BEEF PRODUCTION FROM NITROGEN-FERTILIZED MOTT DWARF ELEPHANTGRASS AND PENSACOLA BAHIAGRASS PASTURES

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ABSTRACT

Beef production was compared on pastures of two N-fertilized grasses, a recently released dwarf elephantgrass (*Pennisetum purpureum* cv. Mott) and bahiagrass (*Paspalum notatum* cv. Pensacola), the predominant pasture grass in Florida. This study was carried out over 3 years during the summer growing season. Average daily liveweight gain (ADG) over the 3 seasons was 0.97 kg for Mott and 0.38 kg for Pensacola. Average stocking rate (SR) on both grasses was approximately 4 yearling steers/ha, and total beef production/ha averaged 483 kg for Mott and 318 kg for Pensacola.

Differences in ADG between grasses was primarily due to higher digestibility and protein in Mott herbage than in Pensacola. Differences in ADG and nutritive value between grasses were particularly pronounced during the late summer to early autumn period, a time when ADG on Pensacola was very low. Estimated dry matter accumulation on Mott and Pensacola pastures averaged 8.2 and 7.1 t/ha/yr over the 3 years.

Mott persists well under good grazing management. The principal limitation to its adoption is the need to propagate it vegetatively. We conclude that Mott has great potential to improve animal production in areas of the tropics and sub-tropics where elephantgrasses are adapted and labor costs are low.

RESUMEN

*Dos pasturas fertilizadas con N fueron comparadas en la producción de carne; el pasto elefante enano (*Pennisetum purpureum *Schum. cv. Mott), liberado recientemente y el pasto bahia (*Paspalum notatum *Flugge cv. pensacola), la pastura predominante en Florida. Este estudio fue conducido por más de 3 años durante la estación de crecimiento, en el verano. En las 3 estaciones, el promedio diario en las ganancias de peso vivo (GDP) fue de 0.97kg para Mott y 0.38kg para pensacola. En ambas pasturas el promedio de la carga animal (CA) fue de aproximadamente 4 novillos/ha, y la producción total de carne promedio/ha fue de 483kg para Mott y de 318kg para pensacola. Las diferencias en las GDP entre las pasturas fue debido a la mayor digestibilidad y proteina del pasto Mott. Las diferencias en GDP y valor nutritivo entre las pasturas fueron pronunciadas particularmente durante el periodo final del verano para los comienzos del otoño, periodo enn donde GDP en pensacola fue bastante bajo. En los 3 años, la acumulación estimada de materia seca en las pasturas Mott pensacola promediaron 8.2 y 7.1 t/ha año.*

Bajo buen manejo del pastoreo, Mott persiste bien. La principal limitante para su adopción es la necesidad de propagarlo vegetativamente. Concluimos que Mott tiene un gran potencial para mejorar la producción animal en qreas de los trópicos y sub-trópicos, donde los pastos elefantes esten adaptados y los costos de la mano de obra sean bajos.

INTRODUCTION

Many improved pasture-livestock systems in the subtropics and tropics are based on warm-season perennial grasses. If soil fertility is maintained, these forages are very productive and support high stocking rates (SR) during months when temperature and soil moisture are not limiting. Gains of steers grazing N-fertilized warm-season grasses, however, generally do not exceed 0.6 kg/d over an entire grazing season (Mott and Moore 1977). Mid-summer gains in the Southeast USA on forages like bahiagrass (*Paspalum notatum*) and limpograss (*Hemarthria altissima*) are often less than 0.2 kg/d (Pitman *et al.* 1984; Prates *et al.* 1974; Rusland *et al.* 1988). Higher quality warm-season grasses could contribute significantly to forage-livestock enterprises.

Preliminary evaluation of Mott dwarf elephantgrass (*Pennisetum purpureum*) indicated that it was a potentially high quality perennial forage that was adapted in Southeast USA and in areas of the subtropics and tropics (Sollenberger *et al.* 1988a). Desirable attributes of Mott include a high leaf:stem ratio over a wide range of maturities (Boddorff and Ocumpaugh 1986), high DM production (Kalmbacher *et al.* 1987), high leaf IVOMD (75%) and CP (14%) of 35-d regrowth (Boddorff and Ocumpaugh 1986), and persistence under grazing when well managed (Sollenberger *et al.* 1988a).

