BERMUDAGRASSES SUPERIOR IN DEHYDRATION AVOIDANCE AND DROUGHT RESISTANCE WHEN COMPARED TO ZOYSIAGRASSES

by

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The objectives of this investigation were to assess the genetic diversity in dehydration avoidance and resultant drought resistance among cultivars/genotypes of 26 bermudagrasses (*Cynodon* spp.) and 9 zoysiagrasses (*Zoysia* spp.). **Dehydration avoidance** is the ability of a plant to avoid tissue damaging water deficits even while growing in a drought environment favoring the development of water stress.

Turfed plugs of 4 inches (100 mm) in diameter were collected from mature stands of at least 4-years age and transplanted in a randomized block arrangement with 4 replications onto a high-sand root zone. Once the turfs were fully rooted, the irrigation was terminated and assessments made over a 5-month period from 1 May to 5 October, 1988 during which only 2.8 inches (72 mm) of rainfall occurred. This included 1.2 inches (30 mm) on day 40, 0.6 inch (15 mm) on day 55, 0.7 inch (18 mm) on day 69, and 0.35 inch (9 mm) on day 124. Then on October 6 irrigation of the turfs was reinitiated and a normal watering frequency was sustained during turf recovery phase.

RESULTS

Substantial genetic diversity in both dehydration avoidance and drought resistance was found among the bermudagrass (*Cynodon*) genotypes, which encompassed 14 *C. dactylon* and 12 *C. dactylon* x *C. transvaalensis* hybrids (Table 1). The mean leaf firing on day 158 was 51% for the bermudagrass genotypes and 95% for the zoysiagrass genotypes. Similarly, the mean shoot recovery 15 days following reinitiation of irrigation was 80% for the bermudagrass genotypes and 16% for the zoysiagrass genotypes. Bermudagrass cultivars that sustained more than the threshold of 80% green shoots through 158 days were FLoraTeX™, NM43, Ormond, and NMS4 bermudagrasses.

Table 1. Leaf firing percent after 60, 90, 120, and 158 days of progressive severe drought stress and the percent shoot recovery 15 days after the initiation of irrigation for 26 bermudagrass (*Cynodon*) genotypes during the drought stress field study.

Bermudagrass (*Cynodon*) genotypes	Leaf Firing (percent)				Percent Shoot Recovery[2]
	day 60	day 90	day 120	day 158	
FLoraTeX™	0 a[1]	4 ab	11 ab	9 a	100 a[1]
NM 43	3 ab	3 a	9 a	10 ab	100 a
Ormond	0 a	4 ab	9 a	13 ab	100 a
NMS 4	0 a	3 a	11 ab	15 ab	100 a
Midiron	0 a	18 c	22 abc	22 abc	100 a
Santa Ana	4 ab	3 a	25 abc	27 abc	100 a
Tifdwarf	8 abc	14 abc	30 bc	28 abc	93 ab
Tiflawn	3 ab	11 abc	28 abc	30 abc	94 ab
Texturf 1F	0 a	5 ab	32 abc	32 abc	98 a
Numex Sahara	5 ab	5 ab	31 abc	35 abc	98 a
Tifgreen	3 ab	0 a	30 abc	53 cd	98 a
Bayshore	0 a	13 abc	55 ef	56 de	79 abc
Tifgreen II	3 ab	8 abc	61 fg	58 de	84 abc
Midlawn	3 ab	11 abc	28 abc	60 ef	84 abc
Tiffine	8 abc	18 c	46 cd	60 ef	72 bc
Sunturf	0 a	8 abc	53 de	65 fg	88 abc
Texturf 10	11 c	13 abc	51 cd	65 fg	65 cd
U-3	4 ab	10 abc	55 ef	66 fg	68 cd
Pee Dee	0 a	10 abc	31 abc	68 fg	82 abc
Guymon	6 abc	10 abc	71 hi	71 gh	72 bc
Tifway	5 ab	16 bc	78 ij	74 gh	73 bc
Midway	14 e	38 g	70 hi	75 gh	53 d
Everglades	13 de	11 abc	69 gh	79 hi	53 d
Arizona Common	14 e	20 cd	83 jk	79 hi	52 d
Vamont	10 bc	21 e	95 kl	95 ij	52 d
Tufcote	5 ab	25 f	99 l	99 j	21 e

[1]Means followed by the same letter within the same column are not significantly different at the 5% level, LSD t test.
[2]At fifteen days after initiation of irrigation.

Bermudagrasses. Among the bermudagrass genotypes, those with the shorter root systems tended to have poorer dehydration avoidance and drought resistance. In contrast, the genetic diversity in dehydration avoidance was much narrower among the nine zoysiagrasses, which included both *Z. matrella* and *Z. japonica* genotypes. The much poorer dehydration avoidance of the zoysiagrasses when compared to the bermudagrasses was attributed primarily to a shallow root system, plus a higher evapotranspiration rate.

