

**ANNUAL PROGRESS REPORT**  
**BREEDING SEED - AND VEGETATIVELY - PROPAGATED**  
**TURF BERMUDAGRASSES**  
**FOR**  
**GOLF COURSES**

For the Period

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## EXECUTIVE SUMMARY

The turf bermudagrass breeding program at Oklahoma State University seeks to develop improved seed- and vegetatively-propagated cultivars for the transition zone. Specific goals of the project are to: 1) assemble and evaluate *Cynodon* germplasm accessions for important descriptors, 2) improve bermudagrass breeding populations for seed production potential and traits conditioning turf performance, and 3) identify bermudagrass parental plants with superior combining ability for use in producing inter- and intra-specific F<sub>1</sub> hybrids.

Recurrent selection (RS) for turf performance traits was continued in broad genetic base *C. dactylon* populations in 1998-99. RS in these populations has increased turf quality, transition zone adaptation, and seed production potential. Seed of 'OKS 91-11', a cold tolerant variety for the upper south, is expected to be available in limited quantity in year 2000. The experimental synthetic seeded variety 'OKS 95-1' had turf quality equal to that of Tifway and Tifgreen in the 1997 NTEP trials for test year 1998. Additional plants were selected in 1998-99 from RS breeding nurseries to generate new populations. The most elite of these selected plants were used as parents in six new field polycrosses established in 1999 to generate experimental synthetic varieties.

Intra- and inter-specific crosses were made to generate F<sub>1</sub> progeny populations for evaluation as potential vegetatively-propagated hybrid turf bermudagrass cultivars. Approximately 2,000 F<sub>1</sub> hybrid progeny from crosses made in 1998 were transplanted into field nurseries in spring 1999 for initial screening. Evaluations of F<sub>1</sub> hybrids planted in screening nurseries in 1997 and 1998 continued through 1999. Plants from these nurseries will be selected in early spring 2000 for inclusion in replicated performance trials. Fifty F<sub>1</sub> hybrid plants, selected over the past 4 years, are now in various stages of evaluation in replicated mowing studies. Additional fertile hybrids derived from  $2n = 6x = 54$  chromosome *C. dactylon* x  $2n = 2x = 18$  chromosome *C. transvaalensis* crosses have been obtained. These tetraploid ( $2n = 4x = 36$  chromosome) plants have one full genome (9 chromosomes) from *C. transvaalensis* and three full genomes (27 chromosomes) from *C. dactylon*. Open-pollinated and hybrid progeny from these plants have shown desirable turf characteristics.

## INTRODUCTION

The turf bermudagrass breeding program at Oklahoma State University is jointly sponsored by the United States Golf Association and the Oklahoma Agricultural Experiment Station. The broad goal of the program is to develop fine-textured, cold-tolerant, seed- and vegetatively-propagated varieties for the transition zone. Supporting objectives of the project are to: 1) assemble and evaluate *Cynodon* germplasm accessions for important descriptors, 2) improve bermudagrass breeding populations for seed production potential and traits conditioning turf performance, and 3) identify bermudagrass parental plants with superior combining ability for use in producing inter- and intra-specific F<sub>1</sub> hybrids.

## BREEDING AND EVALUATION

### Breeding Seed-Propagated Varieties

We continued recurrent selection (RS) for finer texture and increased seed yield in broad genetic base *Cynodon dactylon* populations. One population was developed from cold-hardy germplasm subjected to RS for increased fertility (% of florets setting seed) and finer texture. The second population 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. A new breeding population was developed in 1994 from *C. dactylon* germplasm collected from the Peoples Republic of China in 1993. Recurrent selection nurseries were grown in 1998 in which putative superior plants were identified on the basis on seed set, turf quality, and adaptation. The plants are evaluated for up to 3 years. Each year the breeding nurseries containing the plants are allowed to set seed, then for the duration of the growing season they are mowed at three-fourth inch height in order to assess turf quality. This management and duration of time facilitates selection of plants that develop and maintain the best turf quality while allowing simultaneous selection for seed production characteristics. Assessment of plants for a minimum of 2 years following the year of establishment is necessary to identify plants with performance stability. Differences among plants in performance characteristics, particularly stand retention, are often not expressed for 2-3 years following establishment.

Experimental varieties have been synthesized from the broad base breeding populations at various stages of cyclic development and evaluated for turf performance and adaptation characteristics. The cold-hardy, seed-propagated, strain OKS 91-11, evaluated in the 1992-96 NTEP trial, was officially released in January 1997. Seed is expected to be marketed in year 2000. Selections were made in summer 1998 from 500 spaced plants of OKS 91-3 for the purpose of enhancing turf quality and uniformity. OKS 91-3 was the best of several synthetic varieties tested by Bob Carrow at Griffin, GA. A more recent synthetic, OKS 95-1, offers better adaptation to the southeastern US and higher turf quality than previous products

of this program. OKS 95-1 had a mean (19 locations) turf quality rating (6.6) in 1998 not significantly different from Tifgreen and Tifway (both 6.5). It was significantly greater than all seeded varieties except Princess (6.4) in turf quality. Preliminary results indicate it to be slightly less cold-hardy than OKS 91-11, but substantially more cold hardy than Arizona Common and similar types. Its performance in the 97 NTEP bermudagrass trial at Stillwater is discussed on following pages. Scale up plantings of the parental clones of OKS 95-1 are in place. More information on seed production potential is needed, but trial plantings are in place in Oklahoma, Arizona and California. Our plans are to release the variety at the earliest possible date if test data continue to be positive.

Overall, recurrent selection within broad genetic-base, seeded bermudagrass populations has, over the past 10 years, refined them to the point of acceptable turf quality. Attainment of this threshold level of performance in turf quality and adaptation in these populations will permit new varieties to be developed at an accelerated rate. Continued RS will incrementally improve the populations and the varieties developed from them. Six field polycross nurseries were established in spring 1999 to generate seed of new synthetic varieties. We feel that the program is now at the stage where new varieties can be developed and entered into commercial channels following the Rutgers model.