The high nutritive value of Mott herbage suggests that it may be capable of supporting steer gains in excess of those normally associated with tropical grasses. Thus a grazing trial was conducted to assess animal performance and herbage nutritive value of Mott elephantgrass. It was compared with Pensacola bahiagrass because Pensacola is the predominant pasture grass used in Florida.

MATERIALS AND METHODS

The experiment was conducted from 1984 to 1986 at the Forage Evaluation Field Laboratory of the Beef Research Unit, University of Florida, located 20 km northeast of Gainesville, Florida, USA (lat. 29°60′N). Three, 0.6-ha pastures of Mott elephantgrass and three, 1-ha pastures of Pensacola bahiagrass were established in 1980 and 1981 and regularly defoliated through the summers of 1982 and 1983.

Because of differences between grasses in adaptation to soil drainage, Mott was planted on moderately-well to well-drained sandy Entisols of the Adamsville series, and Pensacola was planted on less well-drained Spodosols of the Pomona series. Soil pH ranged from 5.8 to 6.4, and Mehlich I extractable P and K averaged 20 and 60 mg/kg. Phosphorous and K were broadcast at rates of 20 and 60 kg/ha in March or early April each year. All pastures received a micronutrient mixture that supplied 0.3 kg B, 0.3 kg Cu, 1.8 kg Fe, 0.75 kg Mn, 0.02 kg Mo, and 0.7 kg Zn per hectare annually. Split applications of N were made to provide total annual rates of 240, 120, and 120 kg/ha in 1984, 1985, and 1986 for Mott, and 270, 150, and 130 kg for Pensacola. The first N application was made with the P and K in spring, and subsequently after each grazing period except the last one of the season. Pensacola received more N each year because of a longer grazing season.

Rainfall totals during the 3 grazing seasons (April through November) were 799 mm in 1984, 1220 mm in 1985, and 726 mm in 1986, compared to a 70-yr mean of 1039 mm. The August through October period was very dry in 1984 (161 vs. the 70-yr mean of 447 mm), and April and May were quite dry in 1986 (47 vs. the 70-yr mean of 167 mm).

Grazing seasons for Mott were from May 23 through October 17, 1984 (147 d), June 26 through October 30, 1985 (126 d) and July 2 through November 5, 1986 (126 d). Pensacola was grazed from May 2 through November 7, 1984 (189 d), May 15 through October 30, 1985 (168 d), and June 11 through November 5, 1986 (147 d). Length of grazing seasons varied primarily due to spring temperature and moisture conditions, with grazing initiated late in 1986 because of a spring drought.

Each of the 3 pastures of both grasses was divided into 6 paddocks and a 42-d rotational grazing system, with 7-d grazing and 35-d rest periods, was used. For both grasses, we attempted to attain maximum utilization of DM without jeopardizing persistence. Stubble heights after grazing were 35-40 cm for Mott (Veiga 1983) and 6-8 cm for Pensacola.

Two (Mott) or 4 (Pensacola) 15- to 18-month old steers were assigned as testers to each pasture. Additional grazers were added at weigh days or intermediate times to achieve the desired postgraze stubble height. Steers were implanted with Zeranol (a pituitary stimulant that produces higher growth levels) every 63 d during the trial and had access to a mineral supplement throughout.

Animals were weighed at 21-d intervals after overnight fasting. Weight gain of testers was used to calculate ADG for a specific pasture. Mean SR was calculated using both tester and additional grazer animals, and it is expressed in kg liveweight/ha/d. Animal days/ha was determined by summing kg liveweight units stocked on the pasture over the season and dividing by the mean weight of the testers on that pasture. Gain/ha was calculated as the product of ADG and animal days/ha.

