

## *Utilization Workgroup*

### **Breeding Forage Bermudagrass for the U.S. Transition Zone**

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Bermudagrass, *Cynodon dactylon* (L.) Pers., is an important component of the array of perennial forage grass species used in the upper south traditionally regarded as a zone of transition between plants best adapted to mild and harsh winters. The climatically variable transition zone (Fig. 1) corresponds approximately to USDA plant hardiness zones 5 through 7. Bermudagrass within this geographic region varies from widespread use in the southern half to sparse use at the north boundary. As latitudes increase beyond about 36 °N, bermudagrass becomes progressively less used.

The characteristics that make bermudagrass desirable as a forage species in the transition zone are the same as those that make it so in the deeper south. They include its high biomass production potential, tolerance to close defoliation from grazing and haying, tolerance to drought and high temperatures, and the lack of any insect or disease pests that severely limit its stand persistence and productivity (Harlan, 1970). In portions of the transition zone, bermudagrass is valued for providing forage in the summer months when cool-season perennial grasses are not productive (Decker et al., 1971).

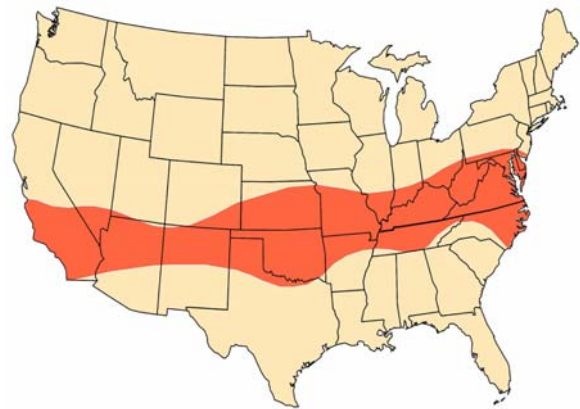


Fig. 1. U. S. transition zone.

Tolerance to low freezing temperatures is the most important criterion for bermudagrass adaptation to the transition zone. Bermudagrasses that are adapted to the transition zone possess levels of freeze tolerance sufficient to withstand winters of average severity without significant injury and periodic substantially more harsh winters without complete winterkill. Fortunately, such bermudagrasses exist in nature. Cold hardy bermudagrass, particularly forms of the cosmopolitan *C. dactylon* var. *dactylon* have evolved under natural selection and are found in parts of Europe and Asia at latitudes extending to about 53° N (Harlan & de Wet, 1969).

### **Introduction and Cultivar Development**

Bermudagrass was brought to the transition zone region and northern states in the 19<sup>th</sup> century by farmer settlers and other agriculturists (Staten, 1952; Taliaferro et al., 2004). One account indicates that bermudagrass sprigs were shipped from Baton Rouge, LA to Ft. Smith, AR about 1833 or 1834 for planting on the parade ground and that this planting subsequently provided sprigs for other plantings in the region (Staten, 1952). State Agricultural Experiment Station agronomists in central and northern states planted bermudagrass from seed and sprigs in the late 1800's that provided germplasm subject to natural selection for adaptation. Many of the bermudagrasses now found in the transition zone emanated from these natural selections. Formal bermudagrass breeding in the transition zone began after the middle of the 20<sup>th</sup> century

and programs have been few in number and small in scope relative to amounts of scientific effort (SY) and financial input.

Forage bermudagrass breeding has been ongoing at Oklahoma State University since 1968. The overall goal has been the development of seed-and vegetatively-propagated cultivars with good adaptation to the region. For traditional clonal cultivars, emphasis has been on combining cold hardiness and high biomass yield potential into cultivars. For seeded bermudagrass, the fundamental goal has been to produce cultivars that combine economic levels of seed production and cold hardiness.

### Clonal Cultivars

The breeding procedure for clonal cultivars has been straightforward, consisting of the crossing of selected parents and field-based selection among large (up to several hundred) F<sub>1</sub> progeny populations. Crossing has been inter-specific within *C. dactylon* and intra-specific involving *C. dactylon* and *C. nlemfuensis* or *C. aethiopicus*. Freeze tolerance, biomass yield, and many other performance characteristics are quantitatively inherited traits substantially influenced by environment. Accordingly, field-based initial screening of progeny populations has encompassed observation over years to assess apparent adaptation and yield potential. Selected elite plants were advanced to small plot testing through time and space.