#### **Breeding Vegetatively-Propagated Varieties**

We continued to use African bermudagrasses, *C. transvaalensis*, selected for adaptation and turf quality features, extensively in crosses with *C. dactylon* tetraploid plants. Approximately 2,000 F<sub>1</sub> progeny plants were transplanted to a preliminary screening nursery in spring 1999. We have produced from 1,000 to 2,000 such hybrids during each of the past 6 years. In 1997, 32 hybrid plants were selected from screening nurseries established in 1995. These hybrid plants were established in a replicated fairway height mowing test on the Turf Research Center. Performance data are given later in this report. Performance notes were taken in 1999 on hybrids in screening nurseries established in 1997 and 1998. Final selections will be made in early spring 2,000 for inclusion in a replicated fairway performance test at the Turf Research Center.

The F<sub>1</sub> hybrid 'OKC 18-4' had a top rating of 6.6 in the 1997 NTEP bermudagrass test for 1998 data. This variety is a candidate for release, though additional information is needed on cold hardiness and sod strength. OKC 18-4 appears to have turf quality advantage over Tifway in spring and summer, but not during the fall. Its decline in turf quality in fall relative to Tifway is due to seedhead formation and somewhat lower retention of fall color.

As mentioned in previous reports, we feel that advances in producing superior F<sub>1</sub> hybrids are due to the development and identification of superior parents, both *C. transvaalensis* and *C. dactylon*. African bermudagrasses like '2352', '2567', '2570', and '3048' were the best of some 500 plants screened in tests on golf courses in the early 1990's. They have been used extensively as parents in crosses to selected *C. dactylon* parents. Elite

*C. dactylon* parents from the recurrent selection breeding populations and from germplasm procurement have added to the overall quality of triploid hybrids produced. *C. dactylon* plants producing superior F<sub>1</sub> hybrids when crossed with the African parents were Q27774 from Australia, PRC-7 from China, and open-pollinated offspring of Texturf 10. Plants developed through interspecific hybridization and subsequent breeding are also now paying dividends. Many of the F<sub>1</sub> plants selected over the past 3 years for advancement to replicated performance trials trace to a parent designated as '320OW 41-8'. The 320OW 41-8 plant is an F<sub>1</sub> hybrid from the cross of an African (*C. transvaalensis*, 2n = 2x = 18 chromosomes) plant with 'Tifton 10' (*C. dactylon*, 2n = 6x = 54 chromosomes). The 320OW 41-8 plant has 2n = 4x = 36 chromosomes, presumably comprises of one genome (9 chromosomes) from the African parent and 3 genomes (27 chromosomes) from the 'Tifton 10' parent.

### 1999 EVALUATIONS

#### Seeded Bermudagrass Herbicide Tolerance.

In summer/fall of 1999, M.S. Candidate Brian Scroggins began screening of Oklahoma State University seeded selections OKS 91-11 and OKS 95-1 at Stillwater, OK for tolerance to 1 and 2 X label rates of commonly used post-emergent herbicides. The purpose of this work was to determine tolerance of these grasses to the normal label rate as well as to an over application of several mainstream post-emergent herbicides. Herbicides included 2, 4-D, Trimec Classic, Confront, MSMA, Sencor, Image, and Manage. Two duplicate studies were established in June (simulating a golf course fairway at 1.3 cm (0.5 in) height) from seed and were treated beginning in August, with the other study treated in September. Turf response variables monitored included weekly clipping yield, as well as phytotoxicity and quality response. Analysis of data is not complete as yet. Preliminary results indicate no ultra sensitivity of these seeded grasses to normal label rates of these management herbicides.

In a related area, research conducted during 1991-1993 on tolerance of newly seeded bermudagrass to commonly used pre-emergent herbicides was presented in January 1999 at the Southern Weed Science Society meetings in Birmingham, AL. An abstract was published on this work: Martin, D.L., C.C. Evans, and D.D. Dobson. 1999. Effects of pre-emergent herbicides on newly seeded common bermudagrass. 1999 Proc. So. Weed Sci. Soc. 52:248-249.

#### Response of OKS 91-11 to Application of Primo L (Trinexapac-ethyl)

M.S. Candidate Brian Scroggins began screening the response of OKS 91-11 seeded bermudagrass at Stillwater, OK to applications of 0.25, 0.5, 0.75, 1.0, 1.5 and 2.0X label rates of Primo Liquid (Trinexapac-ethyl) growth regulator in summer of 1999. The purpose of this work was to determine OKS 91-11 response to normal use rates as well as over applications of Primo growth regulator. Two studies were conducted, one study on OKS 91-11 grown at a 1.3 cm (0.5 in) and the other at a 3.8 cm (1.5 in) height of cut. These studies simulated fairway and rough/lawn type conditions. Phytotoxic response as well as turf quality and clipping yield were monitored on a weekly basis with shoot density sampled every 2 weeks. Analysis of data is not complete as yet. Preliminary results indicated no ultra

sensitivity of OKS 91-11 to normal label rates of this plant growth regulator, which is commonly used on golf course fairways.

### **Spring Dead Spot and General Field Performance Evaluation of Seeded Bermudagrasses.**

In summer of 1995 field plots of OKS 91-11, Jackpot and Mirage were seeded at Stillwater, OK for the purpose of a general field evaluation of these grasses under simulated fairway, and rough/lawn conditions. At the time, Mirage and Jackpot were two of the best commercially available seeded bermudagrasses that OKS 91-11 would have to compete against in the marketplace if it were to be commercialized. Additionally, response of these bermudagrasses to spring dead spot disease caused by *Ohiosphaerella herpotricha* isolate KS 188 was conducted. Spring dead spot disease is one of the most severe disease of bermudagrass in transition zone climates. The pathogen *Ohiosphaerella herpotricha* is the most common cause in Kansas, Oklahoma and north Texas. Results of this 1995-99 work are presented in manuscript format in the appendix. The manuscript is currently in departmental review and will be submitted to Crop Science in late 1999. The results of our spring dead spot research will be presented at the 1999 American Society of Agronomy meetings in Salt Lake City, UT. Golf course superintendents and grounds managers in Kansas were alerted to the projected release of OKS 91-11 in year 2000 during the 2 Dec. 1998 presentation: "Brrr-It's cold up here!" by D.L. Martin, Bermudagrasses for Kansas, 48<sup>th</sup> Annual Kansas Turfgrass Conference, Kansas Expocenter, Topeka, KS, Audience size 230.

