# ANNUAL PROGRESS REPORT

## CONCERNING

## BREEDING AND EVALUATION OF SEEDED COLD-TOLERANT BERMUDAGRASS VARIETIES

## AND

## BERMUDAGRASS VARIETIES FOR GOLF COURSE PUTTING GREENS

For the Period

1 November 1993 -31 October 1994

Submitted by

C. M. Taliaferro
Plant Breeder and Geneticist

D. L. Martin
Turfgrass Science & Extension

J. A. Anderson
Plant Stress Physiologist

Jim Baird
Turfgrass Science

Oklahoma Agricultural Experiment Station
Oklahoma State University

Jointly Sponsored by
United States Golf Association
And
Oklahoma Agricultural Experiment Station

Not for Publication

## EXECUTIVE SUMMARY


The objectives of the Oklahoma State University bermudagrass breeding program are to develop improved seed-and vegetatively-propagated varieties for use in the transition zone and southern states.

Phenotypic recurrent selection (PRS) is continuing in two broad genetic base *C. dactylon* populations, one derived from cold-tolerant relatively infertile germplasm, the other from cold-sensitive highly fertile germplasm. Selection within the cold-tolerant population, $C_{3fer3tex}$, has been for increased seed production potential and finer texture. Selection within the cold-sensitive population ($C_{2ct}$) has been for increased freeze tolerance. An additional cycle of selection was completed within each of the populations over the past year. The $C_{3fer3tex}$ population and synthetic varieties derived from it have demonstrated good cold tolerance and turf quality in multienvironment tests. The seeded experimental OKS 91-11 has performed well in the 1992 NTEP bermudagrass test. Scale-up production has been initiated for two synthetic varieties in preparation for commercialization.

Research with African bermudagrass. *C. transvaalensis*, has demonstrated extensive phenotypic variation within the species for many traits influencing adaptation and turf quality. Development of a genetic population was completed in 1994 that will permit estimation of genetic parameters within the species. Field evaluation of selected African genotypes indicate their major weaknesses to be instability of turf quality and light-green color. In tropical environments the African selections generally maintain good to excellent putting-green turf in winter, but dramatically decline in quality during summer. The decline is less severe in temperate environments. The potential for genetic improvement within the species is indicated by the substantial variation that exists.

Alterations in protein synthesis associated with cold acclimation (CA) have been documented in Midiron and Tifgreen bermudagrasses. Acidic (pi's of ca. 5 to 6) proteins of ca. 34 kD were diminished in crowns of both varieties following CA. Both varieties synthesized cold-regulated (COR) proteins of several size ranges, including ca. 14 to 15 kD, 20 to 28 kD, 32 to 37 kD, and 45 to 55 kD, in association with CA. Midiron crowns synthesized low molecular weight (MW) (ca. 20-28 kD) basic (pi's of ca. 7 to 9) COR proteins in greater numbers and amounts, and intermediate MW (ca. 32 to 37 kD) acidic (pi's of ca. 4 to 6) COR proteins in greater amounts than Tifgreen crowns. Peptide sequence analysis of a prominent 27 kD protein from Midiron crowns indicates it to likely be a chitinase.

## 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 broad 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. 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 for the period 1 November 1993 through 31 October 1994.

## II. RESEARCH PROGRESS

### Breeding Seed-Propagated Varieties.

Two broad genetic base *Cynodon dactylon* populations have been developed using phenotypic recurrent selection (PRS) for seed yield, or turf quality indices, or both. One population designated as $C_{3fer\text{-}3tex}$ was developed from cold-hardy germplasm subjected to three PRS cycles each for increased fertility (% of florets setting seed) and finer texture. The second population, designated as $C_{2ct}$, was developed from cold sensitive germplasm with high seed production potential. This population was developed by initially selecting for seed yield and turf quality among spaced plants growing at Yuma, Arizona followed by two cycles of PRS for increased freeze tolerance. Several synthetic varieties have been synthesized from these populations and are now being evaluated for adaptation and turf performance in tests at Stillwater and other locations. Results from these tests follow.

**Cutting Height x Fertility Trial:** Research was continued in 1994 on the response of 18 bermudagrasses to varying cutting heights and nitrogen fertility regimes. This study is conducted by M.S. Candidate Richard Austin under the supervision of Dr. Dennis Martin. The bermudagrasses in this study were established by seed at the OSU Turfgrass Research Center at Stillwater on July 20 - 24 of 1992. All plots were seeded except for those containing DSM 250, which were established by plugging due to shortage of seed. The soil is a silty clay loam. In spring of 1994 cutting height treatments as well as nitrogen fertilizer treatments were begun. The 8.5 x 17 ft cultivar plots were split into three 4.25 x 5.75 ft subplots, each mowed at 3/8, 1/2 or 1.5 inches 2 - 3 times per week. These cutting heights represented commonly used tee, fairway and rough heights-of-cut on bermudagrass respectively. Mowed subplots were split in half, applying either 3 or 5 lbs of N per 1000 $ft^2$

per year to each subplot. Nitrogen was applied 4 times per year at 0.75 or 1.25 lbs N per 1000 $ft^2$ each time. The experimental design was a randomized complete block with split block application of mowing treatments and an additional split due to fertilizer application. There were three replications in the study. Soil available phosphorus and potassium were maintained at 65 and 250 lbs per acre or greater. A urea formaldehyde (Nutralene, 40-0-0) fertilizer was utilized for nitrogen treatments. Irrigation was performed to supplement natural rainfall and total water received through irrigation and rainfall was monitored and recorded. Visual color and visual quality as well as a visual estimate of seedheads on the plots were measured every two weeks. Additionally, visual density ratings and visual texture ratings were collected one time per month. A divot machine was utilized one time per month in order to create a divot to monitor for recuperative capacity of the grasses. Finally, sample cores for measuring shoots per area and soil cores for measuring root mass distribution were collected two times per growing season and frozen for later analysis. Because of the great amount of time involved in counting individual plants and in washing soil core to retrieve roots, these samples were frozen to allow their analysis during the winter months following the conclusion of the bermudagrass growing season.

Only visual color, quality, density, texture and seedhead ratings had been analyzed at the time of preparation of this report. Additionally, the growing season for bermudagrass had not concluded at the time of preparation of this report. Results presented here should be viewed as preliminary for the 1994 growing season. Season-long mean color ratings are shown in Table 1. Because of the slow and even release of nitrogen from the methylene urea source, very few color rating differences were present under 3 or 5 pounds of nitrogen per 1000 $ft^2$ per year. Only a few subtle differences in color ratings occurred as mowing height increased and this was on a per cultivar basis and not in the form of a general trend. OSU experimentals Ft. Reno 111-1 and BERPC 89-3 as well as Sundevil had the highest color ratings (darkest green color) at the 3/8 and 1/2 inch cuts. These three grasses as well as Guymon had the highest color ratings at the 1.5 inch cut. The seeded African bermudagrass used in this study had the lowest color ratings (more yellow or lighter green). Mean color ratings of several of the entries varied according to cutting height.

Textural ratings are shown in Table 2. Neither cutting height or fertilizer regime had a statistically significant effect on visual texture ratings thus far in 1994. The seeded experimental African bermudagrass was dramatically finer in texture than any of the seeded common bermudagrasses. Other than Sundevil and Guymon being very coarse in texture, very few differences in the other seeded bermudagrasses were present in texture ratings assessed visually in 1994.

Visual density ratings are shown in Table 3. Other than for African bermudagrass, visual density ratings increased as cutting height increased. Visual density ratings were usually equal or slightly larger for bermudagrass grown under 5 lbs of N per 1000 $ft^2$ as compared to 3 lbs of N per 1000 $ft^2$ per year. As shoot counts on plugs sampled from the plots have not been completed for 1994 as yet, no comparison can be made between visual assessment of density and actual quantitative shoot counts. At the 3/8 and 1/2 inch height-of-cut, OSU experimentals BERPC 91-2, Ft. Reno 111-1 as well as commercially available

Jackpot (J-912) were among the seeded common bermudagrasses having the higher visual density ratings. Numerical differences in visual density among cultivars appeared to decrease at the 1.5 in cut as compared to the lower heights-of-cut.

Substantial differences in the mean percent of plots having seedheads were present in the 1994 growing season. Visual estimates of percent seedheads are shown in Table 4. Seedhead production was equal or slightly less under the higher nitrogen regime. Cutting height had no significant effect on seedhead production in 1994. DSM 250, Sonesta and Jackpot had the greatest number of seedheads present on average while African bermudagrass, AZ Common, Poco Verde, Guymon, and BERPC 89-3 had the lowest. Seedhead production of seeded common bermudagrasses under actual golf course conditions will likely be a necessary evil of a successful cold hardy seeded bermudagrass that has adequate seed production potential. Seedhead production under use conditions will likely vary according to geographical region of bermudagrass use. The seedhead parameter collected in this study was in no way intended to be used as an indication of potential seed yield or viability of the seed, but rather as an indication of the effect of seedhead production on the aesthetic performance of the turf. Golfers would likely prefer turfgrasses that produce few to no seedheads.

