test in June 1991.

Work continues on schedule in the screening of C. transvaalensis progeny plants for putting green performance (Table 5). From approximately 4,000 progeny plants grown as spaced plants in breeding nurseries in 1989 we selected 3,300 for inclusion in June 1990 in a Stillwater TRC nursery to be managed as a putting green. In October 1990, 500 of the 3,300 plants were selected for planting in groups of 100 on five Florida golf courses. Plantings were made at: (1) CC of Orlando, Cary Lewis, CGCS; (2) Fiddlesticks CC, Ft. Myers, Lou Conzelmann, CGCS; (3) High Ridge CC, Lantana, David Bailey, CGCS; and (4) Palm Beach CC, Paul Crawford, CGCS. A scheduled planting at the Deerwood CC in Jacksonville was not made. The plants designated for the Deerwood planting, plus an additional 89 new selections, were planted in mid-April 1991 on the Sea Island Golf Club, St. Simons Island, GA, Tom Burton, Superintendent. All of these plantings will be managed as putting greens with the objective of selecting superior plants after "sorting out" has occurred.

Excellent survival of plants was attained in each of the four Florida plantings, but rate of establishment (sod cover) varied greatly among the four sites. This was due primarily to whether the nursery was overseeded. The Orlando and Ft. Myers sites chose to overseed which greatly restricted the spread of the bermudagrasses through late spring 1991. The two plantings in the Palm Beach area were not overseeded and established rapidly. Figs. 4-5 show, respectively, the Palm Beach CC nursery at time of planting and in January. All nurseries are now established and we expect genotypic differences to become increasingly evident over the next 12 months. As indicated in Table 5, the goal is to identify the very best plants (30 or fewer) from these five screening nurseries and place them under intensive evaluation.

Information on the magnitude of variation among C. transvaalensis progeny plants and the potential of the species for putting green use is available from the 1st year results of a study by graduate student David Gerken. David is evaluating the performance of six C. transvaalensis plants in comparison to Tifgreen and Uganda. The six plants were selected in fall 1990 from among the above-mentioned 3,300 on the basis of their appearance at that time. They were increased in the greenhouse during the winter and planted in a randomized complete block test with split plots and four replications. Genotypes (plants) were whole plots and mowing heights (1/8 and 3/16 ins.) were subplots. Size of whole plots is 10'x12'. Figs. 6-7 show the plots in mid-September after color changes due to cool weather.

Data on turf quality, sod density, color and ball speed are given in Table 6. These data support visual observations indicating significant differences among the C. transvaalensis selections. These selections were generally equal to or greater than Tifgreen and Uganda for quality, density, and ball speed. Tifgreen received the highest ranking for color. The most impressive of the C. transvaalensis selections with respect to season-long performance was No. 2747. This accession maintained a dense uniform turf only slightly lighter in color than Tifgreen.

The data from Mr. Gerken's test provide strong evidence of significant variation within C. transvaalensis for major characteristics affecting turf performance. The magnitude of variation within the species for turf performance traits will permit the selection of superior plants for use as commercial varieties and/or as parents in breeding. Additionally, we have experienced wide variation among plants in our nurseries for cold tolerance. A long time goal of some turfgrass scientists has been the procurement of C. transvaalensis plants with higher levels of cold tolerance relative to available plant introductions. We have identified plants in our nurseries with superior cold-tolerance based on survival and spring regrowth. Some of these plants may function well as parents in interspecific crosses with C. dactylon parents.

In spring and early summer 1991, intra-and inter-specific crosses were made between selected C. transvaalensis and C. dactylon parents. Seed from these crosses will be germinated this winter and progeny plants transferred to the field next spring. The crossing of selected parent plants and selection within large progeny populations is a proven, effective procedure for developing superior vegetatively-propagated varieties.

Cold Hardiness Research. We have developed and refined laboratory procedures to screen and evaluate experimental bermudagrass genotypes for superior cold hardiness. Our objective of the latest experiment was to evaluate the effectiveness of the screening procedure.

Seedlings from reciprocal crosses were grown in cone-tainers in the greenhouse. After establishment, plants were transferred to the growth chamber for cold acclimation at 8/0C day/night temperatures for 4 weeks. Acclimated plants were taken to the laboratory and placed in a freeze chamber with a thermocouple junction in each pot to measure temperature. All samples were induced to freeze at -3C, held overnight at this temperature, then cooled 1C per hour. Plants were removed from the chamber when the soil temperature at 2cm depth in the center of the pot reached the target temperature of -8.7C. Samples were slowly thawed overnight in a refrigerator, then taken to the greenhouse for regrowth observations. Plants identified as having vigorous regrowth were retained and reevaluated along with additional, unscreened seedlings from the original crosses.

Sixteen plants were identified as having rapid, vigorous regrowth and were retained from over 1000 plants evaluated in the first screening. Four of the sixteen were retested along with additional seeded plants from the original crosses. Ninety-six percent of retested plants survived while plants not previously screened averaged 16% survival over the six dates the experiment was repeated. Nineteen plants (out of 117 survivors) from the second screening were retained due to strong regrowth. Selected plants were used as parents in isolated polycrosses to produce experimental synthetic varieties and to provide plants for a new selection cycle.

