Influence of Grazing on Morphology and Nutritive Value of Coastal Bermudagrass

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Summary

A study was conducted to measure the effects of graded levels of grazing pressure upon the growth, morphological, and nutritive value responses of Coastal bermudagrass. Four pastures of varying size were stocked with a similar number of cattle to obtain the desired levels of available forage. Beginning in June, forage measurements were made at approximately 2-week intervals through September. The forage growth rate did not differ ($P>0.05$) among grazing pressure levels, although specific forage growth rate increased ($P<0.01$) with increased grazing pressure level. As grazing pressure increased, the proportion of green stem in the available forage decreased ($P<0.01$), and the proportions of green leaf and dead forage in the sward increased ($P<0.01$). The neutral detergent fiber content of the green leaf, green stem, and dead forage components of the sward decreased ($P<0.01$) with increasing grazing pressure level.

Introduction

A major objective of grazing management is to optimize the relationships between the production and utilization of forage and animal performance for a given set of inputs and resources. In order to achieve that optimization, knowledge of the quantitative relations between grazing pressure and the sward and animal responses at the plant-animal interface is necessary. Defoliation by the grazing animal is a major determinant of the growth and morphological structure of the

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forage plant (Harris, 1978). Altering the morphological structure of the plant can affect the degree of selectivity the animal may exert for the preferred forage components (Stobbs, 1973). Additionally, grazing pressure can alter the composition of the available forage, and thereby affect the nutritive value of the diet selected by the grazing animal.

The primary objective of the research reported in this manuscript was to quantitatively measure the growth, morphological, and nutritive value responses of Coastal bermudagrass to different levels of available forage established by graded levels of grazing pressure.

Procedure

Four contiguous pastures of various sizes and graded levels of grazing pressure were used to obtain the desired levels of available forage. The pasture sizes and mean grazing pressures (pound of forage per dry matter/100 lb animal body weight) achieved are listed in Table 1. All pastures were fertilized at the total rate of 250-100-100 of N-P_2O_5-K_2O. Phosphorus and potassium were applied in October and nitrogen applied in five equal applications from February to September.

Each pasture was stocked with a grazing herd consisting of two yearling bi-fistulated (rumen and esophageal) yearling Brahman steers, four F-1 Brahman x Hereford cows and their suckling Simmental-sired calves, and five Brahman crossbred stocker calves. The study utilized cows with fall-born calves (October and November) until the calves were weaned on July 12. On July 15, cows with spring-born calves (February and March) of identical breeding were added to the grazing herd in each pasture, and remained until the conclusion of the study on September 25. The grazing was continuous, using a put-and-take, variable stocking rate to maintain the desired levels of available forage. The targeted levels of available forage (lb forage dry matter/A) are listed in Table 1.

The quantity of available forage and additional measurements of forage growth rate, morphology, and nutritive value of the available forage were made at approximately 14-day intervals. The amount of available forage was determined by clipping to ground level. The forage growth rate (lb forage dry matter/A/day) was determined by differences in the amount of forage dry matter present in two protected, enclosed areas per pasture (F_O) and in unprotected areas available for grazing at the start of the growth period (F_N) when the growth period was N days.

$$\text{Forage Growth Rate} = \frac{F_N - F_O}{N}$$

The specific forage growth rate was calculated by dividing the forage growth rate by the amount of available forage present at the start of the growth period.

$$\text{Specific Forage Growth Rate} = \frac{\text{Forage Growth Rate}}{F_O}$$

TABLE 1. PASTURE SIZE, TARGETED AND ACHIEVED AVAILABLE FORAGE, AND RESULTANT MEAN GRAZING PRESSURES FOR COASTAL BERMUDAGRASS

	Grazing pressure level			
Item	High (H)	Medium high (MH)	Medium low (ML)	Low (L)
Pasture size, A	2.3	3.2	5.3	5.3
Available forage, lb dry matter/A				
Targeted	900	1,800	2,700	4,500
Achieved[1]	980	1,729	2,480	3,971
Grazing Pressure[1] lb forage dry matter/ 100 lb animal wt	12.0	38.9	70.5	156.4

[1]Mean values for study period.