Overall quality ratings are often the best indication of the long term adaptation of turfgrass to the conditions under which it is being subjected. As expected, quality was statistically higher under the 5 lb as compared to the 3 lb per 1000 $ft^2$ year nitrogen regime. The differences in quality ratings of grasses grown under the two regimes though was very subtle. Cutting height had a much more pronounced effect on cultivar performance (Table 5). Cultivar ranking changed depending upon the height at which it was cut. African bermudagrass provided the highest visual quality ratings at the 3/8 inch height of cut, but at the 1.5 inch height-of-cut its quality declined both numerically and as compared to several seeded common bermudagrasses. BERPC 91-2 and Ft. Reno 111-1 had the highest quality ratings of seeded common bermudagrasses cut at 3/8 and 1/2 inch. The seeded common bermudagrasses having the highest quality ratings at the 1.5 inch cut were BERPC 89-3, BERPC 91-2, C2, Primavera and Tropica. The OSU experimental BERPC 91-2 had consistently high quality ratings across all three cutting heights.

**1992 NTEP Bermudagrass Trial in 1994.** Because of unusual weather conditions in 1992 the NTEP Bermudagrass Trial was not established at Stillwater, OK until 10-11 August 1993. Seeded bermudagrasses were sown at 0.85 lbs of seed per 1000 $ft^2$ while vegetative entries were plugged using 2 inch diameter plugs on 1 foot centers. In the remaining growing season of 1993 the trial was mowed at 3/4 inch, however, it was soon noted that several entries in the trial did not reach this height at their maximum growth, so the cutting heights were altered to be 1/2 and 1.5 inches, representing a fairway/tee height and a rough height-of-cut for bermudagrass, respectively. The trial was fertilized with 5 lbs of N per 1000 $ft^2$ per year and watered to prevent wilting except for a water deficit stress applied at the trial one time per year to obtain wilting ratings on the entries. Establishment rate, late-season color retention, spring green-up, winter-kill, genetic color, density, texture, and overall visual quality were monitored on the study. Data pertinent to the development of cold hardy seeded bermudagrasses are discussed in this report.

OKS91-11 provided statistically better late-season color retention than all other seeded bermudagrasses other than Guymon (Table 6). Guymon had slightly less retention than the OKS91-11. Tifway and Tifway II, which are vegetative entries and traditionally have the best late-season color retention at Stillwater, were statistically better than OKS91-11. Late-season color retention in subsequent seasons should be monitored as juvenility of the turf during the first season often results in better late-season color retention than performance in subsequent seasons.

Due to the late time of establishment (10-11 August) considerable winter-kill occurred among the seeded bermudagrasses in the winter of 1993-1994 (Table 6). Additionally, winter-kill has been a regular problem on Arizona Common as well as other seeded bermudagrass the first season after establishment, even if these grasses are established in May. When winter-kill does occur, it is difficult to separate the role of the components of winter-kill and inherently later spring growth on spring green-up ratings (Table 6). The seeded bermudagrasses Guymon, J-27 and OKS91-11 had statistically less winter-kill than all other seeded bermudagrasses in the trial. The former seeded bermudagrasses had less than 20% winter-kill while all others had over 80% winter-kill.

The best resistance to a single episode of drought resulting in wilting was from the seeded bermudagrasses Mirage, FMC3-91, FMC6-91, Guymon, and J-27 (Table 7). Cheyenne showed the greatest amount of wilting of any of the seeded bermudagrasses in the trial. The hybrid bermudagrasses Tifway and Tifway II suffered more wilting than any seeded bermudagrass.

Guymon, OKS91-11 and Mirage provided the best overall visual quality of any of the seeded bermudagrasses in the NTEP Trial in 1994. Quality ratings in 1994 were largely influenced by the large degree of winter-kill. A judgment on long term performance at the Stillwater site should be with held until subsequent years' data are collected and analyzed. Winter-kill is traditionally worst following the first season after establishment.

Mirage, FMC1-90, FMC2-90, Jackpot, and OKS91-11 had inherently the darkest green color of any of the seeded bermudagrasses (Table 8). Considerable differences in inherent color among the seeded and vegetative bermudagrasses were present in the trial. Guymon and J-27 were statistically more coarse than most other seeded bermudagrasses in the trial (Table 8). Considerable differences in density were present among seeded bermudagrasses in the trial (Table 8.) Winter-kill likely served as a very severe selection pressure for seeded bermudagrass plant survival in our trial. In several instances, only a few plants survived the first winter. However, these few plants were often vigorous and they completely reestablished the test plot during the 1994 growing season. The texture and density of the surviving plants from non-cold hardy seeded bermudagrasses may vary dramatically from the norm of the original population. Thus, great differences in density and texture of a particular seeded entry may occur from test site to test site and even within test sites based on time of seeding during the growing season and severity of the first winter after seeding. This effect of selection pressure should be given strong consideration when comparing data from our site with other NTEP Bermudagrass Trial sites across the country.

The NTEP report of 1993 data from all reporting locations indicated the OKS 91-11 variety to have mean turf quality equalling or exceeding all other seeded varieties in the test (Table 9). Additionally, it has survived well in northern locations demonstrating good freeze tolerance.

**Spring Dead Spot Evaluation**. An experiment was initiated in August 1993 to evaluate the tolerance/resistance of 23 seeded and 3 vegetatively-propagated bermudagrasses to Spring Dead Spot Disease. The bermudagrasses were maintained at a 0.5-inch mowing height, 5 lb N/1000 $^{Ft2}$/year and irrigated to prevent wilting. Dr. Ned Tisserat, Plant Pathologist at Kansas State University, inoculated the bermudagrasses with *Ophiosphaerella herpotricha* on September 24, 1994. Spring green-up, winterkill, visual quality, and color ratings for the bermudagrasses are presented in Tables 10 and 11. These ratings together with Spring Dead Spot disease severity will be taken in upcoming years.

**Summary - Breeding Seed-Propagated Varieties**. The turf performance data presently available indicate synthetic varieties from the cold-hardy breeding population are well adapted to the U.S. transition zone and have turf quality equal to or better than other seeded bermudagrasses. Accordingly, we have initiated scale-up production of two of the synthetics in anticipation of commercial release. The Johnston Seed Company, Enid, Oklahoma, is collaborating in commercialization of these materials. Additionally, Pure Seed Testing, Hubbard, Oregon, is cooperating in evaluating these materials for seed production in the Pacific northwest.

## Breeding Vegetatively-Propagated Varieties

**African Bermudagrass**. African bermudagrass selections from screening trials conducted during 1990-93 in Oklahoma and Florida are included in several tests and observation plantings in several states. Results have been inconsistent, but in general point to deficiencies in the African bermudas which must be overcome. The performance of the African selections in central and south Florida tests and observation plantings fluctuates with season. During the winter they have turf quality equal or superior to Tifdwarf, but dramatically decline in turf quality during the summer months as indicated by 1994 data from Dr. Monica Elliott at Ft. Lauderdale (Table 12). The summer decline in turf quality of the African bermudagrasses appears to be far less severe in transition zone climatic conditions. That good turf quality can be maintained by African genotypes through the summer months was demonstrated in the experiment conducted by graduate student Dave Gerkin during the 1991 and 1992 summers (data previously reported). Results from Mr. Gerken's experiment indicated 1) substantial variation among African genotypes for turf quality indices, 2) superior cold tolerance of African genotypes compared to Tifgreen, 3) ability of the African bermudas to tolerate close mowing (1/8"), 4) superior season-long average turf quality of the best African genotypes compared to Tifgreen, but 5) lighter green, thus less appealing color. The good season-long turf quality maintained by the African selections in Mr. Gerken's test was apparently the result of aggressive fertility and thatch management.

African selection Ctr 2747, the best performer in Mr. Gerken's test, was planted in 1993 on a golf green at a golf course near Comanche, Oklahoma and on a tennis court in Tulsa, OK. First year performance and overwintering were excellent on both sites. Some decline in turf quality occurred during 1994 mid-summer months at both sites, possibly due in part to excess watering and nutrient deficiency. Turf quality at both sites improved significantly in response to decreased watering and increased potash and micronutrient use. Managers at both sites expressed satisfaction with overall performance and indicate that varieties of this type could fill a void.

A field study was initiated at the Turfgrass Research Center in June 1994 to screen recent African bermudagrass selections under putting green conditions. Forty-five *C. transvaalensis* selections, some of which were made from hybrid *C. transvaalensis* x *C. transvaalensis* populations in 1993, in addition to Uganda, Tifdwarf, Tifgreen, and TW72 (Georgia) bermudagrasses were plugged into a sand:peat moss (85:15 v/v) research putting green. The experimental design was a randomized complete block with two replications. Establishment rate, color retention, and growth habit were recorded in 1994 and are presented in Tables 13 and 14. These preliminary data show that the African bermudagrass selections which possess a desirable growth habit for putting greens are slower to establish than Tifgreen bermudagrass but faster than Tifdwarf bermudagrass.

