Breeding and Evaluation of Cold-tolerant Bermudagrass Varieties Golf Courses

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Goals:

- *Assemble, evaluate, and maintain Cynodon germplasm with potential for contributing to the genetic improvement of the species for turf.*
- *Improve bermudagrass germplasm populations for seed production potential, cold tolerance, and other traits conditioning turf performance.*
- *Develop, evaluate and release superior seed-propagated, cold-tolerant, fine-textured, turf bermudagrass varieties for the U.S. transition zone and similar climates.*
- *Develop, evaluate and release improved vegetatively propagated bermudagrass varieties with specific adaptations and uses in the southern U.S., e.g. varieties for golf course putting greens in the deep South.*

Cooperators:

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The turf bermudagrass breeding program was initiated in 1986 at Oklahoma State University. The initial objective was to develop fine-textured, winter-hardy, seed-propagated varieties for the U.S. transition zone. This objective has expanded to develop improved seed- and vegetatively-propagated cultivars for the transition zone.

Research supporting the breeding effort includes: 1) the procurement and evaluation of new turf bermudagrass germplasm, 2) development of laboratory and field methods to measure plant response to low temperature and disease stress, and 3) identification of genes involved in plant response to low temperatures and disease stress.

The development of seeded turf bermudagrass cultivars for the transition zone requires combining into breeding populations cold hardiness, economic seed yield potential and acceptable turf quality. Phenotypic recurrent selection (PRS) for these traits in broad genetic base *C. dactylon* populations has resulted in incremental improvement with each cycle of selection. A first product of this breeding effort, OKS 91-11, was released in January 1997. OKS 91-11, initially synthesized in 1991, was included in the 1992-96 NTEP bermudagrass test. Breeding improvement in the broad base populations has now reached threshold levels that will allow more rapid progress in seeded turf bermudagrass cultivar development.

African bermudagrass, *C. transvaalensis*, is important because of its role as a parent in crossing with *C. dactyon* plants to produce the sterile triploid (2n=3x=27 chromosome) hybrids like *TIFGREEN* and *TIFWAY*. African bermudagrass has not been extensively studied and only a few plant introductions have been available for breeding research in the United States. Research with African bermudagrass over the past seven years has demonstrated significant genetic variation for adaptation and turf performance characteristics. African progeny plants with superior performance characteristics were identified and are being used in breeding and other research.

Intra- and inter-specific crossing has been employed over the past five years to develop vegetatively-propagated hybrid turf bermudagrass cultivars. Selected parental plants of *C. dactylon* and *C. transvaalensis* were crossed to produce large progeny populations which were screened for turf performance.

Approximately 50 select hybrid plants are now in advanced stages of evaluation. Potentially valuable fertile hybrid plants 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 3 full genomes (27 chromosomes) from *C. dactylon*. Open-pollinated and hybrid progeny from these plants have shown desirable turf characteristics.

A laboratory procedure was developed to quantify relative cold hardiness of bermudagrass plants. The freeze tolerance of bermudagrass plants has traditionally been assessed by observing survival following test winters. Because freeze injury under field conditions is strongly influenced by many environmental factors, multiple observations through time and space are required to elucidate differences in freeze tolerance and geographic adaptation of cultivars. This laboratory procedure may be used in combination with field studies to more quickly and accurately assess freeze tolerance of bermudagrass plants. The procedure also enables and facilitates other cold hardiness research with turf bermudagrass.

The survival of bermudagrass cultivars exposed to freezing temperatures is determined by their ability to cold acclimate. A cold regulated protein from *MIDIRON* and *TIFGREEN* bermudagrass was identified as chitinase. More recent research used Differential Display-Reverse Transcription PCR procedures to study changes in translatable mRNA populations during cold acclimation of freezing tolerant *MIDIRON* bermudagrass. At least 30 differentially expressed cDNA species were identified using 40 arbitrary and anchored primer combinations. Nine up-regulated and two down-regulated cDNA species have been confirmed. These cDNA's range from 170 to 470 base pairs in length. These partial cDNAs were sequenced and aligned with other known genes in genome databases. Homologies were found with *lti*65 (low temperature-induced) from *Arabidopsis thaliana*, a transcription factor (*nus*G) from *Thermus thermophilus*, a non-dormancy cDNA clone from *Avena fatua*, and a secretory/excretory heat shock protein cDNA from B*rugia malayi*. Efforts are underway to isolate the full length sequences corresponding to the partial cDNAs in order to characterize the cDNAs and confirm identity of these genes.