The clipped forage samples used to measure the amount of available forage were hand-separated into green leaf, green stem, and a category classified as "dead." The dead category contained inflorescences, plant parts which appeared to have senesced, and stolons or rhizomes which were pulled to the surface through grazing. All components were dried in a forced draft oven at 55°C for 48 hours, and then weighed to determine component proportions of the sward. The components were then ground through a Wiley mill fitted with a 2 mm screen and subsequently analyzed for NDF content (Georing and Van Soest, 1970).

Results and Discussion

The quantity of available forage was reduced by increasing the grazing pressure level (Table 2). While the grazing pressure levels of medium low (ML) and low (L) did not hold their targeted rank for quantity of available forage on June 1, distinct differences were maintained among the grazing pressure levels after that date. The forage growth rate did not differ ($P>0.05$) among grazing pressure levels (Table 3). However, a difference was evident ($P<0.01$) across measurement dates with forage growth tending to decline as the season progressed. The forage growth rates measured in

TABLE 2. THE AMOUNT OF AVAILABLE FORAGE ACHIEVED BY FOUR GRAZING PRESSURE LEVELS

	Grazing pressure level			
Date	High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	Pounds of Dry Matter/Acre[1]			
Feb. 24	2,860	2,762	3,338	3,213
Mar. 14	1,039	1,983	1,607	2,387
Apr. 13	782	1,629	1,188	2,124
June 1	318	548	1,270	1,048
June 28	968	1,454	1,640	2,884
July 13	1,044	1,667	2,310	4,411
Aug. 2	1,139	2,703	3,607	6,999
Aug. 20	524	1,540	3,046	6,396
Sept. 4	565	1,999	3,601	5,222
Sept. 17	548	1,011	3,199	5,018
Mean	980	1,729	2,480	3,971

[1]N = Four areas/grazing pressure level/date.

TABLE 3. THE FORAGE GROWTH RATE OF COASTAL BERMUDAGRASS GRAZED AT FOUR GRAZING PRESSURE LEVELS

Date	Grazing pressure level: High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	Pounds of Dry Matter/Acre Day[1]			
June 28	126.3 ± 24.6[2]	115.5 ± 2.1	142.6 ± 31.5	149.4 ± 0.12
July 13	[3]	92.4 ± 38.2	124.3 ± 6.8	243.7 ± 3.0
Aug. 2	67.8 ± 7.1	156.3 ± 7.4	73.7 ± 13.0	116.6 ± 11.6
Aug.	40.1 ± 4.9	16.7 ± 26.1	47.7 ± 2.7	-116.2 ± 7.1
Sept. 4	64.9 ± 16.6	50.0 ± 46.0	76.8 ± 38.7	-6.5 ± 61.3
Sept. 17	44.7 ± 12.6	33.7 ± 41.3	23.6 ± 70.7	35.1 ± 65.1
Mean	68.8	77.4	81.4	70.4

[1]N = Two exclosures/GPL/date.
[2]Values are mean ± Standard deviation.
[3]No observation for H on July 13 due to animals disturbing exclosures.

this study corresponded to the time and amount of moisture received. The greatest amount of precipitation, 8.43 inches, was received during the growth period which ended on June 28 (Table 4). This also coincided with the highest forage growth rates determined for all grazing pressure levels (Table 3). Additionally, the moisture for August was received at a time to account for the small increase noted in forage growth rates for the period ending September 4.

The specific forage growth rate (SFGR) increased ($P<0.01$) with increased grazing pressure level (Table 5) and decreased with advancing date in the season. The SFGR was an indicator of the growth produced by each unit of available forage. The trend for greater SFGR with increased grazing pressure level indicated that each unit of available forage was becoming more productive as grazing pressure was increased.