### **1997 NTEP Bermudagrass Trial**

The Oklahoma State University Turfgrass Research Center is one of several test sites for the 1997 NTEP bermudagrass trial. GN-1 and OKS 91-11 were included at our site in addition to official entries. The trial is maintained at 1.3 cm (0.5 in), fertilized with 240 kg N ha<sup>-1</sup> yr<sup>-1</sup> (5 lbs N 1,000 sq. ft.) and irrigated to simulate a golf course fairway within the region. Standard response parameters of visual color, visual quality, visual density, greenup, visual texture, and winterkill are measured as well as recovery from divoting. Additionally, the study was inoculated with *O. herpotricha*, *O. korrae*, and *Leptosphaeria narmari* in fall of 1997 using a technique described in the attached manuscript on spring dead spot resistance. Spring dead spot disease development was still in the initial phases in early 1999 and no results are presently available.

In the following discussion, Oklahoma State University entries will be compared with industry standard vegetative or seeded types in use within the region. OKC 18-4 demonstrated slightly slower greenup in 1999 (Table 1) than industry standards of Tifsport, Tifway and Midlawn. OKC 19-9 had equal or slightly faster greenup than Tifsport and Tifway. OKS 91-11 and OKS 95-1 seeded bermudagrasses demonstrated equal or slightly faster greenup than other seeded bermudagrasses in the trial. OKS 91-11 and OKS 95-1 exhibited better genetic color ratings than Mirage and Jackpot (Table 2) and a rating equivalent to Princess. OKC 18-4 was the darkest green entry in the trial, not significantly

different from Shanghai. OKC 19-9 ranked statistically lower in color rating than OKC 18-4, higher than many cultivars and not less than Shanghai.

OKC 19-9 received a mean texture rating equivalent to that of Tifsport and Tifway, while all three grasses had slightly finer texture than OKC 18-4 (Table 3). OKS 91-11, OKS 95-1 and Princess had equivalent textural ratings, with all three grasses demonstrating finer texture than the remaining seeded bermudagrasses in the trial. OKC 18-4 and OKC 19-9 had the same density as Tifsport and Tifway in spring, with both grasses providing slightly less dense turf than Tifsport and Tifway in summer (Table 4). By fall, OKC 19-9 had density equivalent to Tifsport and Tifway, with all three grasses exhibiting higher density than OKC 18-4. The density of OKS 91-11, OKS 95-1 and Princess were the highest among seeded bermudagrasses in the spring summer and fall. No significant differences among these three bermudagrasses occurred during the year.

OKC 18-4 provided visual quality equal or exceeding that of Midlawn on all rating dates in 1999 (Table 5). The same was true of OKC 19-9 compared to Midlawn except on one date when quality of OKC 19-9 was less than that of Midlawn. The quality of Tifsport and Tifway did not differ from each during 1999. OKC 19-9 demonstrated quality equal to that of Tifsport and Tifway on 4 dates and quality lower than these two grasses on 2 dates in 1999. OKC 18-4 provided quality better than Tifsport on 1 date, quality equal to Tifsport on 3 dates and quality less than that provided by Tifsport on 1 date. Compared to Tifway, OKC 18-4 provided quality equal to Tifway on 3 dates and less than Tifway on 3 dates in 1999. The visual quality of OKS 91-11 and OKS 95-1 always exceeded that of Jackpot and Mirage in 1999. Significant differences in quality between the OKS selections was not present, however, OKS 95-1 provided slightly numerically higher ratings on select dates. OKS 95-1 provided quality equal to that of Princess. Princess providing quality higher than OKS 91-11 on only 1 date, with quality being equal on all other dates. Few difference in living cover were present among OKC and OKS selections and the respective industry standards (Table 6).

Divot recovery was measured at 1, 1.5, 2, 4 and 6 weeks after divoting (WAD). In general, the 2WAD ratings were indicative of recovery potential, so only 2WAD are presented for the sake of brevity. OKS 95-1 generally recovered equally or more rapidly from divoting than most other seeded bermudagrasses (Table 7). OKS 95-1 demonstrated a faster recovery rate than OKS 91-11. GN-1 demonstrated the most rapid recovery following divoting. In general, OKC 19-9 and OKC 18-4 recovered more rapidly from divoting than Tifsport, Tifway and Midlawn.

### **Fairway bermudagrass Evaluation Trial**

Thirty-one F1 hybrids between *C. dactylon* and *C. transvaalensis* selected from field space planting were established at the OSU Turfgrass Research Center at Stillwater, OK in summer of 1997. The trial is maintained under simulated golf course fairway conditions with mowing at 1.3 cm (0.5 in), fertilization at 240 kg N ha<sup>-1</sup> yr<sup>-1</sup> (5 lbs N 1,000 sq. ft.) and regular irrigation. Tifway, Midlawn, and Tifsport were included as standards for the region. GN-1 was also included because of superintendents' growing interest in this grass. Standard

performance parameters of greenup, color, texture, density, visual quality, and winterkill are being monitored. Additionally, divot recovery ratings are being made. The trial was inoculated in Sept. 1997 with a blend of three *O. herpotricha* isolates from Oklahoma.

Spring dead spot (SDS) symptoms were present on only four entries in 1999 and no significant differences were present in terms of SDS patch size (Table 8). A substantial amount of winterkill occurred at the test site in 1998-99 (Table 8). GN-1 suffered the greatest amount of winterkill of any commercially available grass in the trial. Several Oklahoma experimental selections suffered substantial winterkill as well. Midlawn, long known for its cold hardiness, suffered some of the smallest amount of winterkill of any entry in the trial. The winterkill ratings will allow us to eliminate some of the many experimental entries in the trial from the pool of possible candidates for more intensive evaluation.

Midlawn provided the most rapid greenup of any commercial entry in the trial (Table 8), with experimental entries OKC 74-3 and OKC 78-10 providing green up and winterkill ratings similar to Midlawn.