No experiments have been conducted to assess the magnitudes of genetic variation in *C. transvaalensis*. We have observed substantial phenotypic variation for many traits that affect adaptation and turf quality performance. Included among these traits are cold hardiness, growth rate, plant texture, sod density, and color. Significant variation likely exists for many other traits of importance. We completed the development of a genetic population in 1994 which can be used to assess genetic variation in the species and estimate heritabilities of important traits. In 1992, 32 *C. transvaalensis* plants were randomly chosen from our germplasm pool to include in the mating design. Eight plants were randomly assigned to each of four groups, and within each group four plants were randomly chosen to serve as males and the remaining four to serve as females. Within each group, each male was crossed with each female to provide half- and full-sib progeny. Resultant progeny will be started in the greenhouse this winter for field planting next spring.

**Interspecific Crosses.** A major benefit of the work with African bermudagrasses is the development of new genotypes that may be used as parents in crosses with *Cynodon dactylon*. Over the past 3 years we have made numerous such crosses and presently have growing in preliminary screening nurseries some 1200 putative $F_1$ hybrid plants from *C. transvaalensis x C. dactylon* crosses. Twenty-two $F_1$ hybrids selected from the preliminary nurseries were planted in a replicated test in August 94. Additional selections will likely be made from these nurseries next spring for inclusion in another replicated trial. Additionally, over 100 crosses between selected *C. transvaalensis* and *C. dactylon* parents were made in 1994 that will result in several hundred new $F_1$ progeny.

**Tifdwarf Bermudagrass.** Several tissue culture regenerated somaclonal variant Tifdwarf bermudagrass plants, along with six field collected Tifdwarf mutants, and Foundation Tifdwarf were planted on a sand green in an nonreplicated test. Establishment rate, color retention, and growth habit data are presented in Table 15. Establishment rate varied from 10-100% coverage among the Tifdwarf selections 3 months after plugging. Many of these mutants are dwarfed to a much greater extent than is the Foundation Tifdwarf which presumably is the true original mutant. The field data from this test will be used in association with other cytological and morphological data from greenhouse plantings to verify the mutant phenotypes of these plants.

## Germplasm Procurement

Forty-nine bermudagrasses were collected from southern and central China during August/September 1993. Twenty-four accessions were collected as vegetative propagules and are presently in quarantine in USDA facilities in Glenn Dale, MD. Twenty-five accessions were collected as seed and made available to us in late 1993. Plants of these accessions were field planted in 1994.

## Freeze Tolerance Research.

Significant strides have been made in cold hardiness research in bermudagrass over the past 5 years beginning with the development a laboratory procedure to assess relative or absolute freeze tolerance of individual plants. This technique has been used to quantify freeze tolerance differences among turf bermudagrass varieties. More recently, research led by Dr. Mark Gatschet, Research Associate, has provided exciting new information on cold-regulated (COR) proteins of bermudagrass crowns. This research has demonstrated that protein synthesis in crown tissues of Midiron and Tifgreen is altered in association with cold acclimation. Synthesis of COR proteins 14 to 15, 20 to 26, and 32 to 37 kilodaltons (kD) in size was demonstrated in both Midiron and Tifgreen crowns. Synthesis of basic COR proteins of 20 to 26 kD was significantly greater in Midiron than in Tifgreen crowns. The increased synthesis of these proteins in Midiron crowns correlates with it's greater freeze tolerance compared to Tifgreen. One of the most prominent of these COR proteins was recently determined to be a chitinase. Chitinase proteins frequently function in defense against biotic or abiotic stresses and some have been shown to have anti-freeze activity. The identification of cold-regulated chitinases and other defense-related proteins as having antifreeze activity suggests that some defense-related proteins may have dual roles, i.e., in defense against pathogens and in modulating freezing in plant cells. It is possible that these proteins in bermudagrass may function to enhance freeze tolerance and retard diseases such as spring dead spot. The characterization of the many protein alterations in bermudagrass crowns in response to cold acclimation and the identification of one prominent up-regulated protein as a chitinase provides a solid basis for continued research into the fundamental physiological/genetic mechanisms of stress tolerance in bermudagrass. Two manuscripts detailing results from the freeze tolerance research are appended to this report.

## III. RESEARCH PLANNED

**Seed Propagated Bermudagrasses.**

Two experimental synthetic varieties are being scaled-up in production for commercialization. Additional synthetic varieties are being evaluated. The two broad genetic-base populations will undergo additional cyclic selection and new narrow base synthetic varieties will be developed from them. The cutting height x fertility trial conducted by Mr. Richard Austin under the direction of Dr. Dennis Martin will continue in 1994. Shoot counts, root mass distribution and divot recovery data for 1994 should be available for review in the May 1995 report. At the end of the 1995 growing season we will sample for thatch production of the various entries under the various mowing height/ fertility regimes. Richard will likely begin microscopy work in winter of 1995 to examine surface characteristics of the lemma and palea surrounding the seed of bermudagrass. He will be working on some simple seed treatments to improve germination rate of the improved cold hardy common bermudagrasses, building upon the initial work conducted by Dr. Doug Brede and Dr. Mike Kenna while they were at Oklahoma State University.

The 1992 NTEP bermuda trial will be continued through 1996 in order to determine the response of the various bermudagrasses present in the trial to the climatic conditions at Stillwater, OK. This trial provides a unique opportunity to view the performance of commercially available and experimental seeded as well as vegetatively propagated bermudagrasses. Opportunities to monitor the bermudagrass entries for thatch production as well as response to environmental stresses may present them selves over the next few growing seasons. That information pertinent to the seeded bermudagrass breeding and development effort will be discussed in future USGA reports.

**Vegetatively Propagated Bermudagrasses.**

A 5600 $ft^2$ putting green was constructed in 1994 to evaluate Ctr 2747 and Tifgreen bermudagrasses under putting green management conditions. The genotypes will be planted in spring of 1995 in a replicated experiment. The primary objective of this study will be to determine how cultural practices (e.g., verticutting, topdressing, rolling, mowing height, etc.) affect putting surface quality. Additionally, the 45 African genotypes established on a sand green this year (1994) will be subjected to greens maintenance evaluation beginning in spring 1995.

In 1990, approximately 3300 African bermudagrass genotypes were planted on three 7500 $ft^2$ native-soil Blocks and maintained under putting green conditions. Superior genotypes were then selected for further evaluation. Beginning in 1995, the three Blocks will be used to evaluate African bermudagrass: 1) phytotoxicity from new and commonly used pesticides; and 2) response to varying levels of N, P, and K.

Further selection will be made among the approximately 1200 *C. transvaalensis x C. dactylon* $F_1$ hybrid plants now in preliminary evaluation nurseries. The 25 genotypes selected from these nurseries in 1994 and planted in a replicated test will be evaluated under fairway maintenance beginning in 1995. Hybrids from 1994 crosses will be transplanted to field nurseries in spring 1995.

Experiments to estimate genetic variation and heritabilities in *C. transvaalensis* will begin in 1995 using the genetic population earlier described. This population will consist of 64 crosses, with hopefully a minimum of 5 progeny per cross.

Table 1. Season-long mean color ratings of 18 bermudagrasses under 3 cutting heights and 2 nitrogen levels.

| | Color Ratings | | | | | |
|---|---|---|---|---|---|---|
| | 3/8 inch height | | 1/2 inch height | | 1.5 inch height | |
| | Nitrogen per 1000 $ft^2$/yr | | | | | |
| | 3.0 | 5.0 | 3.0 | 5.0 | 3.0 | 5.0 |
| AZ Common | 6.7 | 6.6 | 6.8 | 6.8 | 7.0 | 7.0 |
| BERPC 89-3 | 7.0 | 7.0 | 7.6 | 7.6 | 7.6 | 7.6 |
| BERPC 91-1 | 6.6 | 6.6 | 7.0 | 7.0 | 6.9 | 6.9 |
| BERPC 91-2 | 6.6 | 6.6 | 7.1 | 7.1 | 7.1 | 7.1 |
| BERPC 91-6 | 6.6 | 6.6 | 7.0 | 7.0 | 7.0 | 6.9 |
| C2 | 6.5 | 6.5 | 7.0 | 7.0 | 6.9 | 7.0 |
| Cheyenne | 6.6 | 6.6 | 7.0 | 7.0 | 6.9 | 6.9 |
| DSM 250 | 6.3 | 6.4 | 6.9 | 6.9 | 6.5 | 6.5 |
| Ft. Reno 111-1 | 7.4 | 7.4 | 7.6 | 7.6 | 7.7 | 7.7 |
| Guymon | 6.8 | 6.8 | 7.4 | 7.4 | 7.9 | 7.9 |
| J 912 | 6.7 | 6.7 | 6.9 | 6.9 | 6.8 | 6.8 |
| Poco Verde | 6.5 | 6.5 | 7.0 | 7.0 | 7.0 | 7.0 |
| Primavera | 6.6 | 6.6 | 7.0 | 7.0 | 6.9 | 6.9 |
| Sonesta | 6.5 | 6.5 | 6.9 | 6.9 | 6.7 | 6.7 |
| Sundevil | 7.1 | 7.1 | 7.7 | 7.7 | 7.9 | 7.9 |
| Tropica | 6.6 | 6.6 | 6.9 | 6.9 | 7.0 | 7.0 |
| Seed from U-3 | 6.5 | 6.5 | 6.9 | 6.9 | 6.9 | 7.0 |
| African Bermudagrass | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.6 |
| LSD (0.05) | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |

Color ratings were made on 1 - 9 scale where 9= very dark green and 1= yellow turf.