Results indicated that plants had been selected based on greater cold tolerance rather than experimental variability. We are continuing to screen experimental genotypes and to evaluate relative hardiness levels compared with released lines.

Acid Soil Tolerance. Eleven seeded and 16 vegetatively-propagated experimental bermudagrasses were sent to Dr. Ronnie Duncan, Georgia Experiment

Station, Griffin, GA in 1990 and again in 1991 for acid soil tolerance testing. Seeded types produced poor stands in the 1990 planting, but several of the vegetative varieties exhibited excellent tolerance according to Dr. Duncan. Dr. Duncan verbally indicated recently that all strains established successfully in this years test and that he is finding excellent tolerance among both the seeded and vegetative strains.

New Germplasm Procurement. The National Plant Quarantine Center in Glen Dale, Maryland released 20 vegetatively-propagated turf bermudagrass accessions during summer 1991. Nine of the accessions were from the Peninsula Country Golf Club in Frankston, Victoria, Australia, David Nickson, Supt. The remainder were collections made by Taliaferro in Zimbabwe in summer 1990 from golf course fairways and greens. Three seed accessions were received during the past 9 months from Helen Moss, Plant Collector for the International Plant Genetics Resources Board. Ms. Moss is headquartered in Harare Zimbabwe and collects grass species over much of southern Africa.

In late 1990, three northeastern U.S. Country Clubs (North Hempstead, Port Washington, NY, North Shore, Glenn Head, NY, and Plymouth, Norristown, PA) submitted samples of bermudagrass occurring on their sites. This was facilitated by Mr. Jim Snow. The bermudagrasses have been on the respective clubs for many years and presumably trace to plantings of the U-3 variety made by or on the recommendation of Fred Grau. No other bermudagrasses are believed to have been planted on these courses. The samples from the three sites are morphologically alike and appear to fit the original description of U-3. We will use these along with other U-3 samples from different sources in our efforts to identify pure U-3 and reestablish Breeder and Foundation planting stocks of the variety.

III. RESEARCH PLANNED

Seed-Propagated Varieties. Evaluation of experimental synthetic varieties will be broadened and intensified to determine their potential for release as quickly as possible . In spring 1992, four experimental varieties along with four check varieties will be placed in a study to evaluate several performance characteristics including establishment rate, texture & density, color, fall color retention, spring green-up and overall turf quality. The grasses will be managed under three N levels (2,4, and 6 lb/1000 ft^2/yr) and two cutting heights (0.75 and 1.5 in.). One or more (probably two) of the experimental synthetic varieties will be entered in the NTEP bermudagrass test scheduled for next year. The experimental varieties will also be established in tests at Stillwater, OK and Yuma, AZ to evaluate seed production.

Breeding improvement of the different populations will continue. We will continue: (1) greenhouse phenotypic recurrent selection for refinement of texture, (2) selection for earlier and more prolific seed head production in cold tolerant populations, and (3) selection for increased cold-tolerance in populations derived from common bermudagrass.

Vegetatively-Propagated Varieties. Experimentals in Test 90-1 will continue to be evaluated through next year. A decision will be made during the year on whether to advance some of these to more intensive and broader testing.

Screening of the 3,300 C. transvaalensis progeny including the 589 planted on golf course putting greens in Florida and Georgia will continue. Selection pressure on the 3,300 progenies planted in 1990 on native soil greens will be intensified. Mowing height will gradually be reduced to 0.125 in., allowing expression of tolerant genotypes. We hope that "sorting out" of the genotypes occurs sufficiently over the next 9 months in the various plantings to permit accurate selection of superior ones. Our plans are to identify 30 or fewer superior plants by the end of the 1992 growing season. This will permit their increase in the greenhouse during the winter for inclusion in intensive multi-environment tests in early 1993. Dave Gerken will continue his study of the six C. transvaalensis experimental plants discussed earlier. Also, evaluation of the 589 selections planted on the sand green in July will also continue.

Hybrid plant populations from intra- and inter-specific crosses made in 1991 will undergo initial field evaluation in 1992. These will be space planted in an unreplicated nursery and managed appropriately to permit expression of turf quality.

Cold-Tolerance Research. Testing and refinement of the cold-tolerance laboratory analytical procedures developed by Dr. Anderson will continue. In conjunction with this process will be continued mass screening of breeding populations for cold tolerant genotypes and the characterization of experimental and commercial varieties for relative cold hardiness.

We plan to initiate experiments to determine the basis for differences in winter survival of bermudagrass plants. Such differential survival may be due to differences in tissue cold tolerance or depth of underground buds or both. We propose to conduct field and laboratory experiments to characterize a set of genotypes, selected on the basis of field observed differences in winterhardiness, for root, crown, and rhizome growth characteristics and relate these data to laboratory measurements of cold tolerance. We were unable to begin these experiments in 1991 as planned and mentioned in the last annual report.