Substantial variation in mean color, texture and density ratings are shown for entries in Tables 9-11 respectively. Most experimental clonal selections had mean color, texture and density ratings equaling or exceeding that of Midlawn.

Substantial variation in mean quality ratings occurred among entries. One of the most promising OKC entries exhibiting consisting high visual quality ratings in addition to having acceptably fine texture, early spring greenup, dark green color and only a small amount of winter kill was OKC 78-18.

No significant differences were seen among entries with respect to the living ground cover that they offered in spring, summer or fall of 1999 (Table 13). Despite substantial winter kill of the above ground shoots of GN-1, this grass recovered extremely rapidly once optimal growing conditions came about. GN-1 usually provided the most rapid rate of recovery following divoting (Table 14) whereas Midlawn was one of the slowest cultivars to recover from divoting. OKC 70-18 provided an intermediate rate of divot recovery, whereas other apparently winter hardy experimental OKC selections such as OKC 74-3 and OKC 78-10 tended to be some of the slowest entries to recover from divoting. Extremely rapid lateral growth of bermudagrass while being beneficial from a divot recovery standpoint can pose problems for the superintendent from the standpoint of bermudagrass encroachment into putting greens. For this reason, it is the author's opinion that a number of bermudagrasses need to be identified which have a variety of recuperative/encroachment capacities. Very rapid recovery is desirable on teeboxes because of heavy use, limited area over which to spread wear, and ease of thatch management on a limited area. On fairways where course design has lead to a surface area that appropriately matches the amount of play, less aggressive growth is needed so that mowing frequency may be reduced and thatch management practices do not become overbearing due to large expanses of fairways. The areas surrounding putting greens need to have adequate recuperative capacity while not having excessive encroachment tendencies since bermudagrass encroachment is a serious problem on bentgrass putting greens.



### **Fairway/Teebox Bermudagrass Trial at Oklahoma City Golf and Country Club.**

A trial of several OSU experimental bermudagrasses was planted in 1997 on a high sand content area at Oklahoma City Golf and Country Club. The area is being managed under simulated teebox and fairway conditions by Mr. Craig Elms, Superintendent. Midlawn and Tifway were included as standards as well as several Oklahoma State Univ. experimental selections, specifically OKC 19-9 and OKC 18-4 among others. To date, OKC 18-4 has provided the best quality in the trial, equaling or exceeding that of Tifway on all sampling dates (data not shown). It is anticipated that the trial will be discontinued in 2000, as other entries in the trial have proven to be less than promising. It is hoped that a future trial with newer experimental varieties can be initiated at the OCG&CC site in late 2000 or early 2001.

### **PLANNED 2000 EVALUATIONS**

#### **Seeded Bermudagrass Herbicide Tolerance**

The post-emergent herbicide tolerance studies on OKS 91-11 and OKS 95-1 will be repeated again in 2000. We anticipate presentation of the results at the 2001 Southern Weed Science Society meetings and publication of the results in *Weed Technology* in late 2001.

#### **Response of OKS 91-11 to Application of Primo**

The growth regulator tolerance studies on OKS 91-11 will be repeated again in 2000. We anticipate presentation of the preliminary results at the Jan. 2000 Southern Weed Science Society meetings and publication of the final results in *Weed Technology* in late 2001.

#### **Response of OKC 18-4 to Application of Primo and Commonly Used Post-emergent Herbicides**

Once the 1999 national data package has been made available for the 1997 NTEP bermudagrass trial, a decision will be made on whether to more intensively evaluate OKC 18-4 for potential commercial release. Should the national data package of OKC 18-4 remain positive relative to existing industry standards, a trial examining the response of this selection to applications of labeled and super labeled rates of Primo growth regulator and commonly used post-emergent herbicides would occur.

#### **Spring Dead Spot and General Field Performance Evaluation of Seeded Bermudagrasses.**

This research will be continued to determine when disease severity subsides on the three cultivars in this studies. Severity has continued to increase during the first three years of the study. Additionally, this study contains some of the oldest OKS 91-11 plots in the region. We would like to continue general field performance evaluations for as long as the plots remain free of contamination.

**1997 NTEP Bermudagrass Trial**

Continued monitoring of general field performance, winterkill, divot recovery and response to spring dead spot inoculation will be continued in 2000.

**Fairway Bermudagrass Evaluation Trial**

Continued monitoring of general field performance, winterkill, divot recovery and response to spring dead spot inoculation will be continued in 2000.

**Field Demonstration**

Cooperation with Mr. David Gerken at Oklahoma State University at Oklahoma City has lead to the development of large demonstration plots of bermudagrasses popular to the region. The demonstration contains U-3, Midlawn, Tifway, Tifsport, Jackpot, and Mirage as commercial standards for fairway use in the region. Mr. Gerken has been very cooperative in allowing OSU at Stillwater personnel to make suggestions concerning grasses for demonstration on the 5-hole golf facility at OSU in Oklahoma City. The area will also show case the OSU experimental bermudagrasses OKC 18-4, OKS 95-1 as well as the new seeded release OKS 91-11. It is critical to emphasize that the Oklahoma City facility is a teaching and demonstration facility and not a research facility. The demonstration will allow superintendents from throughout the region to view large plots of the best-adapted bermudagrasses in a convenient location. No USGA funding is being spent on this particular demonstration.

**Sod Strength Trial**

Once the 1999 national data package has been made available for the 1997 NTEP bermudagrass trial, a decision will be made on whether to more intensively evaluate OKC 18-4 for potential commercial release. Should the national data package of OKC 18-4 remain positive relative to existing industry standards, a trial examining sod production potential of the vegetatively propagated OKC 18-4 would occur.

Table 1. 1999 Spring Greenup Ratings From the NTEP Bermuda Trial at Stillwater, OK.