Table 2. Season-long texture ratings for 18 bermudagrasses in 1994.

| Entry Name | Rating |
|---|---|
| AZ Common | 6.0 |
| BERPC 89-3 | 6.0 |
| BERPC 91-1 | 6.0 |
| BERPC 91-2 | 6.1 |
| BERPC 91-6 | 6.0 |
| C2 | 6.0 |
| Cheyenne | 6.0 |
| DSM 250 | 6.0 |
| FR 111-1 | 5.8 |
| Guymon | 4.5 |
| J 912 | 6.0 |
| Poco Verde | 6.0 |
| Primavera | 6.0 |
| Sonesta | 5.9 |
| Sundevil | 4.8 |
| Tropica | 6.0 |
| Seed from U-3 | 6.0 |
| African Bermudagrass | 9.0 |
| LSD (0.05) | 0.2 |

Texture ratings were made on a scale of 1 - 9 where 1 = very coarse turf and 9 = very fine textured turf.

Table 3. Season-long mean density ratings of 18 bermudagrasses under 3 cutting heights and 2 nitrogen levels.

| | Density Ratings | | | | | |
|---|---|---|---|---|---|---|
| | 3/8 inch height | | 1/2 inch height | | 1.5 inch height | |
| | Nitrogen per 1000 $ft^2$/yr | | | | | |
| | 3.0 | 5.0 | 3.0 | 5.0 | 3.0 | 5.0 |
| AZ Common | 4.9 | 5.0 | 5.7 | 5.7 | 5.9 | 6.5 |
| BERPC 89-3 | 5.4 | 5.4 | 6.1 | 6.1 | 6.4 | 6.5 |
| BERPC 91-1 | 5.3 | 5.3 | 5.7 | 5.8 | 6.2 | 6.3 |
| BERPC 91-2 | 5.6 | 5.9 | 6.3 | 6.5 | 6.6 | 6.6 |
| BERPC 91-6 | 5.3 | 5.4 | 5.8 | 5.9 | 6.1 | 6.6 |
| C2 | 5.1 | 5.1 | 5.6 | 5.5 | 6.5 | 6.6 |
| Cheyenne | 5.3 | 5.4 | 5.9 | 6.0 | 6.3 | 6.5 |
| DSM 250 | 5.1 | 5.5 | 6.1 | 6.0 | 6.1 | 6.5 |
| FR 111-1 | 5.9 | 5.9 | 6.0 | 6.3 | 6.5 | 6.5 |
| Guymon | 4.9 | 4.9 | 5.3 | 5.4 | 6.0 | 6.4 |
| J 912 | 5.6 | 5.7 | 6.3 | 6.3 | 6.5 | 6.5 |
| Poco Verde | 4.6 | 4.7 | 5.1 | 5.2 | 5.9 | 5.9 |
| Primavera | 5.3 | 5.5 | 5.9 | 6.0 | 6.3 | 6.4 |
| Sonesta | 4.6 | 4.7 | 5.2 | 5.3 | 5.5 | 5.8 |
| Sundevil | 4.9 | 5.2 | 5.9 | 6.0 | 6.1 | 6.3 |
| Tropica | 5.1 | 5.2 | 5.7 | 5.6 | 6.4 | 6.6 |
| Seed from U-3 | 4.9 | 4.9 | 5.2 | 5.3 | 5.9 | 6.2 |
| African Bermudagrass | 8.9 | 9.0 | 9.0 | 9.0 | 8.7 | 8.7 |
| LSD (0.05) | 0.7 | 0.7 | 0.8 | 0.8 | 0.7 | 0.5 |

Density ratings were made on 1 - 9 scale where 9= very dense and 1= very open turf.

Table. 4. Percentage of bermudagrass plots covered by seed heads in 1994.

| | Percent Cover<br>lbs of Nitrogen Applied Per 1000 $ft^2$/yr | |
|---|---|---|
| Entry Name | 3 | 5 |
| AZ Common | 6 | 6 |
| BERPC 89-3 | 6 | 6 |
| BERPC91-1 | 13 | 13 |
| BERPC 91-2 | 10 | 10 |
| BERPC 91-6 | 16 | 16 |
| C2 | 7 | 7 |
| Cheyenne | 10 | 9 |
| DSM 250 | 22 | 20 |
| Ft. Reno 111-1 | 9 | 9 |
| Guymon | 7 | 7 |
| Jackpot | 17 | 16 |
| Poco Verde | 7 | 7 |
| Primavera | 11 | 11 |
| Sonesta | 18 | 17 |
| Sundevil | 10 | 10 |
| Tropica | 8 | 8 |
| Seed from U-3 | 8 | 8 |
| African Bermudagrass | 5 | 5 |
| LSD (0.05) | 3 | 3 |

Means are the means across sampling dates in 1994.

Table 5. Seasonal-long mean quality ratings for 18 bermudagrasses as a function of cutting height.

| | Mean Visual Quality Rating | | |
|---|---|---|---|
| | Cutting Height in Inches | | |
| Entry Name | 3/8 | 1/2 | 1.5 |
| AZ Common | 5.0 | 5.5 | 6.1 |
| BERPC 89-3 | 5.1 | 6.1 | 6.4 |
| BERPC 91-1 | 5.0 | 5.6 | 5.8 |
| BERPC 91-2 | 5.5 | 6.4 | 6.4 |
| BERPC 91-6 | 5.1 | 5.5 | 5.9 |
| C2 | 5.0 | 5.8 | 6.4 |
| Cheyenne | 5.2 | 5.8 | 6.2 |
| DSM 250 | 4.9 | 5.8 | 5.6 |
| FR 111-1 | 5.6 | 6.0 | 6.2 |
| Guymon | 4.7 | 5.5 | 6.1 |
| J 912 | 5.2 | 5.6 | 5.7 |
| Poco Verde | 5.0 | 5.1 | 5.6 |
| Primavera | 5.2 | 5.7 | 6.3 |
| Sonesta | 4.4 | 5.0 | 5.2 |
| Sundevil | 5.1 | 5.8 | 6.0 |
| Tropica | 4.9 | 5.4 | 6.3 |
| Seed from U-3 | 4.7 | 5.2 | 5.7 |
| African Bermudagrass | 5.7 | 6.0 | 5.2 |
| LSD (0.05) | 0.7 | 0.7 | 0.7 |

Quality ratings were made using a 1 -9 scale where 9= maximum quality and 1 = very poor quality.

Table 6. Late season color retention in 1993, Spring Greenup in 1994 , and percent winter-kill following the winter of 1993-94 on bermudagrasses in the NTEP Bermudagrass Trial at Stillwater,OK.

| | Late-season Color Retention in 1993 | | Spring Green-up in 1994 | | | % winter-kill |
|---|---|---|---|---|---|---|
| Cultivar | 10/ 22 | 11/2 | 3/22 | 4/13 | 5/2 | 4/21 |
| Mirage* | 4.0 | 3.3 | 1.7 | 2.3 | 4.0 | 87.5 |
| Cheyenne* | 4.0 | 3.3 | 1.0 | 2.0 | 2.0 | 97.6 |
| FBH-135 | 5.3 | 4.7 | 2.3 | 2.3 | 3.7 | 49.4 |
| FMC1-90* | 4.0 | 3.0 | 1.0 | 1.3 | 2.0 | 97.9 |
| FMC2-90* | 4.3 | 3.3 | 1.0 | 2.0 | 2.3 | 97.9 |
| FMC3-91* | 4.0 | 3.0 | 1.3 | 2.0 | 2.3 | 97.9 |
| FMC5-91* | 4.0 | 3.7 | 1.0 | 2.3 | 3.0 | 95.2 |
| FMC6-91* | 4.3 | 3.3 | 1.7 | 2.0 | 3.3 | 95.1 |
| Guymon* | 5.0 | 4.7 | 3.3 | 4.3 | 7.3 | 3.5 |
| J-27* | 4.3 | 4.3 | 3.3 | 4.0 | 5.7 | 7.2 |
| Jackpot* | 4.7 | 3.7 | 1.3 | 2.0 | 3.0 | 94.4 |
| Midfield | 6.0 | 5.7 | 4.3 | 7.0 | 8.3 | 22.9 |
| Midiron | 6.3 | 5.0 | 5.3 | 6.7 | 8.3 | 0.0 |
| Midlawn | 7.0 | 6.0 | 4.3 | 7.0 | 8.7 | 0.0 |
| OKS91-1* | 4.3 | 3.0 | 1.0 | 2.0 | 3.3 | 95.1 |
| OKS91-11* | 5.7 | 5.0 | 3.7 | 3.3 | 5.7 | 15.8 |
| AzCommon | 5.0 | 4.7 | 1.3 | 2.3 | 4.3 | 81.3 |
| AzCommon* | 4.0 | 3.0 | 1.0 | 1.7 | 2.0 | 97.9 |
| STF-1 | 6.7 | 5.3 | 3.3 | 5.7 | 7.7 | 1.4 |
| Sahara* | 4.0 | 3.0 | 1.0 | 1.0 | 2.0 | 97.9 |
| Sonest* | 4.3 | 3.0 | 1.0 | 1.7 | 2.0 | 97.9 |
| Sundevil* | 4.0 | 3.0 | 1.3 | 1.7 | 2.0 | 97.9 |
| Sunturf | 5.7 | 5.3 | 2.7 | 4.7 | 7.0 | 18.8 |
| TDS-BM1 | 5.3 | 5.0 | 4.7 | 7.0 | 8.0 | 2.1 |
| Tifgreen | 5.3 | 5.0 | 4.3 | 6.7 | 8.3 | 0.7 |
| Tifton10 | 5.7 | 5.0 | 3.7 | 5.0 | 8.3 | 0.7 |
| Tifway | 6.3 | 5.7 | 1.7 | 3.3 | 6.3 | 36.8 |
| TifwayII | 7.0 | 6.0 | 2.0 | 3.0 | 5.7 | 30.5 |
| Texturf10 | 6.0 | 5.3 | 2.7 | 3.3 | 5.7 | 9.8 |
| Vamont | 6.3 | 5.7 | 5.0 | 7.0 | 8.7 | 0.0 |
| LSD(0.05) | 0.8 | 0.7 | 0.9 | 1.1 | 1.3 | 26.5 |