Herbage samples were taken before and after grazing every third week. In Mott pastures, leaf herbage mass was predicted from measurement of canopy height. The relationship between height and leaf mass (r^2 = 0.8 to 0.9) was similar to that reported by Veiga (1983). The disk meter was used to determine herbage mass to ground level in Pensacola pastures (Santillan *et al.* 1979). Herbage accumulation during the rest periods was calculated by summing pregraze herbage mass over the year and subtracting the sum of all values of postgraze herbage mass except the last (Frame, 1981). Growth during each grazing period was calculated from growth rate (g herbage DM/d) during the preceding rest period. Herbage accumulation was the sum of estimated growth during grazing and accumulation during rest periods. Herbage allowance was calculated as the sum of pregraze herbage mass over the season divided by the seasonal total of kg units of liveweight stocked.

In 1984 and 1986, hand-plucked samples were taken at 20 to 30 locations prior to each grazing. Herbage was severed at the target postgraze stubble height. These samples were dried and ground to pass a 1-mm screen using a Wiley mill and were analyzed for N and IVOMD. Samples were digested for N determinations using a modification of the aluminum block digestion procedure (Gallagher *et al.* 1975). Ammonia in the digestate was determined by semiautomated colorimetry (Hambleton 1977), and CP (DM basis) was calculated as N x 6.25. *In vitro* organic matter digestibility was determined using a modified two-stage procedure (Moore and Mott 1974).

RESULTS AND DISCUSSION

Steer gains on Mott averaged 0.97 kg/d over 3 grazing seasons (Table 1). No perennial tropical grass evaluated at our location has previously supported gains of this magnitude. By comparison, gains on Pensacola averaged 0.38 kg/d (Table 1). Under the management imposed, mean herbage allowance was 4.9% of steer liveweight for Mott compared to 3.7% for Pensacola (Table 2). Pastures were grazed slightly below or at least to the low end of the target stubble height ranges in 1984, and herbage allowance was lower than in 1985 and 1986. The primary reason for increasing stubble heights to the upper boundary of the range for 1985 and 1986 was to insure persistence. If grazed somewhat less intensively, ADG may have been higher on Pensacola than the levels we observed. Our gain per animal responses, however, were similar to or higher than most reported in the literature for bahiagrasses (Prates *et al.* 1974; Utley *et al.* 1974), and markedly lower than those on Mott.

Gain per hectare and mean SR of Mott and Pensacola pastures were higher in 1984 than in 1985 or 1986 due to higher N fertilizer rates in 1984 (Table 1). Despite a shorter grazing season for Mott, gain/ha averaged 483 kg/yr compared to 318 kg/yr for Pensacola (Table 1). Mott SR was not different than for Pensacola pastures in any year, but it tended to be somewhat lower (Table 1) despite greater herbage accumulation on Mott pastures. Intake of steers on Pensacola was likely lower than on Mott, and this partially explains the relationship between herbage accumulation and SR. Relative to Pensacola, Mott was more productive in autumn, but to ensure persistence, SR on Mott pastures needed to be reduced in late September as plant growth rates declined.

Over 3 yr, mean leaf DM accumulated on Mott pastures was 8.2 t/ha/yr in grazing seasons that averaged 133 d (Table 2). Pensacola herbage accumulation was 7.1 t/ha in an average of 168 d. Pasture productivity was higher in 1984 than in 1985 and 1986,

TABLE 1

Seasonal average daily gain (ADG), late-summer to early-autumn ADG, mean stocking rate (SR), and gain/ha of yearling steers grazing Mott dwarf elephantgrass and Pensacola bahiagrass pastures.

Year	Days of grazing		ADG		Late summer ADG[1]		SR[2]		Gain/ha	
	Mott	Bahia	Mott	Bahia	Mott	Bahia	Mott	Bahia	Mott	Bahia
	(d)		(kg)		(kg)		(kg LW/ha/d)		(kg)	
1984	147	189	0.93a[3]	0.42b	1.02a	0.32b	1760a	2030a	651a	490b
1985	126	168	0.89a	0.17b	0.99a	−0.03b	1410a	1530a	333a	131b
1986	126	147	1.09a	0.56b	1.25a	0.37b	1370a	1470a	465a	334b
Mean	133	168	0.97a	0.38b	1.09a	0.22b	1510a	1680a	483a	318b
SE[4]			0.01		0.03		63		17	

[1] Late summer to early autumn was a 63-d period from July 25 to September 26, 1984, August 7 to October 9, 1985, and July 23 to September 24, 1986.
[2] Mean stocking rate is expressed as kg liveweight (LW)/ha/d.
[3] Means within years followed by different letters are different ($P<0.05$).
[4] Standard error of a grass mean over years.