Cultivar	Spring Greenup Ratings <sup>1</sup>			
	03-25-99	04-01-99	04-06-99	04-12-9
AZ Common	2.0	2.6	3.3	4.6
Blackjack	2.0	2.0	3.6	5.0
Bluemuda	2.0	2.6	3.6	5.0
Cardinal	2.6	4.6	6.0	7.6
CN2-9	1.3	2.0	2.6	4.6
GN-1	1.6	2.0	2.0	3.6
J-1224	1.6	2.3	3.6	5.0
J-540	2.0	2.6	3.3	5.0
Jackpot	2.6	3.0	4.0	5.0
Majestic	2.0	2.3	3.6	4.6
Midlawn	3.0	3.6	5.0	6.3
Mini-verde	1.0	1.0	1.6	3.6
Mirage	2.0	2.3	3.6	5.0
NuMex Sahara	2.0	2.6	3.6	4.6
OKC 18-4	1.0	1.0	2.3	4.3
OKC 19-9	2.0	2.3	4.0	6.3
OKS 91-11	3.0	4.0	4.3	6.0
OKS 95-1	2.6	3.0	4.0	5.6
Princess	1.3	1.3	2.0	4.0
PST-R69C	1.6	2.0	3.0	5.0
Pyramid	2.0	2.6	3.3	4.6
Savannah	2.0	2.3	3.0	4.6
Shanghai	1.3	1.6	2.3	4.0
Shangri La	1.6	2.6	3.0	4.3
Sundevil	1.6	2.3	3.3	4.6
SW1-11	1.3	1.3	1.3	3.3
SW1-7	2.0	2.3	3.3	5.0
Tifgreen	1.3	2.0	3.0	5.6
Tifsport	1.0	2.0	2.6	5.0
Tifway	1.3	2.0	3.6	6.0
LSD(p=0.05)	0.6	0.7	0.8	0.8

<sup>1</sup>Greenup was rated on a 1-9 scale, where 1=straw colored and 9=complete greenup.

Table 2. 1999 Color Ratings From the 1997 NTEP Bermuda Trial at Stillwater, OK.

Cultivar	Color Ratings <sup>1</sup>
	05-17-99
AZ Common	6.6
Blackjack	6.3
Bluemuda	6.6
Cardinal	5.0
CN2-9	7.6
GN-1	7.6
J-1224	7.0
J-540	6.3
Jackpot	6.3
Majestic	6.6
Midlawn	7.0
Mini-verde	7.6
Mirage	6.3
NuMex Sahara	6.6
OKC18-4	8.3
OKC19-9	7.6
OKS91-11	7.3
OKS-95-1	7.0
Princess	7.0
PST-R69C	6.6
Pyramid	6.6
Savannah	6.6
Shanghai	8.0
Shangri La	6.6
Sundevil	6.3
SW1-11	6.6
SW1-7	6.6
Tifgreen	7.0
Tifsport	7.0
Tifway	7.0
LSD(p=0.05)	0.70

<sup>1</sup>Color ratings were made on a 1-9 scale, where 1=straw colored and 9=dark green.

Table 3. 1999 Texture Ratings from the 1997 NTEP  
Bermuda Trial at Stillwater, OK.

Cultivar	Texture Ratings <sup>1</sup>
	10-14-99
AZ Common	5.0
Blackjack	5.3
Bluemuda	5.0
Cardinal	8.3
CN2-9	8.0
GN-1	6.6
J-1224	5.6
J-540	5.6
Jackpot	5.6
Majestic	5.6
Midlawn	7.6
Mini-verde	9.0
Mirage	5.3
NuMex Sahara	5.0
OKC 18-4	7.0
OKC 19-9	8.0
OKS 91-11	7.0
OKS 95-1	7.0
Princess	7.0
PST-R69C	6.0
Pyramid	5.6
Savannah	5.6
Shanghai	5.3
Shangri La	5.3
Sundevil	5.6
SW1-11	5.6
SW1-7	5.6
Tifgreen	8.0
Tifsport	8.0
Tifway	8.0
LSD	0.6

<sup>1</sup>Texture ratings were made on a 1-9 scale, where 1=coarse texture and 9= very fine texture.

Table 4. 1999 Density Ratings From The 1997 NTEP Bermuda Trial at Stillwater, OK.

Cultivar	Density Ratings <sup>1</sup>		
	05-17-99	08-16-99	10-14-99
AZ Common	6.0	5.3	5.0
Blackjack	6.0	6.0	5.6
Bluemuda	6.3	6.0	5.0
Cardinal	8.0	7.0	7.6
CN2-9	8.0	8.0	8.0
GN-1	7.6	8.0	8.6
J-1224	6.0	6.0	6.0
J-540	6.0	6.0	5.6
Jackpot	6.0	6.0	5.0
Majestic	6.6	6.0	6.3
Midlawn	7.6	7.0	7.3
Mini-verde	9.0	9.0	9.0
Mirage	6.0	6.0	5.3
NuMex Sahara	6.0	5.6	5.3
OKC 18-4	8.0	7.6	7.6
OKC 19-9	8.0	7.0	8.0
OKS 91-11	7.3	7.0	7.0
OKS 95-1	7.3	7.3	7.0
Princess	7.0	7.3	7.0
PST-R69C	6.6	6.6	7.0
Pyramid	6.0	6.0	5.3
Savannah	6.3	6.0	6.0
Shanghai	7.0	7.3	7.3
Shangri La	6.0	6.0	5.3
Sundevil	6.3	6.0	5.6
SW1-11	6.6	6.0	6.3
SW1-7	6.3	6.0	5.6
Tifgreen	8.0	8.0	8.0
Tifsport	8.0	8.0	8.0
Tifway	8.0	8.0	8.0
LSD(p=0.05)	0.6	0.4	0.8

<sup>1</sup>Density ratings were made on a 1-9 scale, where 1=very low density and 9=very high density.

Table 5. 1999 Visual Quality Ratings From the 1997 NTEP Bermuda Trial at Stillwater, OK.