Color retention was rated on a 1-9 scale where 1=straw brown and 9=completely green. Green-up was rated on a 1-9 scale where 1=straw brown turf and 9=complete plot area with green cover. Percentage of plot area winter-killed was evaluated using a 64 point intersection grid placed over the plots. Study established 10 and 11 August 1993. Grasses mowed at 1.5 inches.

Table 7. Wilting ratings and visual quality ratings for bermudagrasses in summer of 1994 in the NTEP Bermudagrass Trial at Stillwater, OK in 1994.

| | Wilting Ratings | Visual Quality Ratings | | | | | |
|---|---|---|---|---|---|---|---|
| Cultivar | June 28 | June 14 | July 14 | Aug 31 | Sept 30 | Oct 26 | Ave. 1994 |
| Mirage* | 7.3 | 4.7 | 4.7 | 6.3 | 7.0 | 6.7 | 5.9 |
| Cheyenne* | 4.0 | 2.7 | 3.3 | 5.7 | 5.7 | 5.0 | 4.5 |
| FBH-135 | 4.0 | 3.3 | 3.3 | 3.3 | 4.0 | 5.3 | 3.9 |
| FMC1-90* | --- | 1.3 | 2.3 | 3.7 | 4.3 | 4.7 | 3.2 |
| FMC2-90* | 5.7 | 2.7 | 3.7 | 6.0 | 6.3 | 6.0 | 5.0 |
| FMC3-91* | 7.0 | 2.7 | 3.7 | 5.7 | 7.0 | 6.3 | 5.1 |
| FMC5-91* | 5.7 | 3.3 | 4.3 | 6.0 | 6.3 | 6.7 | 5.3 |
| FMC6-91* | 7.0 | 3.0 | 4.3 | 6.7 | 7.0 | 6.3 | 5.5 |
| Guymon* | 6.7 | 5.3 | 5.3 | 7.0 | 6.0 | 6.3 | 6.0 |
| J-27* | 6.7 | 4.3 | 4.3 | 6.0 | 5.7 | 5.7 | 5.2 |
| Jackpot* | 5.7 | 3.7 | 3.7 | 5.7 | 5.7 | 6.3 | 5.0 |
| Midfield | 5.3 | 6.7 | 6.3 | 7.0 | 7.7 | 6.7 | 6.9 |
| Midiron | 3.7 | 5.7 | 6.3 | 7.0 | 6.7 | 6.7 | 6.5 |
| Midlawn | 2.7 | 6.3 | 6.3 | 7.3 | 8.0 | 7.0 | 7.0 |
| OKS91-1* | 5.3 | 3.7 | 4.3 | 5.3 | 6.3 | 6.0 | 5.1 |
| OKS91-11* | 5.3 | 4.3 | 4.3 | 7.0 | 7.0 | 7.0 | 5.9 |
| AzCommon | 5.0 | 4.3 | 4.3 | 5.7 | 6.0 | 5.7 | 5.2 |
| AzCommon* | --- | 1.7 | 2.0 | 4.0 | 5.0 | 4.3 | 3.4 |
| STF-1 | 6.7 | 5.0 | 5.3 | 6.3 | 6.7 | 7.0 | 6.1 |
| Sahara* | --- | 1.3 | 3.0 | 5.7 | 5.7 | 5.7 | 4.3 |
| Sonest* | 6.0 | 2.3 | 2.7 | 4.3 | 5.0 | 5.0 | 3.9 |
| Sundevil* | 6.0 | 2.0 | 3.3 | 5.3 | 5.7 | 5.7 | 4.4 |
| Sunturf | 4.3 | 7.0 | 7.0 | 8.0 | 8.7 | 8.0 | 7.7 |
| TDS-BM1 | 5.7 | 6.7 | 6.3 | 7.7 | 8.3 | 8.0 | 7.4 |
| Tifgreen | 5.3 | 6.3 | 5.7 | 7.0 | 8.3 | 7.7 | 7.0 |
| Tifton10 | 5.7 | 7.0 | 6.3 | 7.3 | 7.3 | 6.3 | 6.9 |
| Tifway | 1.7 | 5.3 | 5.7 | 7.3 | 8.7 | 8.0 | 7.0 |
| TifwayII | 2.3 | 6.7 | 6.0 | 7.3 | 9.0 | 8.0 | 7.4 |
| Texturf10 | 6.0 | 5.0 | 5.3 | 6.3 | 7.7 | 7.0 | 6.3 |
| Vamont | 8.7 | 5.7 | 5.7 | 6.0 | 7.0 | 6.0 | 6.1 |
| LSD(0.05) | 1.6 | 1.3 | 1.6 | 1.8 | 1.7 | 1.3 | 1.3 |

Wilting ratings were taken visually using a 1-9 rating scale, 1=completely wilted bermudgrass and 9=no visual signs of wilting. At the time of wiliting ratings, some plots had so little cover due to winter-kill that they were unable to be accurately assessed for wilting. Visual quality was assessed using a 1-9 scale where 1=poor quality and 9=maximum bermudagrass quality. Grasses mowed at 1.5 inches. Entries followed by an asterisk are seeded entries whereas those without asterisks were established by plugs.

Table 8. Genetic color, texture and density ratings for bermudagrasses in the NTEP bermudagrass trial at Stillwater, OK in 1994.

| Entry Name | Color | Texture | Density |
|---|---|---|---|
| Mirage* | 8.0 | 5.7 | 6.3 |
| Cheyenne* | 7.0 | 5.7 | 5.7 |
| FBH-135 | 8.0 | 8.0 | 9.0 |
| FMC1-90* | 8.7 | 6.0 | 4.7 |
| FMC2-90* | 8.7 | 6.3 | 6.7 |
| FMC3-91* | 6.3 | 6.3 | 6.0 |
| FMC5-91* | 7.7 | 6.3 | 6.7 |
| FMC6-91* | 6.3 | 6.3 | 7.0 |
| Guymon* | 7.7 | 5.0 | 6.0 |
| J-27* | 7.3 | 4.7 | 5.3 |
| Jackpot* | 8.0 | 6.0 | 6.0 |
| Midfield | 5.3 | 7.0 | 7.0 |
| Midiron | 6.0 | 7.0 | 7.3 |
| Midlawn | 6.7 | 7.0 | 7.7 |
| OKS91-1* | 6.7 | 5.7 | 6.0 |
| OKS91-11* | 8.0 | 6.0 | 6.7 |
| AzCommon | 8.0 | 5.7 | 6.0 |
| AzCommon* | 7.7 | 6.0 | 5.0 |
| STF-1 | 6.3 | 6.7 | 7.0 |
| Sahara* | 8.0 | 6.0 | 5.3 |
| Sonest* | 7.3 | 6.0 | 5.3 |
| Sundevil* | 7.0 | 5.3 | 5.3 |
| Sunturf | 9.0 | 8.0 | 8.0 |
| TDS-BM1 | 7.7 | 8.0 | 8.0 |
| Tifgreen | 6.7 | 8.0 | 8.0 |
| Tifton10 | 7.3 | 6.0 | 7.0 |
| Tifway | 8.3 | 8.0 | 8.0 |
| TifwayII | 9.0 | 8.0 | 8.0 |
| Texturf10 | 8.3 | 6.7 | 7.0 |
| Vamont | 6.3 | 5.3 | 6.7 |
| LSD(0.05) | 1.5 | 0.9 | 1.2 |

Color was rated on a 1-9 scale where 1=yellow turf and 9=dark green. Texture was rated on a 1-9 scale where 1=very coarse texture and 9=very fine texture. Density was rated on a 1-9 scale where 1= very open turf and 9=very dense turf. Grasses mowed at 1.5 inches. Entries followed by an asterisk are seeded entries whereas those without asterisks were established by plugs.