Mr. Mark Gatschet, a Ph.D. graduate student in Crop Science, recently began a study of "cold-shock" proteins in bermudagrass. Using Tifgreen and Midiron bermudagrasses, Mark's objectives are to: (1) develop a temperature response curve, (2) determine any differences that exist between the protein compositions of control and cold-acclimated tissues, (3) characterize protein synthetic response to low temperature, and (4) measure correlations of cold shock proteins and cold tolerance.

Table 1. Turf performance ratings of seeded bermudagrass cultivars in Test 89-1, Turf Research Center, Stillwater, OK.[1]

	1991																					
	Spring Greenup[2]							% Cover	Color[2]	Density[2]	Texture[2]	Habit[2]	Uniformity[2]	Turf Quality[2]								
Entry	3/9	3/25	4/2	4/8	4/15	4/22	4/29	5/7	5/8	5/8	5/8	5/8	5/8	5/8	6/3	7/8	7/31	8/20	8/26	9/27	10/18
Numex Sahara	0.3	1.3	2.7	5.0	5.7	8.3	8.3	97	7.7	6.7	8.0	7.7	7.3	7.3	7.0	7.3	7.0	8.0	8.0	7.3	7.7
Common	0.3	1.3	2.7	5.3	6.0	8.3	8.7	100	8.0	6.7	8.3	7.3	8.0	7.7	7.0	8.0	7.7	7.3	6.7	7.3	7.3
Guymon	0.0	1.3	3.0	6.0	7.3	9.0	9.0	100	8.0	7.7	6.7	6.7	7.3	7.3	7.3	7.7	7.7	8.3	7.0	6.3	6.3
OKS-1	1.0	2.0	4.7	7.7	8.3	8.7	9.0	95	7.0	8.0	9.0	8.7	8.3	7.7	7.0	8.7	8.0	6.3	7.3	6.3	7.0
OKS-2	0.3	1.7	3.0	5.0	6.0	8.3	9.0	100	8.3	8.0	6.7	6.3	7.7	7.3	7.3	7.7	7.7	9.0	7.7	7.7	7.3
OKS-3	0.0	1.3	3.0	4.3	6.3	8.0	8.7	100	8.3	7.7	6.7	7.3	7.0	7.0	7.0	7.0	7.3	8.3	7.0	6.3	6.0
OKS-4	0.3	1.0	3.3	5.3	7.0	9.0	9.0	100	8.0	7.7	6.0	6.3	7.0	7.0	7.0	7.3	7.3	8.7	6.7	6.7	6.7
OKS-5	0.0	1.0	3.3	5.0	6.7	8.3	9.0	100	8.0	7.7	6.0	6.7	7.3	7.3	7.0	7.7	8.0	9.0	7.0	7.0	6.7

[1] Test established 6/18/89. Randomized complete block with three replications.

[2] Rated on a scale of 1-9, with 9 being best or greatest. Habit relates to growth characteristic, i.e., upright vs. decumbent.

Table 2. Color retention ratings of seeded bermudagrass cultivars in test 89-1, Block 2, Turf Research Center, Stillwater, OK.[2]

	1990																		
	Color Retention[2]																		
Entry	10/01	10/09	10/17	10/22	10/26	10/29	11/01	11/05	11/09	11/13	11/16	11/20	11/26	11/30	12/03	12/07	12/10	12/13	12/18
Numex Sahara	8.0	8.3	7.7	7.3	4.7	5.7	4.7	4.7	5.3	5.3	5.3	5.3	5.7	3.7	2.3	1.3	1.3	1.0	0.7
Arizona Common	8.0	8.3	7.3	7.3	5.7	5.0	4.7	4.7	4.7	4.0	4.0	4.7	4.7	3.3	2.3	1.3	0.7	0.7	0.3
Guymon	8.7	8.3	8.0	8.0	6.0	5.3	5.3	5.3	5.3	5.3	4.7	5.0	4.7	3.0	1.7	3.0	0.7	0.3	0.0
OKS-1	8.0	8.3	7.7	7.3	6.0	6.3	6.0	6.0	5.7	6.3	6.0	6.3	6.3	4.7	3.3	2.3	1.3	1.3	1.0
OKS-2	9.0	8.7	7.6	7.3	5.3	4.0	3.6	3.6	4.3	4.7	4.3	4.7	4.7	2.7	2.0	1.3	0.3	0.3	0.0
OKS-3	8.0	8.0	7.6	7.0	5.3	4.7	4.0	4.0	4.0	4.3	4.0	4.7	4.7	3.0	2.7	1.0	1.0	0.0	0.0
OKS-4	8.6	8.6	8.0	8.0	5.0	5.3	5.0	4.7	4.3	4.7	4.3	5.0	4.3	2.7	1.7	1.0	0.7	0.3	0.0
OKS-5	8.6	8.6	7.6	7.0	5.0	4.3	4.0	4.0	4.7	5.0	4.3	4.3	4.3	2.7	1.7	1.0	1.0	0.7	0.0

[1] Test established 6/18/89. Randomized complete block design with three replications.