Sixty-two accessions representing 11 *Cynodon* taxa (species and taxonomic varieties) were used in a molecular study of genetic relatedness. Phylogenetic analysis of accessions was performed using the DAF (DNA Amplification Fingerprinting) procedure. Parsimony and bootstrap analysis was performed to produce the consensus phylogenetic tree using the PAUP 3.0 program. The results demonstrate interesting genetic relationships among and within *Cynodon* taxa. For instance, much diversity was found within the cosmopolitan species *C. dactylon*. Accessions within taxonomic varieties generally were grouped together, except for *C. dactylon var. dactylon*, in which wide differences were evident. Small, but definite, variations were found in *C. arcuatus, C. transvaalensis, and C. plectostachyus,* all endemic species to small geographic regions of southern Africa.

Table 4. 1996 mean turfgrass qauality ratings of bentgrass cultivars for each month grown on a green at twenty-five locations in the U.S. and Canada.

Name	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct	Nov.	Dec.
TIFWAY	4.0	3.5	4.3	5.8	6.6	7.0	7.4	7.3	7.6	6.7	5.5	4.4
BABY (TDS-BM1)	3.4	3.7	4.5	5.7	6.0	7.0	7.1	7.0	7.0	6.0	4.7	4.0
MIDIRON	3.6	3.8	4.5	6.1	6.2	6.6	6.6	6.4	6.7	5.7	4.2	3.8
TIFGREEN	3.4	3.5	4.6	5.1	5.6	6.4	6.6	6.9	6.8	5.8	4.7	3.9
MIDLAWN	3.4	3.2	4.0	5.9	5.7	6.2	6.5	6.4	6.3	5.4	4.4	3.8
MIDFIELD	3.6	3.3	4.1	5.8	5.7	6.1	6.6	6.2	6.0	5.4	4.9	3.9
OKS 91-11	3.4	3.0	3.9	5.6	5.4	5.7	5.9	6.0	5.8	5.4	4.1	3.7
STF-1	3.3	3.0	4.3	5.2	5.0	5.8	5.8	5.9	6.1	5.1	4.1	3.8
MIRAGE (90173)	3.4	3.3	4.5	5.1	5.2	5.7	6.0	5.8	5.9	5.5	4.3	3.8
TEXTURF 10	3.6	3.2	3.8	5.1	4.7	5.4	5.9	6.1	6.3	5.5	4.7	4.0
JACKPOT(J-912)	3.4	3.2	4.2	4.9	4.9	5.7	5.9	5.8	5.9	5.5	4.3	3.8
FMC-6 (FMC 6-91)	3.6	3.3	4.1	5.1	4.8	5.3	5.5	5.8	5.8	5.3	4.4	3.7
J-27	3.6	3.5	4.1	5.3	5.3	5.4	5.6	5.6	5.4	5.1	3.9	3.7
FMC 5-91	3.6	3.5	3.9	4.5	4.7	5.1	5.3	5.5	5.6	5.0	4.3	3.9
GUYMON	3.6	3.2	4.3	5.3	5.1	5.1	5.4	5.4	5.3	4.6	3.9	3.8
SUNDEVIL	3.4	3.2	4.2	4.5	4.7	5.1	5.4	5.4	5.4	5.1	4.1	3.9
FMC 3-91	3.7	3.2	4.3	4.7	4.5	4.9	5.3	5.4	5.6	5.3	4.3	3.9
OKS 91-1	3.6	3.5	3.6	4.3	4.5	4.9	5.1	5.3	5.2	5.1	3.9	3.7
FMC 2-90	3.4	3.2	3.8	4.1	4.4	4.9	5.0	5.4	5.7	4.9	3.9	3.9
CHEYENNE	3.6	3.2	3.7	4.0	4.4	4.7	4.9	5.3	5.4	5.0	3.8	3.8
NUMEX-SAHARA	3.3	3.2	4.2	4.6	4.4	4.6	4.8	5.2	5.3	4.7	3.9	3.7
PRIMAVERA	3.6	3.3	3.5	3.8	4.1	4.6	4.8	5.1	5.4	4.9	4.1	3.8
SONESTA	3.4	3.3	3.7	4.6	4.3	4.5	4.6	5.0	5.1	4.7	3.7	3.7
ARIZ. COM. SEED	3.4	3.2	3.6	3.8	3.9	4.1	4.4	4.8	5.0	4.7	3.9	3.6
FLORADWARF	3.6	3.2	3.2	3.7	3.3	3.9	4.2	4.4	4.2	3.9	3.4	3.2
ARIZ. COM. VEG.	3.4	3.5	3.3	3.7	3.5	3.7	4.0	4.2	4.4	3.9	3.9	3.7
LSD	0.8	1.2	1.1	1.1	0.7	0.6	0.6	0.6	0.6	0.9	0.6	0.6

[1]Turfgrass quality ratings on a 1 to 9 scale where 9 = ideal turf. To determine statistical differences among entries, subtract on entry's mean from another entry's mean. Statistical differences occur when this value is larger than the corresponding $LSD_{0.05}$ value.