A significant difference ($P<0.01$) existed among grazing pressure levels as the proportion of the green leaf component present in the available forage (Table 6) increased with increased grazing pressure level. In addition, the proportion of green leaf component differed ($P<0.01$) among measurement dates. The proportion of green leaf component in the available forage of this study followed a pattern suggested by the SFGR. All grazing pressure levels achieved their maximum SFGR during the growth period ending June 28, which coincided with the highest leaf proportions for all grazing pressure levels, except the high (H) grazing pressure level. After June 28, the decline in proportion of green leaf in the sward coincided with a time of moisture shortage and decreased SFGR, although the amount of available forage continued to increase.

Increasing the grazing pressure level tended to decrease ($P>0.01$) the stem proportion of the sward (Table 7). The changes in morphological composition of the sward due to grazing pressure were exemplified by the divergent trends and growth habits on the L and H pastures, respectively (Table 8). Coastal bermudagrass grown at L had an erect form and a high tiller density. Visual observations suggested that new growth was expressed as fine, long leaves extending beyond the

TABLE 4. MEAN RAINFALL AND RAINFALL MEASURED AT TEXAS AGRICULTURAL EXPERIMENT STATION, OVERTON FROM MAY THROUGH SEPTEMBER

Month	Rainfall measured during trial	16-year mean rainfall
	Inches	
May	7.20	4.49
June	8.43	4.45
July	1.57	2.95
August	2.17	1.81
September	1.18	4.37
Total	20.55	18.07

TABLE 5. THE SPECIFIC FORAGE GROWTH RATE OF COASTAL BERMUDAGRASS GRAZED AT FOUR GRAZING PRESSURE LEVELS

Date	Grazing pressure level: High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	Specific Forage Growth Rate[1]			
June 28	0.396 ± 0.035[2]	0.241 ± 0.119	0.113 ± 0.018	0.144 ± 0.021
July 13	[3]	0.064 ± 0.025	0.076 ± 0.004	0.085 ± 0.002
Aug. 2	0.066 ± 0.005	0.098 ± 0.029	0.032 ± 0.003	0.027 ± 0.007
Aug. 20	0.036 ± 0.010	0.005 ± 0.008	0.013 ± 0.001	-.017 ± 0.001
Sept. 4	0.124 ± 0.032	0.031 ± 0.027	0.025 ± 0.013	-.001 ± 0.010
Sept. 17	0.083 ± 0.029	0.033 ± 0.041	0.006 ± 0.021	0.007 ± 0.013
Mean	0.141	0.079	0.044	0.041

[1]N = Two exclosures/GPL/date.
[2]Values are mean ± Standard deviation.
[3]No observation for H on July 13 due to animals disturbing exclosures.

terminal growing point of the stem. This structure of the plant and high tiller density enabled the animal to easily select the new growth of leaves in the upper horizon of the forage canopy, and to discriminate against stem material with little restriction on bite size. In contrast, observations of the sward growing at the H indicated an altered growth structure resulting from this level of defoliation. Tiller density on the H pastures was reduced as compared to the other grazing pressure levels, with the growth being characterized by short, thick rhizomes growing horizontal to the ground and producing short leaves which remained close to the stem. The very low growth structure makes accessibility by the animal difficult. And, coupled with only slight extension of the leaf from the stem, the ability of the animal to select against stem material may be restricted.

A trend was present at increased grazing pressure levels for a decrease in ($P<0.01$) the NDF content of the green leaf (Table 9), green stem (Table 10), and the dead (Table 11) forage components. Further, all forage components increased ($P<0.01$) in NDF content with advancing date in the season. The NDF content of forages is an indication of the amount of cell wall constituents present (Goering and Van Soest, 1970). Young, growing plant tissue has a lower cell wall content than mature or senescent material of the same species (Mowat et al., 1969). The trend for an increase in the NDF content of the green leaf at the ML and L and the green stem