[2] Rated on a scale of 1-9, with 9 being best.

Table 3. Mean performance ratings of seeded- and vegetatively-propagated turf bermudagrasses in Test 90-1, Turf Research Center, Stillwater, OK. 1991.[1]

Entry No.	Strain	Propagation Method	Greenup 3/19	3/25	4/02	4/08	4/15	4/22	4/29	Density 5/08	Texture 5/08	Habit 5/08	Uniformity 5/08	Turf Quality 5/08	6/03	7/01	7/31	8/26	9/27	10/18
1	OKS 90-1	Seed	0.0	1.0	1.5	2.5	3.0	4.0	5.0	2.5	5.5	5.0	5.0	5.5	5.0	5.5	5.5	5.5	5.5	6.0
2	OKS 90-2	Seed	0.0	0.5	1.0	3.0	3.0	3.5	5.0	3.0	6.0	5.0	6.0	5.5	4.0	4.0	4.0	6.5	5.5	5.0
3	OKS 90-3	Seed	0.0	1.0	2.0	2.0	4.0	4.0	6.0	1.0	7.0	4.0	6.0	5.0	4.0	4.0	5.0	5.5	5.0	4.5
4	OKS 90-4	Seed	0.5	2.0	3.0	4.0	4.0	4.0	5.0	3.0	5.5	5.6	6.0	6.0	4.5	4.5	5.0	5.5	5.0	4.5
5	OKS 90-5	Seed	0.0	1.0	2.0	4.0	4.0	5.0	6.0	5.0	5.0	5.0	4.0	5.0	4.0	5.0	5.0	4.0	4.0	4.0
6	OKS 90-6	Seed	0.5	2.5	3.5	4.5	5.5	6.5	7.5	4.0	5.5	5.5	5.5	5.5	5.5	6.0	6.0	5.5	5.0	5.0
7	OKS 90-7	Seed	1.5	3.5	5.0	6.5	7.0	7.0	8.0	5.5	6.5	7.0	7.0	7.0	6.5	7.0	5.5	4.5	5.0	4.5
8	OKS 90-8	Seed	0.5	3.0	4.5	7.0	7.5	8.0	8.5	6.0	5.5	6.0	7.0	6.5	6.5	6.5	6.0	5.5	5.5	5.0
9	OKS 90-9	Seed	0.5	2.5	3.0	4.5	5.5	6.0	7.0	3.5	5.0	5.0	5.5	6.5	5.5	5.0	5.0	5.0	6.0	6.0
10	OKS 90-10	Seed	1.0	1.5	2.5	3.5	3.0	4.0	4.0	3.0	6.0	5.5	5.5	5.5	4.5	4.5	5.5	5.5	5.5	5.5
11	OKS 90-11	Seed	1.5	3.0	4.5	6.5	7.5	8.0	8.0	5.0	6.0	5.5	5.0	5.5	6.0	6.5	6.0	5.0	5.0	5.0
12	OKC 90-1	Sprigs	0.5	2.0	3.5	6.0	6.5	7.0	7.5	7.0	8.5	8.5	7.5	8.0	8.0	8.0	7.5	7.0	6.0	6.5
13	Virginia CC A-12181[2]	Sprigs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	-	-	-	6.0	5.5	6.0	6.0
14	OKC 90-3	Sprigs	1.0	2.5	3.5	6.0	7.0	7.5	8.5	7.0	7.5	7.5	7.5	7.5	7.5	8.0	7.0	6.5	7.0	6.5
15	OKC 90-4	Sprigs	0.5	2.5	4.5	7.0	7.5	8.0	8.5	7.0	7.0	7.0	7.5	7.0	7.5	7.5	7.5	6.0	6.5	7.0
16	OKC 90-5	Sprigs	0.0	1.5	1.5	2.5	3.0	4.5	5.0	5.0	9.0	7.5	7.5	7.0	6.0	5.5	7.0	4.5	6.0	6.5
17	OKC 90-6	Sprigs	0.0	3.0	4.0	6.5	7.5	7.0	7.5	7.0	8.5	8.5	8.0	8.0	7.5	8.0	7.5	7.0	6.5	6.5
18	OKC 90-7	Sprigs	0.5	2.5	4.5	6.5	7.0	7.0	8.0	5.5	8.0	7.0	8.0	7.0	7.0	6.5	7.0	7.0	7.0	6.5
19	OKC 90-8	Sprigs	1.0	4.0	5.5	6.5	7.5	7.5	8.5	6.5	8.0	8.5	8.5	8.0	7.5	8.0	7.0	6.5	6.5	7.0
20	OKC 90-9	Sprigs	1.5	2.0	3.0	5.0	6.5	6.5	7.0	6.0	9.0	9.0	8.0	8.0	7.0	6.5	7.5	6.0	6.5	6.5
21	OKC 90-10	Sprigs	1.5	3.5	4.0	5.5	6.0	6.5	7.5	6.5	9.0	9.0	8.0	8.0	7.0	7.0	7.5	6.0	6.5	7.0
22	OKC 90-11	Sprigs	1.5	2.5	3.5	5.0	6.0	6.0	7.0	6.5	9.0	8.5	8.0	8.0	7.0	7.0	7.5	6.5	6.0	6.5
23	OKC 90-12	Sprigs	2.0	2.5	3.5	5.0	6.0	6.0	7.0	6.0	9.0	9.0	7.5	8.0	7.0	6.5	6.5	5.5	6.5	6.0
24	OKC 90-13	Sprigs	2.0	3.0	4.5	6.5	6.5	7.0	8.0	7.0	9.0	9.0	8.0	8.0	7.0	7.0	6.5	6.5	6.5	6.0
25	OKC 90-14	Sprigs	2.0	3.0	4.0	6.0	6.0	7.0	8.0	7.0	9.0	9.0	8.0	8.0	7.0	7.0	7.0	6.5	6.5	6.0
26	Quicksand Com A-12180	Sprigs	1.5	3.0	4.0	5.5	6.0	6.5	7.5	6.5	7.5	6.0	7.0	6.5	6.0	6.5	7.5	6.5	6.0	6.5
27	Tifton 10	Sprigs	0.0	1.0	1.5	1.5	3.5	3.5	4.5	4.5	6.0	4.5	7.0	6.0	5.5	5.5	6.5	6.0	6.0	5.5
28	Tifgreen	Sprigs	1.0	1.0	2.0	2.5	3.5	4.0	4.5	3.5	9.0	7.5	7.5	7.0	6.0	6.5	6.0	6.0	7.0	7.0
29	Midlawn	Sprigs	0.5	2.0	3.5	7.0	7.0	8.0	8.0	8.0	8.5	8.0	7.5	8.0	7.0	7.0	7.0	6.0	6.0	6.0
30	Midfield	Sprigs	1.0	2.0	4.5	6.0	7.0	7.0	8.0	6.0	8.0	7.0	7.5	7.0	7.0	6.5	7.0	6.5	6.0	7.0