TABLE 9

**MEAN TURFGRASS QUALITY RATINGS OF BERMUDAGRASS (SEEDED) CULTIVARS**
**GROWN AT TWENTY-ONE LOCATIONS IN THE U.S.**
**1993 DATA**

**TURFGRASS QUALITY RATINGS 1-9; 9=IDEAL TURF 1/**

| NAME | AL1 | AR1 | AZ1 | CA2 | CA3 | FL1 | GA1 | GA2 | IL2 | KS2 | KY1 | LA2 | MO2 | MS1 | NE1 | OK1 | TX1 | TX2 | UB1 | VA1 | VA4 | MEAN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OKS 91-11 | 6.3 | 7.3 | 6.8 | 5.4 | 6.0 | 5.5 | 5.3 | 5.0 | 5.5 | 7.2 | 5.7 | 4.8 | 3.8 | 4.6 | 6.5 | 6.0 | 5.7 | 4.2 | 6.2 | 4.9 | 5.1 | 5.6 |
| JACKPOT (J-912) | 6.6 | 7.3 | 5.4 | 5.4 | 5.4 | 5.5 | 5.6 | 4.8 | 5.2 | 7.0 | 5.0 | 5.4 | 3.2 | 5.0 | 4.8 | 7.0 | 5.8 | 5.1 | 6.5 | 5.8 | 5.4 | 5.6 |
| SULTAN (FMC 6-91) | 6.3 | 7.4 | 5.7 | 5.2 | 5.4 | 6.0 | 5.8 | 5.6 | 5.7 | 7.1 | 4.9 | 5.2 | 2.2 | 5.1 | 5.5 | 5.7 | 5.8 | 4.7 | 6.2 | 5.0 | 5.6 | 5.5 |
| J-27 | 5.8 | 6.5 | 6.4 | 5.3 | 5.6 | 5.1 | 5.2 | 4.8 | 4.0 | 7.8 | 6.3 | 5.2 | 4.4 | 4.7 | 5.5 | 5.3 | 5.8 | 5.4 | 5.5 | 5.4 | 5.0 | 5.5 |
| MIRAGE (90173) | 6.2 | 5.8 | 6.0 | 5.2 | 5.4 | 5.9 | 5.8 | 5.2 | 3.8 | 7.3 | 5.9 | 5.5 | 4.3 | 5.0 | 5.0 | 6.0 | 5.6 | 5.1 | 6.0 | 4.8 | 5.1 | 5.5 |
| FMC 5-91 | 5.9 | 6.8 | 5.3 | 5.3 | 5.5 | 5.4 | 5.8 | 5.1 | 5.5 | 7.1 | 4.9 | 4.8 | 2.8 | 4.9 | 5.0 | 7.0 | 5.8 | 4.8 | 4.8 | 4.8 | 5.0 | 5.4 |
| FMC 2-90 | 6.0 | 6.8 | 4.9 | 5.1 | 5.3 | 5.8 | 6.0 | 5.2 | 4.7 | 6.8 | 5.0 | 5.0 | 2.3 | 4.8 | 5.0 | 6.3 | 4.9 | 4.7 | 6.0 | 4.5 | 4.8 | 5.2 |
| GUYMON | 5.8 | 6.0 | 6.1 | 5.3 | 5.4 | 4.9 | 5.9 | 4.8 | 2.4 | 7.3 | 5.5 | 5.2 | 4.6 | 4.6 | 4.7 | 6.3 | 5.8 | 4.7 | 4.7 | 5.0 | 4.8 | 5.2 |
| OKS 91-1 | 6.1 | 6.3 | 5.2 | 4.8 | 5.1 | 5.7 | 5.8 | 5.2 | 4.8 | 6.6 | 4.7 | 4.7 | 3.1 | 4.9 | . | 6.0 | 5.0 | 4.9 | 5.5 | 4.6 | 4.7 | 5.2 |
| FMC 3-91 | 5.7 | 5.7 | 5.8 | 4.9 | 5.4 | 5.5 | 5.6 | 5.0 | 4.6 | 6.3 | 4.7 | 5.3 | 2.1 | 4.6 | 5.0 | 6.0 | 5.5 | 4.9 | 5.7 | 4.3 | 5.1 | 5.1 |
| NUMEX-SAHARA | 6.2 | 6.1 | 5.8 | 4.9 | 5.3 | 5.6 | 5.6 | 5.1 | 5.0 | 6.2 | 4.8 | 5.2 | 1.9 | 4.6 | 4.8 | 6.0 | 5.2 | 4.3 | 5.5 | 4.0 | 4.8 | 5.1 |
| SUNDEVIL | 6.0 | 5.8 | 5.4 | 5.1 | 5.3 | 5.6 | 5.7 | 5.3 | 4.4 | 6.6 | 4.9 | 4.6 | 2.9 | 4.8 | 4.5 | 6.3 | 5.1 | 4.5 | 5.5 | 4.1 | 4.8 | 5.1 |
| SONESTA | 5.7 | 5.8 | 5.7 | 5.0 | 5.2 | 5.9 | 5.4 | 4.3 | 5.2 | 6.3 | 4.3 | 5.0 | 2.0 | 4.8 | 5.3 | 6.3 | 5.2 | 4.7 | 5.2 | 4.2 | 4.5 | 5.0 |
| PRIMAVERA (FMC 1-90) | 5.4 | 5.8 | 4.8 | 4.9 | 5.3 | 5.1 | 5.5 | 5.1 | 4.5 | 6.1 | 4.5 | 4.6 | 1.9 | 4.6 | 5.3 | 6.3 | 4.9 | 4.9 | 5.2 | 4.2 | 4.7 | 4.9 |
| CHEYENNE | 5.2 | 5.8 | 5.2 | 4.9 | 5.2 | 5.4 | 5.7 | 4.5 | 4.3 | 5.4 | 3.9 | 4.3 | 2.6 | 4.8 | . | 6.0 | 4.8 | 4.5 | 6.0 | 3.5 | 4.3 | 4.8 |
| ARIZONA COMMON-SEED | 5.5 | 5.3 | 5.1 | 4.7 | 5.1 | 5.5 | 5.6 | 5.3 | 4.1 | 6.2 | 3.8 | 4.4 | 2.8 | 4.7 | 4.5 | 6.0 | 4.7 | 4.1 | 5.5 | 3.2 | 4.3 | 4.8 |
| LSD VALUE | 0.6 | 0.8 | 1.0 | 0.2 | 0.3 | 0.5 | 0.9 | 0.8 | 1.1 | 0.8 | 0.5 | 0.5 | 1.5 | 0.4 | 1.3 | 0.9 | 0.5 | 0.6 | 0.5 | 1.0 | 0.5 | 0.2 |

Table 10. Spring green-up ratings and winterkill of bermudagrass varieties in the spring dead spot evaluation test, Turfgrass Research Center, Stillwater, OK.

| | Spring Greenup | | Winterkill(%) | |
|---|---|---|---|---|
| Genotype | 3/22/94 | 4/13/94 | 5/2/94 | 4/21/94 |
| BERPC 91-12 | 5.33 | 5.67 | 7.67 | 13.20 |
| BERPC 91-13 | 5.33 | 4.33 | 6.00 | 46.23 |
| Midlawn | 5.00 | 7.00 | 6.00 | *----- |
| BERPC 89-3 | 5.00 | 5.67 | 7.67 | 22.80 |
| Sundevil | 4.67 | 4.33 | 6.33 | 33.53 |
| BERPC 91-3 | 4.67 | 4.67 | 6.00 | 48.80 |
| BERPC 91-4 | 4.33 | 4.67 | 7.67 | 28.10 |
| Guymon | 4.33 | 4.67 | 7.67 | 14.50 |
| Ft. Reno | 4.00 | 4.00 | 7.33 | 38.97 |
| African Bermuda | 3.67 | 5.33 | 7.67 | 13.67 |
| Midfield | 2.67 | 6.00 | 6.67 | *----- |
| Tifton 10 | 2.67 | 4.67 | 6.00 | *----- |
| BERPC 91-6 | 2.00 | 2.33 | 4.67 | 79.17 |
| Cheyenne | 1.67 | 2.00 | 2.67 | 94.00 |
| 91173 | 1.67 | 2.67 | 5.67 | 60.17 |
| 91180 | 1.67 | 2.00 | 3.00 | 94.47 |
| BERPC 91-2 | 1.33 | 2.33 | 3.67 | 83.87 |
| Arizona Common | 1.00 | 1.00 | 2.00 | 98.00 |
| C 2 | 1.00 | 1.00 | 2.00 | 97.90 |
| NuMex Sahara | 1.00 | 1.67 | 2.00 | 97.97 |
| Poco Verde | 1.00 | 1.00 | 2.00 | 97.60 |
| Primavera | 1.00 | 1.33 | 2.00 | 97.97 |
| Sonesta | 1.00 | 1.67 | 2.00 | 97.93 |
| BERPC 91-1 | 1.00 | 2.00 | 2.33 | 93.57 |
| J 912 | 1.00 | 2.00 | 3.00 | 92.10 |
| Tropica | 1.00 | 1.00 | 2.00 | 94.87 |
| LSD | 0.81 | 1.19 | 1.27 | 20.38 |
| CV | 18.56 | 22.11 | 16.56 | 18.51 |

Greeup ratings were on a scale of 1-9, with 9 being best.
* Winterkill ratings were not taken for plots that were plugged.