‘Midland 99’ and ‘Ozark’ are recent releases from the program. Both were tested extensively prior to release in small-plot forage yield trials. Data from central and eastern Oklahoma trials comparing dry biomass yields of Midland 99 and Ozark with selected standards are given in Table 1. Yields of Midland 99, Ozark, and Tifton 44 in central and eastern Oklahoma tests have generally been of similar magnitude and not statistically different ( $P>0.05$ ).

Table 1. Forage yields of Midland 99 and Ozark in comparison to selected standard bermudagrass cultivars in Oklahoma Tests.

Cultivar	Location, Test, Years						
	Haskell, OK				Chickasha, OK		
	90-2	94-1	98-1	01-1	90-1	94-2	98-2
	91-93	95-98	99-03	02-04	91-93	95-98	99-03
	----- tons dm/ac/yr -----						
Midland 99	10.68	9.74	8.54	10.78	9.47	9.46	10.18
Ozark	9.67	9.10	--	11.04	9.36	9.47	--
Midland	9.01	8.05	--	--	8.35	8.19	
Tifton 44	9.89	9.18	7.46	10.49	9.00	10.34	9.76
Greenfield	--	6.83	5.46	--	--	5.60	6.17
Quickstand	--	7.16	--	--	--	6.51	--
World Feeder	--	6.54	--	--	--	5.59	--
5% LSD	0.57	0.70	0.45	0.48	0.81	0.94	0.81
CV (%)	8.63	7.59	10.00	6.10	13.15	9.76	16.00

300 # N/ac/yr in 3 applications. Usually 4 harvests.

In the same region, yields of Greenfield, Quickstand, and World Feeder have usually been significantly lower than those of Midland 99, Ozark, and Tifton 44. Yields of Midland have usually been intermediate to those of the aforementioned groups. In a 6-yr irrigated test at Goodwell in the Oklahoma Panhandle mean yields (Tons DM/Ac/Yr) were Ozark (12.11) > Midland 99 (10.94) > Midland (9.66) = Tifton 44 (9.10) (Fig. 2). Forage quality of Midland 99 and Ozark are similar to Midland and Tifton 44 (Fig. 3). Relative freeze tolerance of the three

cultivars as indicated by laboratory data (Fig. 4) and field observations is Ozark > Midland99 > Tifton 44. The relatively small but meaningful cold hardiness differences among the three cultivars are important in northern portions of the transition zone. Additional to winter hardiness, Midland 99 and Ozark have not shown susceptibility to any diseases that limit their performance. Both have had good stand persistence in Oklahoma, Kansas, Missouri, and Arkansas.

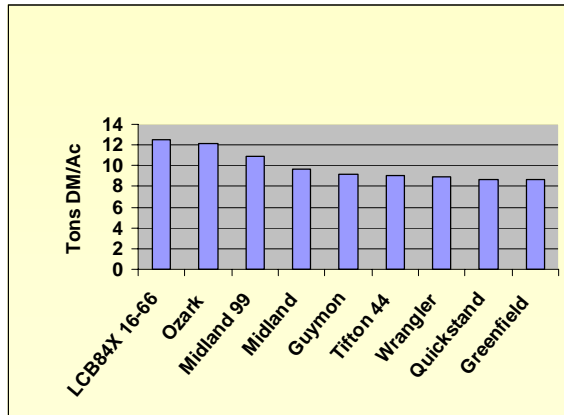


Fig. 2. Six year (1998-2003) mean yields of bermudagrass cultivars at Goodwell, Oklahoma.

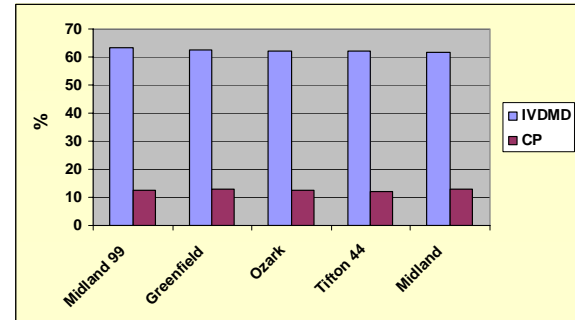


Fig. 3. Mean *in vitro* dry matter digestibility (IVDMD) and crude protein concentrations in bermudagrass cultivars. Means over four tests encompassing two locations and four years, four harvests/season, and four replications.