[1] Planted August 13-14, 1990. Randomized complete block with 2 replications. All ratings are on a scale of 1-9, with 9 being best.
[2] Winterkilled and was reestablished June, 1991.

Table 4. Mean color retention ratings of seeded- and vegetatively-propagated turf bermudagrasses in Test 90-1. Turf Research Center, Stillwater, OK. 1990.

Entry No.	Strain	Propagation Method	10/22	10/26	10/29	11/01	11/05	11/09	11/13	11/16	11/20	11/26	11/30	12/03	12/07	12/10	12/13	12/18
1	OKS 90-1	Seed	7.0	6.0	5.0	5.0	4.5	4.5	4.5	4.5	4.5	5.5	5.0	4.5	2.5	2.0	1.0	1.0
2	OKS 90-2	Seed	5.5	4.5	4.5	4.5	4.5	4.5	4.5	4.0	4.0	4.0	4.0	3.0	2.0	2.0	1.5	0.5
3	OKS 90-3	Seed	6.0	5.0	5.0	5.0	5.0	5.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	2.0	1.0	0.5
4	OKS 90-4	Seed	6.0	5.5	5.0	5.0	5.0	5.0	5.0	4.5	4.5	4.5	4.5	4.0	2.5	2.0	1.0	0.5
5	OKS 90-5	Seed	6.0	5.0	4.5	4.5	4.0	4.0	4.0	4.0	4.5	5.0	4.5	3.0	2.0	1.5	1.5	0.5
6	OKS 90-6	Seed	7.0	6.5	5.5	5.5	6.0	5.5	5.5	5.0	5.5	6.0	5.0	4.0	2.5	2.0	1.0	0.0
7	OKS 90-7	Seed	7.0	6.5	6.0	6.0	5.0	5.0	5.0	4.5	5.5	6.0	5.5	4.0	2.5	2.0	1.5	0.0
8	OKS 90-8	Seed	7.5	6.5	5.0	5.0	4.5	4.5	4.5	4.0	4.5	4.5	3.5	3.5	2.0	1.5	1.0	0.0
9	OKS 90-9	Seed	6.0	5.5	4.5	4.5	4.0	4.0	4.0	4.0	4.5	5.0	4.0	3.0	2.0	1.5	1.0	0.0
10	OKS 90-10	Seed	5.5	4.5	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.5	3.5	2.5	2.0	1.5	0.5
11	OKS 90-11	Seed	5.5	5.5	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.5	2.0	2.0	1.0	0.5
12	OKC 90-1	Sprigs	7.0	6.0	6.0	6.0	6.0	6.0	6.0	5.0	5.0	4.5	4.0	3.5	1.0	0.5	0.5	0.0
13	Virginia CC A-12181	Sprigs	7.5	6.5	6.5	6.5	6.0	6.0	6.0	6.0	5.5	5.5	5.0	5.0	3.0	2.5	1.5	1.0
14	OKC 90-3	Sprigs	8.0	7.0	6.5	6.5	5.5	6.0	6.5	6.0	7.0	7.0	6.0	5.0	4.0	3.0	2.5	0.5
15	OKC 90-4	Sprigs	8.5	8.0	7.5	7.5	7.0	7.0	6.5	6.5	7.5	7.5	7.0	5.5	4.5	3.0	2.5	1.0
16	OKC 90-5	Sprigs	7.0	6.5	6.0	6.0	5.5	5.5	5.5	5.5	6.0	6.0	5.5	5.0	4.5	3.5	3.5	3.0
17	OKC 90-6	Sprigs	7.5	6.5	5.5	5.5	5.5	5.5	5.5	4.5	5.5	6.0	5.5	5.5	3.0	2.0	1.0	0.0
18	OKC 90-7	Sprigs	7.5	7.0	6.0	6.0	6.0	6.0	6.0	5.0	5.5	5.5	5.0	4.0	3.5	2.5	1.5	0.5
19	OKC 90-8	Sprigs	8.0	7.5	6.5	6.5	6.0	6.0	6.0	5.5	6.5	6.0	6.0	5.0	4.0	2.5	2.0	0.0
20	OKC 90-9	Sprigs	8.5	7.0	6.0	6.0	6.0	6.0	6.0	5.5	6.5	6.5	6.5	5.5	5.0	3.5	2.5	1.0