Cultivar	Visual Quality Ratings <sup>1</sup>					
	05-19-99	06-15-99	07-15-99	08-16-99	09-14-99	10-14-99
AZ Common	6.0	5.3	5.0	5.0	5.0	5.0
Blackjack	5.6	6.0	5.0	5.6	5.6	5.0
Bluemuda	6.0	6.0	5.0	5.3	5.0	5.0
Cardinal	6.0	5.3	4.3	4.3	4.0	6.3
CN2-9	7.3	7.3	7.6	7.6	7.3	6.6
GN-1	7.0	7.3	6.6	7.0	7.0	6.0
J-1224	5.6	6.0	5.3	5.6	5.3	5.0
J-540	6.0	6.0	5.0	6.0	5.3	5.0
Jackpot	5.0	6.0	5.0	5.6	5.0	5.0
Majestic	6.6	6.0	5.0	6.0	5.6	5.3
Midlawn	7.3	7.6	7.0	7.6	7.0	6.3
Mini-verde	5.3	6.3	5.0	5.3	5.0	5.3
Mirage	5.0	6.0	5.0	5.6	5.6	5.3
NuMex Sahara	6.0	5.3	5.0	5.3	5.6	6.0
OKC 18-4	8.6	8.3	7.3	7.3	7.6	6.0
OKC 19-9	7.3	8.0	7.6	8.0	6.3	6.0
OKS 91-11	6.6	7.0	6.0	7.0	7.0	6.0
OKS 95-1	7.0	7.0	7.0	7.0	7.0	6.6
Princess	6.3	7.0	7.0	7.0	7.0	6.6
PST-R69C	6.0	6.6	6.0	6.0	6.0	5.6
Pyramid	6.0	6.0	5.0	6.0	5.0	5.3
Savannah	5.3	6.0	6.0	6.3	5.0	5.0
Shanghai	6.6	7.3	6.3	6.0	6.6	5.0
Shangri La	5.3	6.0	5.0	6.0	5.3	5.3
Sundevil	5.3	6.3	5.3	5.6	5.3	5.0
SW1-11	5.0	6.0	6.0	6.3	5.6	5.6
SW1-7	5.6	6.0	5.6	6.0	5.3	5.0
Tifgreen	8.0	8.0	7.6	8.0	7.3	7.0
Tifsport	7.6	8.0	8.0	7.6	8.0	7.0
Tifway	8.0	8.0	8.0	8.0	8.0	7.0
LSD(p=0.05)	0.9	0.6	0.5	0.7	0.7	0.7

<sup>1</sup>Visual quality was rated on a 1-9 scale where 1= poor quality and 9=excellent quality.

Table 6. 1999 Percent Living Cover Ratings from the 1997 NTEP Bermuda Trial at Stillwater, OK.

Cultivar	Percent Living Cover Ratings <sup>1</sup>		
	05-17-99	08-16-99	10-14-99
AZ Common	91.0	97.0	90.6
Blackjack	91.3	97.3	91.6
Bluemuda	92.0	97.3	90.0
Cardinal	98.0	97.6	95.0
CN2-9	95.0	99.0	96.0
GN-1	94.6	99.0	95.6
J-1224	86.0	97.6	90.0
J-540	92.6	98.0	92.6
Jackpot	91.3	97.3	91.6
Majestic	92.3	97.6	91.6
Midlawn	97.0	98.0	95.3
Mini-verde	91.3	97.0	99.0
Mirage	90.0	97.3	92.6
NuMex Sahara	90.3	97.6	93.3
OKC 18-4	97.0	98.0	95.0
OKC 19-9	95.6	98.6	96.3
OKS 91-11	90.6	97.6	96.3
OKS 95-1	94.6	99.0	96.3
Princess	91.3	99.0	96.3
PST-R69C	93.0	98.0	91.6
Pyramid	91.6	97.6	90.6
Savannah	89.0	98.0	91.0
Shanghai	94.6	98.0	92.0
Shangri La	89.0	97.0	94.0
Sundevil	85.0	97.6	91.3
SW1-11	75.3	97.0	93.3
SW1-7	93.6	97.6	90.0
Tifgreen	97.3	99.0	97.0
Tifsport	95.3	99.0	96.6
Tifway	97.3	99.0	96.3
LSD(p=0.05)	8.9	1.3	0.7

<sup>1</sup>Living cover was rated on a 0-99 scale where 0=no cover and 99=complete cover.



Table 7. Divot Recovery Ratings in 1999 from the 1997 NTEP Bermuda Trial at Stillwater, OK.

Cultivar	Percent Divot Recovery 2 WAD <sup>1</sup>		
	June cutting	July cutting	Aug. cutting
AZ Common	78	86	83
Blakjack	83	86	83
Bluemuda	85	82	81
Cardinal	86	62	61
CN2-9	84	76	66
GN-1	97	94	92
J-1224	92	80	86
J-540	89	86	85
Jackpot	86	84	80
Majestic	88	88	86
Midlawn	82	79	68
Mini-Verde	93	89	91
Mirage	87	90	83
NuMex Sahara	82	85	84
OKC 18-4	92	88	84
OKC 19-9	90	85	90
OKS 91-11	83	86	81
OKS 95-1	97	94	92
Princess	95	94	85
PST-R69C	91	87	87
Pyramid	88	89	86
Savannah	87	85	80
Shanghai	97	91	83
Shangri La	86	81	76
Sundevil	88	87	79
SW1-11	91	80	75
SW1-7	90	86	78
Tifgreen	95	87	89
Tifsport	86	72	67
Tifway	82	75	68
LSD(p=0.05)	7	7	8

<sup>1</sup>WAD = weeks after divoting. Percent recovery estimate made using a 20 point microgrid.

Table 8. 1999 Spring Greenup, Winterkill And Spring Dead Spot (SDS) Area Of Turf In The USGA Fairway Bermudagrass Trial at Stillwater, OK.