Table 11. Visual quality and color ratings of bermudagrass varieties in the spring dead spot evaluation test, Turfgrass Research Center, Stillwater, OK.

| | Visual Quality | | | Color |
|---|---|---|---|---|
| Genotype | 6/6/94 | 7/11/94 | 9/15/94 | 9/15/94 |
| Midfield | 6.33 | 6.33 | 8.00 | 7.00 |
| African Bermuda | 6.00 | 6.67 | 7.33 | 6.33 |
| Tifton 10 | 5.33 | 6.33 | 8.00 | 7.00 |
| Midlawn | 5.33 | 6.00 | 7.00 | 6.33 |
| BERPC 91-6 | 4.67 | 5.67 | 6.67 | 7.00 |
| Guymon | 4.33 | 5.67 | 6.33 | 6.00 |
| 91173 | 4.00 | 5.67 | 7.00 | 7.00 |
| BERPC 91-3 | 4.00 | 5.00 | 7.00 | 6.67 |
| Ft. Reno | 4.00 | 5.67 | 7.67 | 7.00 |
| BERPC 91-4 | 4.00 | 5.67 | 7.33 | 7.00 |
| BERPC 91-13 | 3.67 | 5.67 | 7.00 | 7.00 |
| BERPC 91-12 | 3.67 | 5.67 | 7.00 | 6.33 |
| BERPC 91-2 | 3.67 | 6.00 | 7.33 | 7.00 |
| BERPC 89-3 | 3.67 | 5.67 | 7.33 | 7.00 |
| 91180 | 3.33 | 5.67 | 6.33 | 7.00 |
| BERPC 91-1 | 3.00 | 5.33 | 6.33 | 7.00 |
| Cheyenne | 3.00 | 5.33 | 6.00 | 7.00 |
| Sundevil | 2.67 | 5.67 | 7.33 | 7.00 |
| J 912 | 2.67 | 5.00 | 6.33 | 6.67 |
| Sonesta | 2.33 | 4.33 | 6.00 | 7.00 |
| Arizona Common | 2.00 | 3.33 | 5.67 | 7.00 |
| Tropica | 2.00 | 4.00 | 6.33 | 7.00 |
| Poco Verde | 2.00 | 3.67 | 6.00 | 7.00 |
| NuMex Sahara | 1.67 | 2.67 | 6.00 | 6.67 |
| C 2 | 1.67 | 3.33 | 5.67 | 7.00 |
| Primavera | 1.67 | 3.67 | 5.67 | 7.00 |
| LSD | 1.19 | 1.08 | 0.68 | 0.55 |
| CV | 20.93 | 12.80 | 6.20 | 4.93 |

Ratings were on a scale of 1-9, with 9 representing best.

Table 12 Quality scores of bermudagrass selections on FGCSA Research Green at the Fort Lauderdale Research and Education Center (May-September 1994).

| Selection[a] | May 4[b] | May 17 | June 6 | June 20 | July 5 | July 27 | Aug 16 | Sept 8 |
|---|---|---|---|---|---|---|---|---|
| Tifdwarf | 6.750 | 6.625 | 6.500 | 4.375 | 6.500 | 6.125 | 6.375 | 7.000 |
| Tifgreen | 5.875 | 5.500 | 5.375 | 3.375 | 4.750 | 5.000 | 3.500 | 3.500 |
| Quality | 7.000 | 6.750 | 6.626 | 5.250 | 6.750 | 6.375 | 6.250 | 7.000 |
| Classic | 6.750 | 6.500 | 6.375 | 5.000 | 6.500 | 6.125 | 5.875 | 6.375 |
| TW72 | 6.750 | 6.625 | 6.125 | 4.375 | 6.375 | 6.000 | 6.250 | 6.000 |
| T596 | 6.750 | 6.375 | 6.500 | 4.625 | 6.250 | 6.000 | 6.000 | 6.500 |
| CTR 1111 | 5.125 | 4.750 | 5.750 | 4.125 | 4.750 | 4.250 | 3.500 | 3.125 |
| CTR 2352 | 5.000 | 4.500 | 5.500 | 3.750 | 4.500 | 4.000 | 3.750 | 3.375 |
| CTR 2570 | 4.500 | 3.875 | 3.375 | 2.500 | 2.875 | 2.750 | 2.625 | 2.375 |
| CTR 3048 | 4.125 | 4.250 | 4.875 | 3.625 | 4.000 | 4.000 | 4.000 | 3.250 |
| CTR 2747 | 4.875 | 4.375 | 4.750 | 3.500 | 4.250 | 3.625 | 3.500 | 2.875 |
| Height[c] | 0.188 | 0.188 | 0.188 | 0.180 | 0.180 | 0.160 | 0.160 | 0.170 |

[a]Tifdwarf and Tifgreen obtained from Foundation material in Athens, GA. Quality and Classic Tifdwarf-type grasses obtained from sod producers in Florida. TW72 (Tifway mutant) and T596 (Tifdwarf mutant) obtained from Dr. Wayne Hanna, USDA, Tifton, GA. CTR 1111-2747 are *C. transvaalensis* selections obtained from Dr. Charles Talifarro, Oklahoma State University.

[b]Quality scores based on color and density using a scale of 1 (poor quality) to 10 (best quality). Values presented are means of four replicate plots. No statistical analysis have been performed on data. Two people (Marcus Prevatte and myself) rate the plots and our scores are then averaged for each plot.

[c]Plots are cut six days per week with a Toro walk-behind greens mower. For reference, 3/16 inch equals 0.188 inch and 5/32 inch equals 0.156 inch.

Table 13. Growth rate as indicated by percent plot cover of African bermudagrasses and check varieties planted June 2 and 3, 1994. Turf Research Center, Stillwater, OK.

| | Percent Cover | | | | |
|---|---|---|---|---|---|
| Genotype | 7/21/94 | 7/29/94 | 8/5/94 | 8/17/94 | 9/22/94 |
| OKC 90-10 | 60.00 | 62.50 | 87.50 | 100.00 | 100.00 |
| Tifgreen | 52.50 | 50.00 | 67.50 | 95.00 | 100.00 |
| OKC 90-13 | 45.00 | 52.50 | 67.50 | 97.50 | 95.00 |
| OKC 90-16 | 42.50 | 42.50 | 57.50 | 90.00 | 97.50 |
| 1111 | 37.50 | 50.00 | 60.00 | 90.00 | 97.50 |
| 27-12 | 37.50 | 42.50 | 55.00 | 90.00 | 92.50 |
| 2420 | 37.50 | 45.00 | 52.50 | 85.00 | 95.00 |
| 26-5 | 37.50 | 40.00 | 55.00 | 85.00 | 100.00 |
| 27-3 | 35.00 | 42.50 | 60.00 | 87.50 | 100.00 |
| 27-11 | 35.00 | 40.00 | 55.00 | 77.50 | 97.50 |
| 223 | 32.50 | 42.30 | 47.50 | 80.00 | 92.50 |
| OKC 90-14 | 32.50 | 37.50 | 55.00 | 80.00 | 92.50 |
| Uganda | 32.50 | 37.50 | 50.00 | 87.50 | 95.00 |
| 1946 | 32.50 | 37.50 | 52.50 | 85.00 | 97.50 |
| 1202 | 30.00 | 42.50 | 60.00 | 87.50 | 95.00 |
| 1120 | 30.00 | 40.00 | 52.50 | 72.50 | 92.50 |
| 1943 | 27.50 | 37.50 | 47.50 | 85.00 | 90.00 |
| 2462 | 27.50 | 35.00 | 47.50 | 75.00 | 90.00 |
| 25-9 | 27.50 | 37.50 | 45.00 | 75.00 | 95.00 |
| 21-4 | 27.50 | 35.00 | 45.00 | 75.00 | 97.50 |
| 2352 | 27.50 | 37.50 | 50.00 | 75.00 | 92.50 |
| 2570 | 25.00 | 37.50 | 45.00 | 67.50 | 92.50 |
| 2302 | 25.00 | 40.00 | 50.00 | 72.50 | 92.50 |
| 1264 | 25.00 | 35.00 | 47.50 | 75.00 | 92.50 |
| Fiddlesticks | 25.00 | 37.50 | 50.00 | 82.50 | 95.00 |
| 1228 | 22.50 | 35.00 | 45.00 | 62.50 | 85.00 |
| 24-8 | 22.50 | 35.00 | 45.00 | 65.00 | 90.00 |
| TifTW72 | 22.50 | 30.00 | 40.00 | 42.50 | 67.50 |
| 2747 | 22.50 | 32.50 | 45.00 | 70.00 | 90.00 |
| 2306 | 22.50 | 35.00 | 45.00 | 75.00 | 92.50 |
| 2107 | 22.50 | 37.50 | 52.50 | 77.50 | 90.00 |
| 3048 | 22.50 | 32.50 | 47.50 | 75.00 | 92.50 |
| 21-2 | 22.50 | 32.50 | 40.00 | 52.50 | 72.50 |
| 2946 | 20.00 | 32.50 | 42.50 | 65.00 | 87.50 |
| 24-10 | 20.00 | 32.50 | 42.50 | 62.50 | 90.00 |
| 22-3 | 20.00 | 32.50 | 45.00 | 57.50 | 75.00 |
| 24-7 | 20.00 | 30.00 | 45.00 | 65.00 | 95.00 |
| 26-7 | 20.00 | 30.00 | 40.00 | 55.00 | 75.00 |
| 25-1 | 20.00 | 32.50 | 45.00 | 65.00 | 92.50 |
| 25-6 | 20.00 | 35.00 | 45.00 | 70.00 | 92.50 |
| 2849 | 20.00 | 35.00 | 47.50 | 72.50 | 95.00 |
| 798 | 20.00 | 32.50 | 42.50 | 65.00 | 90.00 |
| 2718 | 17.50 | 32.50 | 42.50 | 60.00 | 90.00 |
| 2552 | 17.50 | 27.50 | 40.00 | 60.00 | 80.00 |
| 22-4 | 17.50 | 30.00 | 42.50 | 52.50 | 80.00 |
| 18-10 | 17.50 | 27.50 | 40.00 | 45.00 | 72.50 |
| Tifdwarf | 17.50 | 27.50 | 42.50 | 40.00 | 65.00 |
| 27-2 | 17.50 | 32.50 | 42.50 | 50.00 | 72.50 |
| 26-2 | 15.00 | 30.00 | 40.00 | 45.00 | 75.00 |
| | | | | | |
| LSD | 14.19 | 9.45 | 11.94 | 20.10 | 16.29 |
| CV | 26.06 | 12.74 | 12.08 | 13.90 | 9.06 |