TABLE 6. THE PROPORTION OF GREEN LEAF IN COASTAL BERMUDAGRASS SWARDS GRAZED AT FOUR GRAZING PRESSURE LEVELS

Date	Grazing pressure level: High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	Leaf percent[1]			
June 28	52.1 ± 7.1[2]	49.7 ± 5.0	46.7 ± 3.9	43.2 ± 1.8
July 13	47.9 ± 8.9	49.6 ± 1.1	43.3 ± 2.0	40.0 ± 4.5
Aug. 2	25.7 ± 2.2	21.9 ± 2.0	38.5 ± 8.9	30.7 ± 2.9
Aug. 20	33.2 ± 2.1	20.4 ± 0.32	34.5 ± 1.2	42.5 ± 6.7
Sept. 4	62.0 ± 1.9	32.0 ± 1.5	44.6 ± 5.3	31.4 ± 0.67
Sept. 17	68.2 ± 3.1	31.2 ± 6.1	42.5 ± 1.8	26.6 ± 0.28
Mean	48.2	34.1	41.7	35.8

[1]N = Four samples/GPL/date.
[2]Values are mean ± Standard deviation.

TABLE 7. THE PROPORTION OF GREEN STEM IN COASTAL BERMUDAGRASS SWARDS GRAZED AT FOUR GRAZING PRESSURE LEVELS

Date	Grazing pressure level: High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	Stem percent[1]			
June 28	42.0 ± 7.6[2]	46.1 ± 4.8	49.7 ± 2.5	51.2 ± 3.2
July 13	38.9 ± 6.2	45.1 ± 3.7	52.4 ± 3.3	55.7 ± 5.2
Aug. 2	47.6 ± 4.3	59.9 ± 4.2	57.7 ± 9.9	66.8 ± 1.4
Aug. 20	43.6 ± 12.4	64.5 ± 0.32	58.3 ± 12.3	56.8 ± 5.8
Sept. 4	34.8 ± 0.34	64.5 ± 0.49	58.6 ± 5.0	62.5 ± 0.62
Sept. 17	29.9 ± 5.7	61.2 ± 3.2	50.4 ± 1.0	71.8 ± 0.01
Mean	39.5	56.9	54.5	60.6

[1]N = Four samples/GPL/date.
[2]Values are mean ± Standard deviation.

TABLE 8. THE PROPORTION OF DEAD FORAGE IN COASTAL BERMUDAGRASS SWARDS GRAZED AT FOUR GRAZING PRESSURE LEVELS

Date	Grazing pressure level: High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	Dead Forage percent[1]			
June 28	5.8 ± 5.0[2]	4.1 ± 3.1	4.0 ± 2.9	5.6 ± 3.1
July 13	13.0 ± 7.3	5.0 ± 2.6	4.3 ± 2.3	4.2 ± 1.5
Aug. 2	26.7 ± 3.8	18.2 ± 5.1	3.8 ± 1.9	2.6 ± 1.8
Aug. 20	23.2 ± 10.3	15.2 ± 0.59	7.2 ± 8.8	0.7 ± 0.82
Sept. 4	3.2 ± 2.2	3.5 ± 1.1	4.3 ± 0.26	6.1 ± 0.06
Sept. 17	4.5 ± 1.1	7.6 ± 2.8	7.1 ± 2.8	1.6 ± 0.28
Mean	12.2	9.0	5.1	3.8

[1]N = Four samples/GPL/date.
[2]Values are mean ± Standard deviation.

TABLE 9. THE NEUTRAL DETERGENT FIBER (NDF) CONTENT OF GREEN LEAF IN COASTAL BERMUDAGRASS SWARDS GRAZED AT FOUR GRAZING PRESSURE LEVELS

Date	Grazing pressure level: High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	NDF percent[1]			
June 28	68.7 ± 3.2[2]	69.4 ± 2.3	74.3 ± 3.0	74.3 ± 1.9
July 13	68.3 ± 1.6	72.2 ± 2.2	76.2 ± 2.5	75.4 ± 1.8
Aug. 2	77.4 ± 1.6	76.5 ± 1.5	76.4 ± 1.5	74.5 ± 0.58
Aug. 20	74.7 ± 3.4	74.8 ± 2.5	77.4 ± 2.3	76.0 ± 1.7
Sept. 4	74.8 ± 0.42	76.6 ± 0.18	77.9 ± 0.07	76.8 ± 0.42
Sept. 17	75.9 ± 3.3	76.6 ± 0.47	77.9 ± 0.01	76.9 ± 0.23
Mean	73.3	74.4	76.7	75.7

[1]N = Four samples/GPL/date.
[2]Values are mean ± Standard deviation.