Cultivar	Greenup <sup>1</sup>			Winterkill <sup>2</sup>	SDS Area
	24Mar99	31Mar99	7Apr99	16Apr99	15Apr99 (dm <sup>2</sup> )
25-7	1.5	1.0	2.0	97.5	0.0
47-1	1.0	1.5	2.0	75.0	0.0
51-14	2.0	2.5	3.0	50.0	0.0
94-2	1.0	2.0	2.5	55.0	0.0
Tifway	1.5	2.0	3.0	55.0	0.7
10-9	2.0	1.5	2.5	72.5	1.4
1-20	1.5	2.0	3.0	60.0	0.0
18-11	3.0	3.0	4.0	22.5	0.0
19-18	2.0	2.0	3.0	70.0	0.0
24-4	2.0	2.5	3.5	20.0	0.9
25-15	1.0	2.0	2.5	67.5	0.0
25-6	1.5	1.0	2.5	67.5	0.0
26-13	1.0	1.5	2.0	87.5	0.0
30-20	2.5	2.5	4.5	22.5	0.5
38-2	2.0	2.0	3.0	72.5	0.0
46-4	1.0	1.0	1.0	97.5	0.0
49-17	1.0	1.0	2.0	92.5	0.0
52-15	1.5	2.5	3.5	27.5	0.0
53-1	1.0	2.0	2.5	82.5	0.0
6-12	3.0	3.0	5.0	22.5	0.0
68-9	1.5	2.0	2.5	70.0	0.0
70-18	3.5	3.5	2.0	11.0	0.0
74-3	3.5	4.5	6.5	5.0	0.0
78-10	4.0	4.0	6.0	7.5	0.0
9-4	2.0	2.0	3.5	50.0	0.0
GN-1	2.0	2.0	3.0	95.0	0.0
Midlawn	3.0	4.0	5.0	7.5	0.0
Tifsport	1.5	2.0	3.0	45.0	0.0
20-6	1.5	2.0	2.5	32.5	0.0
22-10	1.0	1.5	3.0	52.5	0.0
22-13	1.0	2.5	3.5	55.0	0.0
25-1	2.5	2.5	4.0	32.5	0.0
47-7	1.0	1.0	2.0	97.5	0.0
55-5	1.5	2.0	3.0	57.5	0.0
56-14	1.0	1.5	3.0	27.5	0.0
ERSTurf	2.0	2.5	3.5	22.5	0.0
LSD (0.05)	1.0	1.0	1.2	47.0	NS

<sup>1</sup>Ratings were on a scale of 1-9, with 9 being best.

<sup>2</sup>Ratings for winterkill were on a percent scale.

Table 9. 1999 Color Ratings From the USGA Fairway Bermuda Trial at Stillwater, OK.

Cultivar	Color Ratings <sup>1</sup>	
	05-03-99	06-15-99
10-9	9.0	8.0
1-20	8.0	7.0
18-11	7.5	7.0
19-18	7.5	7.5
20-6	7.5	6.5
22-10	8.0	8.0
22-13	6.5	6.5
24-4	8.0	7.5
25-1	8.0	7.0
25-15	9.0	8.0
25-6	8.0	7.0
25-7	8.0	9.0
26-13	8.0	8.0
30-20	7.5	7.0
38-2	8.0	7.0
46-4	8.0	8.0
47-1	9.0	8.0
47-7	8.0	8.0
49-17	8.0	8.0
51-14	8.0	8.0
52-15	7.5	7.5
53-1	7.5	7.0
55-5	9.0	8.0
56-14	9.0	8.0
6-12	7.5	7.0
68-9	8.0	7.5
70-18	8.0	8.0
74-3	6.5	7.5
78-10	6.5	6.5
9-4	8.5	7.5
94-2	8.0	8.0
ERS Turf	7.0	7.0
Tifway	6.5	8.0
GN-1	8.0	8.5
Midlawn	6.5	6.5
Tifsport	7.0	8.5
LSD (p=0.05)	0.9	0.8

<sup>1</sup>Color ratings were made on a 1-9 scale, where 1=straw colored and 9=dark green.

Table 10. 1999 Texture Ratings From the USGA  
Fairway Bermuda Trial at Stillwater, OK.

Cultivar	Texture Ratings <sup>1</sup>
	10-14-99
10-9	7.5
1-20	8.0
18-11	8.0
19-18	8.0
20-6	8.0
22-10	8.0
22-13	9.0
24-4	8.0
25-1	8.5
25-15	8.0
25-6	8.0
25-7	7.0
26-13	8.0
30-20	8.0
38-2	8.0
46-4	8.0
47-1	9.0
47-7	8.0
49-17	8.5
51-14	9.0
52-15	8.0
53-1	8.0
55-5	8.5
56-14	8.0
6-12	8.0
68-9	8.0
70-18	8.0
74-3	8.0
78-10	8.0
9-4	8.0
94-2	8.0
ERS Turf	7.0
Tifway	8.0
GN-1	7.0
Midlawn	7.0
Tifsport	8.0
LSD(p=0.05)	0.5

<sup>1</sup>Texture ratings were made on a 1-9 scale, where 1=coarse texture and 9= very fine texture.

Table 11. 1999 Density Ratings From the USGA  
Fairway Bermuda Trial at Stillwater, OK.

Cultivar	Density Ratings <sup>1</sup>		
	05-19-99	08-16-99	10-14-99
10-9	7.0	7.5	8.0
1-20	8.0	6.0	7.0
18-11	7.0	6.5	8.0
19-18	8.0	7.0	7.5
20-6	8.5	6.0	7.5
22-10	8.5	7.0	7.5
22-13	8.5	6.5	7.5
24-4	7.5	7.5	6.5
25-1	8.5	7.0	8.0
25-15	8.0	7.0	8.0
25-6	8.0	6.5	7.0
25-7	7.0	8.0	8.0
26-13	7.5	6.5	7.0
30-20	8.0	6.5	8.0
38-2	8.0	7.0	8.0
46-4	8.5	7.5	7.5
47-1	9.0	7.0	8.0
47-7	7.5	7.5	7.5
49-17	9.0	6.0	6.0
51-14	9.0	7.0	9.0
52-15	7.5	6.0	7.0
53-1	8.0	6.5	7.5
55-5	8.0	6.5	8.0
56-14	8.5	7.0	7.5
6-12	8.0	7.0	8.0
68-9	8.0	8.0	8.5
70-18	8.0	6.5	8.0
74-3	7.5	6.0	7.0
78-10	7.5	6.0	7.0
9-4	7.0	6.0	7.5
94-2	8.0	7.0	7.5
ERS Turf	7.5	8.0	7.5
Tifway	8.5	7.0	8.0
GN-1	7.5	8.0	8.5
Midlawn	7.0	6.0	6.0
Tifsport	8.0	7.0	8.0
LSD(p=0.05)	0.9	1.0	1.0

<sup>1</sup>Density ratings were made on a 1-9 scale, where 1=very low density and 9=very high density.