TABLE 2

Herbage accumulation, herbage allowance, and mean hand-plucked herbage crude protein (CP) and in vitro organic matter digestibility (IVOMD) on Mott elephantgrass and Pensacola bahiagrass pastures during 1984 to 1986.

Year	Herbage accumulation		Herbage allowance[1]		Whole season CP		Whole season IVOMD		Late summer[2] CP		Late summer[2] IVOMD	
	Mott	Bahia	Mott	Bahia	Mott	Bahia	Mott	Bahia	Mott	Bahia	Mott	Bahia
	(t/ha)		(%)		(%)							
1984	9.5a[3]	8.5a	4.4a	2.9b	13.8a	11.2b	71.2a	60.8b	14.5a	10.4b	71.2a	58.4b
1985	8.1a	7.3b	5.2a	4.1a	–	–	–	–	–	–	–	–
1986	6.9a	5.5b	5.2a	4.2a	12.7a	12.0a	69.3a	55.7b	13.1a	11.3b	69.3a	54.2b
Mean	8.2a	7.1b	4.9a	3.7b	13.2a	11.6b	70.2a	58.3b	13.8a	10.8b	70.3a	56.3b
SE[4]	0.27		0.26		0.02		0.11		0.05		0.18	

[1] Kilograms of herbage (based on pregraze herbage mass) as a percentage of kg units of animal liveweight on pasture.
[2] Late summer to early autumn was a 63-d period from July 25 to September 26, 1984; August 7 to October 9, 1985; and July 23 to September 24, 1986.
[3] Means within a year followed by different letters are different ($P<0.10$ for herbage accumulation and allowance; $P<0.01$ for CP and IVOMD).
[4] Standard error of a grass mean over years.

primarily due to higher N rates. Drought conditions early in the 1986 growing season limited herbage accumulation in that year.

Nutritive value of hand-plucked Mott herbage was high relative to Pensacola, and is thought to be responsible for higher ADG on Mott. Mean IVOMD over the season was more than 10 percentage units higher for Mott in both 1984 and 1986 (Table 2). Protein concentration in Mott herbage was higher than in Pensacola in 1984 when pastures were heavily fertilized, but concentrations were not different in 1986 (Table 2). The most striking aspect of the nutritive value data was the fact that Mott maintained digestibilities of approximately 70%, a level that is markedly higher than commonly observed for tropical grasses of similar maturity.

High ADG was maintained on Mott pastures throughout the year whereas with Pensacola there were patterns in ADG within years. Gains on Pensacola were highest in spring and dropped dramatically during the hot, humid mid-summer to early autumn period (Table 1). Pensacola CP and IVOMD averaged 0.8 and 2 percentage units lower than the annual mean during this period of low ADG (Table 2). In contrast, Mott CP, IVOMD, and ADG were as high or higher during mid-summer to early autumn as over the whole year (Tables 1 and 2). Within year variation in forage quality of warm-season perennial grass pastures has been well documented. During 3 years of grazing on 4 warm-season grass cultivars in South Florida, Pitman *et al.* (1984) reported mean spring and autumn daily gains of 0.79 and 0.63 kg, compared to 0.15 kg in August. Similarly, Prates *et al.* (1974) observed gains on Pensacola bahiagrass of 1 kg/d in May and 0.14 kg in August.

These data highlight the potential for Mott in forage livestock systems where maintaining high gains throughout the growing season is critical. The only times during the trial when gains on Mott were low (0.55 kg) occurred in the first grazing period of both 1984 and 1985. Steers used in those years had not grazed the grass before, and were reluctant to graze it for the first several days to 1 week.

We conclude that Mott dwarf elephantgrass is a persistent, high quality, perennial forage grass capable of supporting an average of 4 yearling steers/ha during the growing season. Daily gains on Mott approached 1 kg/d, far exceeding those reported for other tropical grasses in Florida. Consistently high IVOMD and CP levels were associated with excellent animal performance. The principal limitation to use of Mott in the USA is that it must be vegetatively propagated using stem cuttings (Sollenberger *et al.* 1988b).

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