TABLE 10. THE NEUTRAL DETERGENT FIBER (NDF) CONTENT OF GREEN STEM IN COASTAL BERMUDAGRASS SWARDS GRAZED AT FOUR GRAZING PRESSURE LEVELS

Date	Grazing pressure level: High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	NDF percent[1]			
June 28	70.3 ± 2.7[2]	69.5 ± 2.0	72.7 ± 2.8	73.3 ± 2.9
July 13	71.9 ± 0.84	71.9 ± 1.6	74.2 ± 0.77	76.2 ± 1.1
Aug. 2	71.3 ± 6.9	77.6 ± 0.82	78.0 ± 0.94	76.8 ± 2.7
Aug. 20	74.6 ± 0.62	76.1 ± 0.86	77.5 ± 4.4	76.5 ± 1.3
Sept. 4	75.2 ± 0.14	77.0 ± 0.14	80.0 ± 0.21	80.0 ± 0.78
Sept. 17	78.1 ± 0.33	78.8 ± 1.2	79.5 ± 0.98	80.0 ± 0.75
Mean	73.6	75.2	77.0	77.1

[1]N = Four samples/GPL/date.
[2]Values are mean ± Standard deviation.

TABLE 11. THE NEUTRAL DETERGENT FIBER (NDF) CONTENT OF DEAD FORAGE IN COASTAL BERMUDAGRASS SWARDS GRAZED AT FOUR GRAZING PRESSURE LEVELS

Date	Grazing pressure level: High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	NDF percent[1]			
June 28	74.2 ± 0.53[2]	67.8 ± 0.48	70.9 ± 0.40	69.9 ± 0.46
July 13	59.5 ± 0.97	69.1 ± 0.49	69.7 ± 0.25	74.2 ± 0.17
Aug. 2	63.0 ± 0.15	71.3 ± 0.18	73.1 ± 0.38	72.3 ± 0.59
Aug. 20	69.3 ± 1.4	79.8 ± 1.4	77.9 ± 0.64	78.8 ± 1.4
Sept. 4	80.1 ± 0.13	79.1 ± 0.57	78.6 ± 0.14	81.9 ± 0.64
Sept. 17	80.1 ± 1.1	80.1 ± 0.64	78.6 ± 0.41	78.6 ± 0.18
Mean	71.0	74.5	74.8	76.0

[1]N = Two samples/GPL/date.
[2]Values are mean ± Standard deviation.

material of the bermudagrass at the four grazing pressure levels may be due to the accumulation and consequent aging of this forage (Burton et al., 1967). A higher defoliation rate associated with an increased grazing pressure level would theoretically result in a younger mean age of leaf material in the sward and a subsequent lower NDF content. Although the NDF content of green leaf declined with increased grazing pressure level, the small difference in NDF content of green leaf between the high and low grazing pressure levels did not infer a great difference in age. The similarity among grazing pressure levels to increase in NDF content of forage material with advancing date may have been the result of the increased environmental temperatures (Deinum, 1966). The trend of declining NDF content of forage components with increased grazing pressure level indicated a sward of greater nutritive value at the H grazing pressure level.

In conclusion, the level of grazing pressure did not alter the forage growth rate of the sward. However, increasing the grazing pressure level resulted in an increase in the growth rate per unit of available forage, which was attributed to the greater proportions of the green leaf component present in the sward. The higher rates of defoliation associated with increased levels of grazing pressure were deemed casual of the increase in proportion of the green leaf component in the sward and the decrease in NDF content of forage components.

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