21	OKC 90-10	Sprigs	8.0	6.5	6.5	6.5	6.0	6.0	6.0	6.0	6.0	6.5	6.0	5.5	4.5	4.0	3.5	2.5
22	OKC 90-11	Sprigs	7.0	6.0	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.0	5.0	4.0	3.0	3.0	1.0
23	OKC 90-12	Sprigs	8.0	6.5	5.5	5.5	5.0	5.5	5.5	5.5	6.5	7.0	7.0	6.5	5.5	4.0	4.0	2.5
24	OKC 90-13	Sprigs	8.0	6.0	5.5	5.0	5.5	5.0	5.0	5.0	5.0	5.0	5.0	5.0	4.0	3.5	3.0	1.0
25	OKC 90-14	Sprigs	7.5	7.0	6.5	6.5	7.0	7.0	6.0	6.0	7.0	7.0	7.0	6.5	6.0	5.0	4.0	2.0
26	Quicksand Com A-12180	Sprigs	5.0	5.0	4.5	4.5	4.5	4.5	4.5	4.5	5.0	5.0	4.5	4.0	2.5	2.5	2.0	1.0
27	Tifton 10	Sprigs	7.5	7.5	7.0	7.0	6.5	6.5	6.5	6.5	8.0	8.5	7.5	6.0	4.0	3.0	2.5	1.0
28	Tifgreen	Sprigs	7.5	7.0	6.0	6.0	6.0	6.0	6.0	5.5	5.5	5.5	5.0	4.5	4.0	2.5	2.5	2.0
29	Midlawn	Sprigs	7.5	6.5	6.5	6.5	6.5	6.5	6.0	5.5	5.5	6.0	5.0	4.5	3.0	3.0	2.5	1.0
30	Midfield	Sprigs	7.0	7.0	6.5	6.5	6.5	6.5	6.5	6.5	7.5	7.5	7.0	5.0	4.0	3.0	2.5	1.5

Table 5. Research timetable for developing new putting green varieties.

89/90	W	* Selections from breeding nurseries- 3000
	Sp	* Establish and evaluate 3000 selections under putting green maintenance.
Yr 1		
	Su	* Field selection - 500 best plants. Establish and evaluate in Florida nurseries.
	F	
1991	W	* Greenhouse evaluation (Rooting and Drought).
	Sp	
Yr 2	Su	* Field and greenhouse evaluation (Flowering and breeding behavior).
	F	* Greenhouse evaluations (Disease and Drought).
1992	W	* Increase best selections (30 selections).
	Sp	
Yr 3	Su	* Establish and evaluate in 8-10 preliminary variety trials in Florida and Oklahoma.
	F	
1993	W	* Increase best selections (3-5 Selections).
	Sp	* Establish and evaluate final variety trial (30 environments = 15 loc X 2 yr).
Yr 4	Su	
	F	* Evaluate Sod Production Potential.
1994	W	* Greenhouse evaluation (Nutrition).
	Sp	* Establish field increase blocks.
Yr 5	Su	* Cultural practice studies.
		* Establish entire green on golf course in south Florida.
	F	
1995	W	* Compile five year history of best selection and release as a named vegetative variety.
	Sp	

Table 6. Putting green performance ratings for six *Cynodon transvaalensis* selections and Tifgreen and Uganda maintained at two cutting heights. Turf Research Center, Stillwater, OK. 1991.[1]