Table 14. Color retention ratings of African bermudagrasses and check varieties planted June 2 and 3, 1994. Turf Research Center, Stillwater, OK.Block 9 South

| Genotype | Color Retention 9/22/94 | Growth Habit 10/11/94 |
|---|---|---|
| 1111 | 9.00 | 5.00 |
| 1120 | 9.00 | 5.50 |
| 1202 | 9.00 | 5.50 |
| 1228 | 9.00 | 5.50 |
| 2420 | 9.00 | 5.00 |
| 223 | 9.00 | 5.50 |
| 25-1 | 9.00 | 4.50 |
| 2306 | 9.00 | 6.50 |
| Fiddlesticks | 9.00 | 6.50 |
| OKC 90-10 | 9.00 | 4.50 |
| OKC 90-13 | 9.00 | 4.00 |
| 22-3 | 9.00 | 5.50 |
| 22-4 | 9.00 | 5.00 |
| 27-3 | 9.00 | 4.50 |
| 2302 | 9.00 | 6.50 |
| 27-12 | 9.00 | 4.50 |
| 2352 | 9.00 | 5.50 |
| 26-2 | 9.00 | 5.50 |
| 2570 | 9.00 | 6.50 |
| Tifgreen | 9.00 | 5.50 |
| 26-5 | 9.00 | 5.00 |
| 27-11 | 9.00 | 4.50 |
| OKC 90-16 | 9.00 | 4.50 |
| 2946 | 8.50 | 6.00 |
| 2462 | 8.50 | 4.50 |
| 21-4 | 8.50 | 5.50 |
| 2718 | 8.50 | 7.50 |
| 24-8 | 8.50 | 5.50 |
| Uganda | 8.50 | 4.00 |
| 24-10 | 8.50 | 5.00 |
| 1943 | 8.50 | 5.00 |
| 1946 | 8.50 | 5.50 |
| 1264 | 8.50 | 7.00 |
| 2747 | 8.50 | 7.50 |
| Tifwarf | 8.50 | 7.00 |
| 2849 | 8.50 | 5.50 |
| 26-7 | 8.00 | 5.00 |
| TifTW72 | 8.00 | 6.50 |
| 24-7 | 8.00 | 5.00 |
| OKC 90-14 | 8.00 | 5.00 |
| 2107 | 8.00 | 6.00 |
| 2552 | 8.00 | 7.00 |
| 3048 | 8.00 | 6.00 |
| 25-6 | 7.50 | 5.00 |
| 27-2 | 7.50 | 5.50 |
| 18-10 | 7.50 | 6.50 |
| 798 | 7.00 | 5.50 |
| 21-2 | 6.50 | 6.00 |
| 25-9 | 6.00 | 6.50 |
| | | |
| LSD | 1.01 | 1.14 |
| CV | 5.90 | 10.25 |

Table 15. Growth rate as indicated by percent plot cover of Tifdwarf mutant plants planted June 2 and 3, 1994. Turf Research Center, Stillwater, OK.1994 Rating Date

| | 1994 Rating Date | | | | | | |
|---|---|---|---|---|---|---|---|
| Genotype | 7/21 | 7/29 | 8/5 | 8/17 | 9/22 | 9/22 | 10/19 |
| 14-2 | 10.00 | 15.00 | 25.00 | 5.00 | 10.00 | 9.00 | 7.00 |
| 15-5 | 10.00 | 10.00 | 20.00 | 5.00 | 15.00 | 9.00 | 7.00 |
| 20-5 | 20.00 | 20.00 | 40.00 | 55.00 | 85.00 | 9.00 | 7.00 |
| 14-10 | 25.00 | 25.00 | 35.00 | 50.00 | 85.00 | 9.00 | 7.00 |
| 14-13 | 30.00 | 30.00 | 45.00 | 90.00 | 100.00 | 9.00 | 7.00 |
| 15-3 | 15.00 | 15.00 | 25.00 | 10.00 | 20.00 | 9.00 | 7.00 |
| 14-11 | 25.00 | 25.00 | 30.00 | 40.00 | 75.00 | 9.00 | 7.00 |
| 14-5 | 15.00 | 15.00 | 20.00 | 15.00 | 15.00 | 8.00 | 7.00 |
| 15-13 | 10.00 | 10.00 | 15.00 | 5.00 | 10.00 | 9.00 | 7.00 |
| 15-2 | 15.00 | 15.00 | 20.00 | 5.00 | 15.00 | 9.00 | 7.00 |
| 15-7 | 15.00 | 20.00 | 20.00 | 10.00 | 20.00 | 9.00 | 7.00 |
| 15-4 | 15.00 | 15.00 | 20.00 | 10.00 | 15.00 | 8.00 | 7.00 |
| 15-1 | 10.00 | 10.00 | 15.00 | 15.00 | 10.00 | 9.00 | 7.00 |
| 15-9 | 10.00 | 10.00 | 20.00 | 10.00 | 15.00 | 8.00 | 7.00 |
| 14-4 | 10.00 | 15.00 | 20.00 | 10.00 | 20.00 | 9.00 | 7.00 |
| 15-6 | 15.00 | 20.00 | 30.00 | 40.00 | 65.00 | 8.00 | 7.00 |
| Foundtif | 20.00 | 20.00 | 25.00 | 45.00 | 80.00 | 9.00 | 7.00 |
| 15-11 | 15.00 | 15.00 | 20.00 | 10.00 | 20.00 | 9.00 | 7.00 |
| 15-8 | 15.00 | 15.00 | 20.00 | 10.00 | 20.00 | 8.00 | 7.00 |
| 14-12 | 20.00 | 25.00 | 25.00 | 45.00 | 75.00 | 9.00 | 7.00 |
| 15-10 | 15.00 | 15.00 | 20.00 | 15.00 | 15.00 | 8.00 | 7.00 |
| 14-1 | 15.00 | 15.00 | 20.00 | 15.00 | 25.00 | 8.00 | 7.00 |
| 14-3 | 15.00 | 20.00 | 30.00 | 20.00 | 30.00 | 8.00 | 7.00 |
| 14-9 | 20.00 | 20.00 | 25.00 | 45.00 | 80.00 | 9.00 | 7.00 |
| 14-6 | 20.00 | 20.00 | 25.00 | 25.00 | 30.00 | 9.00 | 7.00 |
| 14-8 | 20.00 | 25.00 | 30.00 | 40.00 | 65.00 | 9.00 | 7.00 |
| 20-4 | 15.00 | 15.00 | 25.00 | 65.00 | 90.00 | 9.00 | 7.00 |
| 15-12 | 10.00 | 10.00 | 20.00 | 20.00 | 20.00 | 8.00 | 7.00 |