Superior dehydration avoidance, as expressed by an 80% or higher green color retention after 158 days, was found for 4 bermudagrass genotypes: FLoraTeX™, NM 43, Ormond, and NMS 4 bermudagrasses. Six other genotypes were in the same statistical grouping, but were numerically below the 80% green color retention threshold. Tufcote and Vamont had the most severe leaf firing at 99 and 95% after 158 days. Drought resistance was outstanding for most of the bermudagrass genotypes, as demonstrated by the degree of green shoot recovery of the turf at 15 days following reinitiation of irrigation on the plot area.

Assuming an objectionable level of turf discoloration occurs at a 20% leaf firing threshold, all 26 bermudagrass genotypes retained acceptable appearance through 60 days, 23 through 90 days, and 4 through 120 and 158 days. In the case of the zoysiagrasses, all genotypes retained acceptable color through 60 days and 6 through 90 days, with none retaining acceptable color at 120 days and beyond. There were 8 bermudagrass genotypes that exhibited no leaf firing through 60 days. Included were FLoraTeX™, Ormond, Midiron, NMS 4, Texturf 1F, Bayshore, Sunturf, and PeeDee.

Zoysiagrasses. Among the zoysiagrass genotypes, FC13521 had moderate dehydration avoidance at 35% leaf firing after 120 days, with Diamond ranked the next best with 46% leaf firing (Table 2). All nine zoysiagrass genotypes had 85 to 100% leaf firing after 158 days, which indicates an inferior dehydration avoidance mechanism compared to the bermudagrasses.

Shoot recovery following reinitiation of irrigation on the study area indicated that the zoysiagrass genotype FC13521 ranked best in drought resistance of the 9 genotypes, followed by Meyer, Korean Common, El Toro, and Diamond, all being in the same statistical grouping. The other 4 genotypes had the poorest drought resistance of the zoysiagrasses assessed.

Table 2. Leaf firing percent after 60, 90, 120, and 158 days of progressive severe drought stress and the percent shoot recovery 15 days after the initiation of irrigation for 9 zoysiagrass (*Zoysia*) genotypes during the drought stress field study.

Zoysiagrass (*Zoysia*) genotypes	Leaf Firing (percent)				Percent Shoot Recovery[2]
	day 60	day 90	day 120	day 158	
FC 13521	4 a[1]	9 ab	35 a	85 a	33 a[1]
Diamond	9 ab	3 a	46 b	90 a	15 abc
Emerald	6 ab	14 abc	79 cd	96 a	5 c
Dalz 8501	9 ab	8 ab	93 cd	88 a	9 bc
Dalz 8508	3 a	6 ab	99 d	100 a	9 bc
Meyer	5 ab	20 bc	100 d	100 a	29 ab
El Toro	9 ab	24 c	100 d	100 a	19 abc
Korean Common	10 ab	50 d	100 d	100 a	24 abc
Belair	18 b	43 d	100 d	100 a	4 c

[1]Means followed by the same letter within the same column are not significantly different at the 5% level, LSD t test.
[2]At fifteen days after initiation of irrigation.

DISCUSSION

Among the *Cynodon dactylon* genotypes, those developed under warm climatic conditions tended to rank in the top group in terms of both dehydration avoidance and drought resistance, with the exception Midiron; while those developed in the cooler climates with emphasis on cold hardiness tended to rank poorest, with the exception of Everglades.

Previous studies revealed that the *Zoysia* cultivar Meyer possessed better internal tissue dehydration tolerance than the *Cynodon* cultivar Tifway (5). As these results reveal the superior overall drought resistance of bermudagrasses in comparison to the zoysiagrasses, this indicates that the dominant component of drought resistance influencing this differential is the superior dehydration avoidance of the *Cynodon* genotypes, and not the dehydration tolerance.

The key characteristics contributing to the superior dehydration avoidance of the bermudagrass genotypes include: (a) A much greater root depth, density, and biomass (5). The genetic potential for rooting of 11 zoysiagrass genotypes is less than 1.1 feet (0.35 m) (9). In contrast, 24 bermudagrass genotypes had a genetic rooting potential of at least 7 feet (2.1 m) in depth, with the lowest being greater than 4.3 feet (1.3 m) (8). (b) A lower evapotranspiration rate. The zoysiagrass genotypes have a higher evapotranspiration rate under both peak evaporative demand (2, 3, 4, 6) and (c) A more rapid rate of surface wax formation over the stomata during progressive water stress in comparison to the *Zoysia* species (5).

Since the zoysiagrass genotypes had poorer dehydration avoidance in terms of leaf firing percent (Tables 1 and 2), and thus entered drought dormancy earlier, this results in a longer period for the internal tissue water stress to develop. This could be an important contributing factor to the inferior drought resistance even though zoysiagrass has been characterized by better internal dehydration tolerance than the bermudagrasses.

The significant differentials between the bermudagrass and zoysiagrass groups of genotypes in both dehydration avoidance and drought resistance are associated with the environmental conditions under which each originated. That is, the *Cynodon* species evolved under the hot, dry, droughty conditions of southeastern Africa, whereas the center of origin for the *Zoysia* species is in the more humid, wet environment of southeast Asia.

The inferior rooting, dehydration avoidance, and resultant drought resistance of the zoysiagrass genotypes in comparison to the bermudagrass genotypes results in a higher irrigation requirement to maintain actively growing, green turf conditions in the case of the zoysiagrass genotypes.

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