	Cutting height (ins.)							
Entry	0.125	0.188	0.125	0.188	0.125	0.188	0.125	0.188
	--quality[2]--		--density[2]---		---color[2]---		-ball speed[3]-	
1397	5.75	7.00	5.95	6.90	6.30	7.10	8.08	7.47
1415	6.00	7.25	6.30	7.15	6.30	7.05	7.85	6.90
2387	5.60	6.75	5.95	6.95	6.05	6.86	8.46	7.49
2747	6.80	7.65	7.50	7.85	6.60	7.30	8.06	7.00
2864	6.55	7.60	6.75	7.70	6.30	7.05	8.22	7.38
696	5.75	6.95	6.00	6.85	6.10	7.05	7.92	7.11
Tifgreen	5.40	6.55	6.20	7.15	7.30	8.10	8.04	6.95
Uganda	6.05	7.05	6.30	7.30	4.30	5.00	7.82	6.76

[1] Test established May - 1991; randomized complete block design with split plots and four replications.
[2] Quality, density, and color ratings are on a scale of 1-9 with 9 best. Values are means of five dates and four replications.
[3] Stempmeter measurements in feet. Values are means of four dates and four replications.

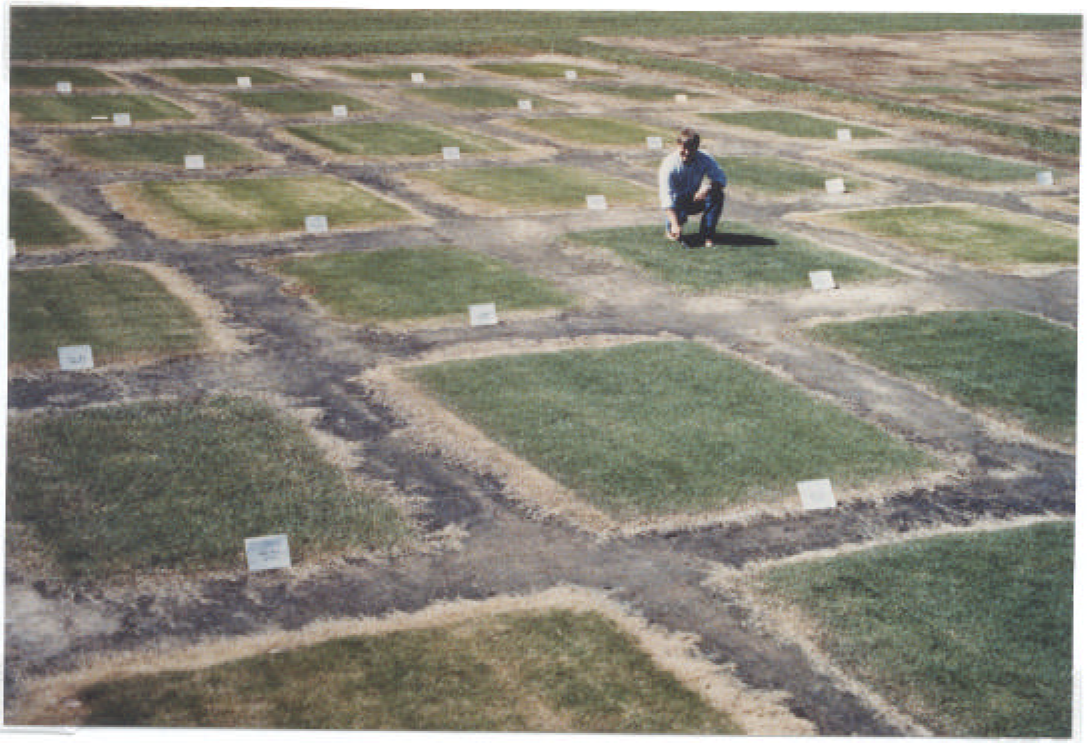
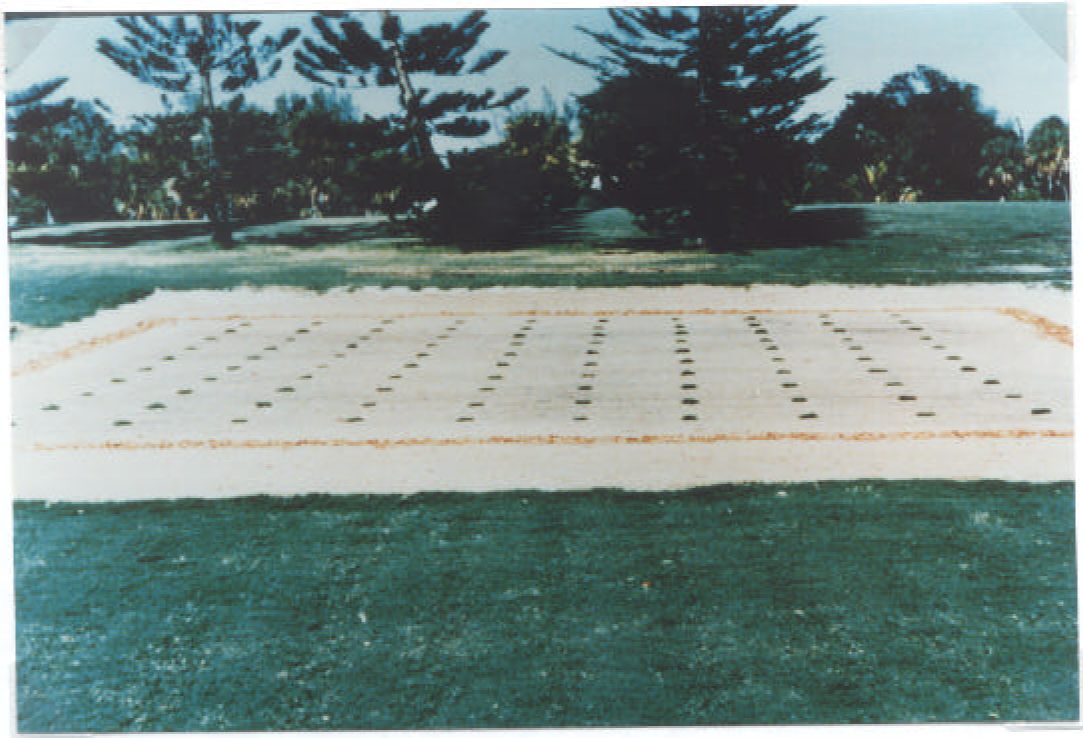
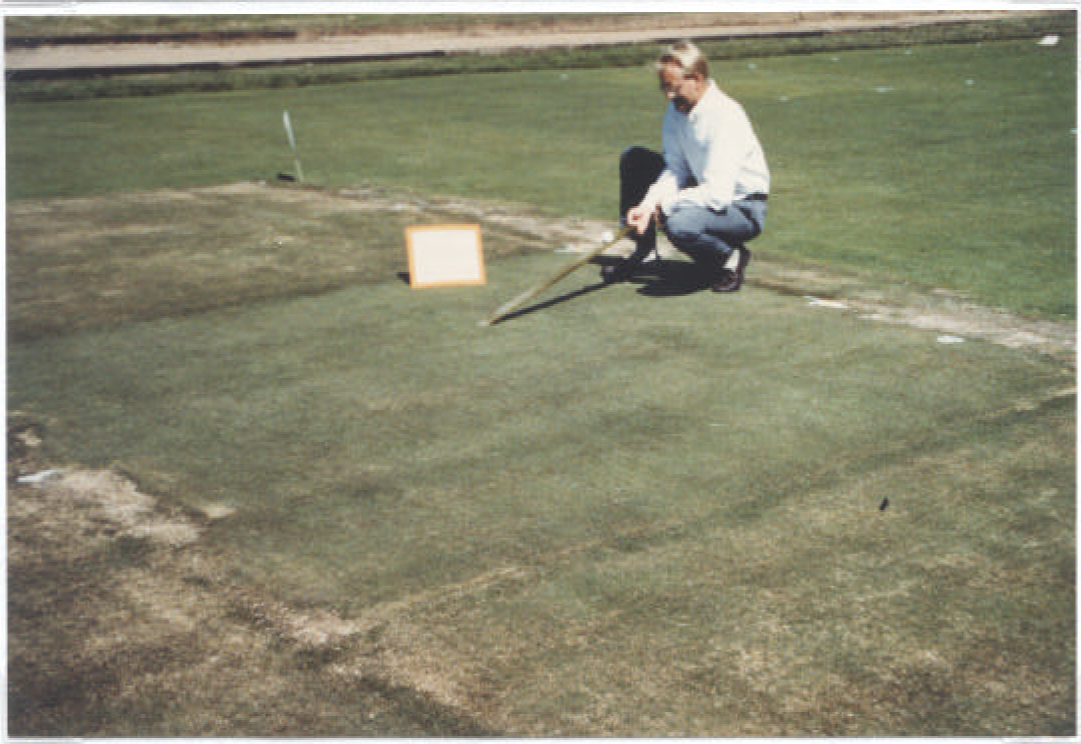


Fig. 1. Seed- and vegetatively-propagated bermudagrass breeding lines under evaluation in Test 90-1, Turfgrass Research Center, Stillwater, OK.

Figs. 2-3. A polycross population of plants (Fig. 2 above) and a single plant in that population (Fig. 3 below) being used in developing seeded, cold-tolerant, fine-textured, turf varieties. These plants were started and selected in the greenhouse for finer texture.



Figs. 4-5. Cynodon transvaalensis selections at time of planting, 10/30/90, (Fig. 4 above) and in January (Fig. 5 below) at the Palm Beach Country Club, Palm Beach, FL.



Figs. 6-7. *Cynodon transvaalensis* selections being evaluated under putting green management and two mowing heights. An overview of the test (Fig. 6 above) shows differences in color due to genotype and cut height. Fig. 7 (below) shows Graduate Student David Gerken taking stimpmeter readings. Photos were taken in mid-September following onset of cool weather which resulted in bermudas going offcolor. Color differences among genotypes demonstrates the variation that exists in the *C. transvaalensis* taxon.