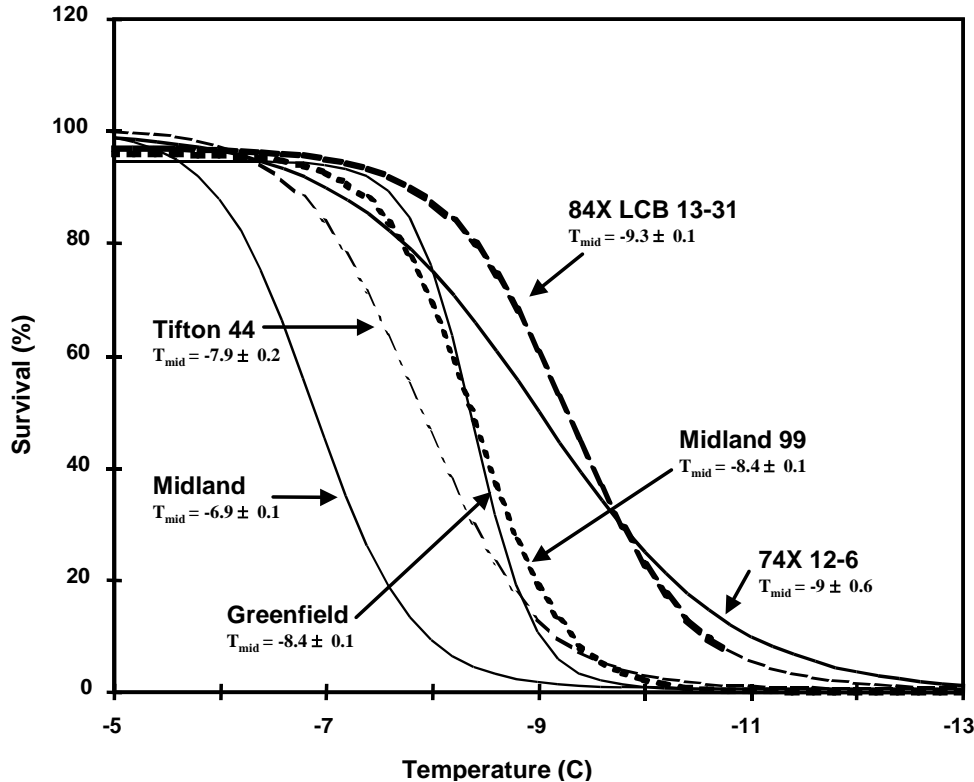


Fig. 4. Survival of cold-acclimated forage bermudagrasses subjected to freezing temperatures ranging from -5 to -13°C in a controlled chamber. Ozark = 74X 12-6.

## Seeded Cultivars

The 1970's discovery of cold hardy bermudagrass germplasm with reasonably good seed production created the opportunity to breed seeded cultivars for the transition zone. The germplasm was in the *Cynodon* collection assembled at OSU by J. R. Harlan and associates in the 1960's. A small effort has been ongoing for seeded forage bermudagrass since that time. 'Guymon' bermudagrass, released in 1984, represented the first seeded variety with good adaptation to the northern half of the transition zone. Guymon seed yields were economically marginal (~200 Lbs PS/Ac). Recurrent selection over a number of years for higher seed production provided the parent plants of 'Wrangler' bermudagrass. Production field seed yields of Wrangler have averaged about 500 pounds pure seed acre<sup>-1</sup> year<sup>-1</sup> in Oklahoma over the past 10 years. Guymon and Wrangler have advantage over "Arizona Common" and derivative cultivars in the northern half of the transition zone because of their greater freeze tolerance. Biomass yields of Guymon and Wrangler in this region are on a par with cultivars such as Greenfield, Quickstand, and World Feeder (Fig 1). The Arizona Common and derivative cultivars have higher biomass production than Guymon and Wrangler in regions where they are not winter stressed.

## Breeding Objectives & Future Potential

The enormous genetic diversity within *Cynodon* has barely been tapped. Traditional breeding procedures are capable of achieving progressive advances in clonal- and seed-propagated cultivar development for many traits that interact to condition overall transition zone performance. These include traits related to stand establishment (vegetative and seed), freeze tolerance, and yield and/or quality of biomass and seed. These and other performance traits differ substantially in ease of breeding manipulation based on magnitudes of natural genetic variation, mode of inheritance, heritability, and the efficiency and effectiveness of selection screens. Molecular techniques offer the same potential for genetic manipulation of bermudagrass as for other plant species. Genetic transformation and marker assisted selection are respective techniques that hold great promise in helping achieve breeding goals that are not attainable or difficult to attain with traditional techniques. The most important determinant of future genetic improvement of bermudagrass is the amount of resources that will be devoted to the effort.

## References

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