Table 12. 1999 Visual Quality Ratings From The USGA Fairway Bermuda Trial at Stillwater, OK.

Cultivar	Visual Quality Ratings <sup>1</sup>					
	05-19-99	06-15-99	07-15-99	08-16-99	09-14-99	10-14-99
10-9	7.5	7.5	7.0	6.5	7.0	7.0
1-20	7.0	7.0	6.5	5.5	6.5	8.0
18-11	6.0	7.0	7.0	7.0	6.0	7.5
19-18	7.0	7.0	7.0	6.0	6.5	7.0
20-6	7.5	7.0	6.0	6.0	6.0	7.5
22-10	7.0	8.0	8.0	6.5	6.5	7.5
22-13	7.0	7.0	6.0	6.0	6.0	6.0
24-4	7.0	6.5	7.5	6.5	7.0	5.5
25-1	7.5	7.5	7.5	7.0	6.0	8.0
25-15	8.0	7.5	8.0	6.5	7.0	7.0
25-6	8.0	8.0	6.5	5.5	6.5	7.0
25-7	5.5	8.0	7.0	7.5	7.0	8.0
26-13	7.0	8.0	7.0	6.0	6.5	6.0
30-20	7.0	7.5	6.0	6.0	6.5	8.0
38-2	7.5	7.0	7.0	6.5	6.5	7.0
46-4	7.0	8.0	7.5	6.0	6.5	6.5
47-1	8.0	8.0	6.5	6.0	6.5	7.0
47-7	7.0	8.0	8.0	7.0	7.0	6.5
49-17	7.5	8.0	6.0	6.0	6.5	6.5
51-14	8.5	8.0	6.5	7.0	7.0	7.5
52-15	7.0	7.0	6.0	6.0	6.0	7.0
53-1	7.0	7.0	6.5	5.5	6.0	7.5
55-5	8.0	8.0	7.5	6.5	6.5	7.0
56-14	7.0	8.0	7.0	6.0	6.5	7.5
6-12	6.5	7.0	7.5	6.5	6.5	7.0
68-9	8.5	7.5	8.0	7.5	7.5	8.0
70-18	8.0	8.0	7.0	7.0	7.5	8.0
74-3	6.0	7.0	6.5	6.0	6.0	7.5
78-10	6.5	7.0	6.0	6.0	6.0	8.0
9-4	7.0	7.0	7.5	6.0	6.0	8.0
94-2	7.5	8.0	7.0	6.5	7.0	7.5
ERS Turf	7.0	7.0	6.5	6.0	6.5	7.0
Tifway	7.0	8.0	8.0	6.5	7.0	7.5
GN-1	8.0	7.5	7.0	6.5	7.0	7.5
Midlawn	6.5	6.5	7.0	6.0	6.5	7.0
Tifsport	7.0	8.0	8.0	6.5	7.0	7.5
LSD(p=0.05)	1.0	0.7	1.2	0.9	NS	0.9

<sup>1</sup>Visual quality was rated on a 1-9 scale where 1= poor quality and 9=excellent quality.

Table 13. 1999 Percent Living Cover Ratings From the USGA Fairway Bermuda Trial at Stillwater, OK.

Cultivar	Percent Living Cover Ratings <sup>1</sup>		
	05-19-99	08-16-99	10-14-99
10-9	97.5	99.0	99.0
1-20	99.0	99.0	99.0
18-11	99.0	99.0	99.0
19-18	99.0	99.0	98.5
20-6	99.0	99.0	98.5
22-10	99.0	99.0	99.0
22-13	99.0	99.0	99.0
24-4	94.5	99.0	99.0
25-1	99.0	99.0	99.0
25-15	99.0	99.0	99.0
25-6	99.0	99.0	98.5
25-7	99.0	99.0	98.5
26-13	99.0	99.0	99.0
30-20	99.0	99.0	99.0
38-2	99.0	99.0	99.0
46-4	99.0	99.0	99.0
47-1	99.0	99.0	99.0
47-7	99.0	99.0	99.0
49-17	99.0	99.0	98.0
51-14	99.0	99.0	99.0
52-15	99.0	99.0	99.0
53-1	99.0	99.0	99.0
55-5	99.0	99.0	98.5
56-14	99.0	99.0	99.0
6-12	99.0	99.0	99.0
68-9	99.0	97.5	97.5
70-18	99.0	99.0	98.5
74-3	99.0	99.0	99.0
78-10	99.0	99.0	99.0
9-4	99.0	99.0	99.0
94-2	99.0	99.0	98.0
ERS Turf	99.0	99.0	99.0
Tifway	99.0	99.0	99.0
GN-1	99.0	99.0	99.0
Midlawn	99.0	98.5	98.0
Tifsport	99.0	99.0	99.0
LSD (p=0.05)	NS	NS	NS

<sup>1</sup>Living cover was rated on a 0-99 scale where 0=no cover and 99=complete cover.

Table 14. 1999 USGA Bermuda Fairway Trial Divot Recovery Ratings at Stillwater, OK.

Cultivar	Percent Divot Recovery at 2 WAD <sup>1</sup>		
	June Divoting	July Divoting	Aug. Divoting
10-9	91	91	87
1-20	92	84	80
18-11	91	88	82
19-18	90	88	80
20-6	86	82	75
22-10	92	82	74
22-13	81	77	76
24-4	90	91	87
25-1	92	91	82
25-15	94	88	81
25-6	92	89	77
25-7	96	96	84
26-13	92	86	80
30-20	88	88	80
38-2	95	88	75
46-4	82	87	83
47-1	92	86	83
47-7	97	92	85
49-17	74	75	65
51-14	96	94	85
52-15	92	85	80
53-1	90	80	70
55-5	88	92	76
56-14	88	91	78
6-12	96	93	86
68-9	99	93	86
70-18	91	88	80
74-3	85	86	78
78-10	85	85	71
9-4	92	92	76
94-2	86	83	73
ERS-Turf	95	89	73
Tifway	90	90	78
GN-1	100	97	85
Midlawn	86	86	68
Tifsport	89	87	77
LSD(p=0.05)	7	5	9

<sup>1</sup>WAD = weeks after divoting. Percent recovery estimate made using a 20-point microgrid.