Influence of Grazing Pressure on Forage Digestibility, Intake, and Liveweight Gain

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Summary

The effects of grazing pressure on organic matter intake (OMI), organic matter digestibility (OMD) of the diet, and average daily gain (ADG) by cattle were evaluated with 'Marshall' ryegrass-'Mt. Barker' subterranean clover-Coastal bermudagrass pastures. A put-and-take, variable stocking rate technique was used to establish four grazing pressure levels (high, H; medium high, MH; medium low, ML; and low, L). Each grazing pressure level was stocked with two esophageal fistulated yearling steers, four lactating cows and their suckling calves, and five stocker calves. The neutral detergent fiber (NDF) content of the diet of the esophageal fistulated steers decreased ($P<0.01$) as grazing pressure level increased. The OMD of the diet was highest ($P<0.01$) at the MH and L grazing pressures. The OMI of fistulated steers and lactating cows was highest ($P<0.01$) on ML, and lowest on H pastures. In contrast, the OMI by the suckling calves declined ($P<0.01$) as the grazing pressure level was reduced. The ADG of stocker calves, suckling calves, and lactating cows declined ($P<0.01$) as grazing pressure level increased. The results of this study indicated that although diet quality was improved as grazing pressure level increased, the greater competition for the available forage restricted the nutrient uptake of cattle on the H grazing pressure and this resulted in a depressed ADG.

KEYWORDS: Coastal bermudagrass/stocking rate/animal performance/intake/digestibility.

Introduction

The performance of the individual grazing animal generally decreases as grazing pressure is increased, while a simultaneous increase in total liveweight gain per unit of land is noted. These responses to grazing pressure appear to be mediated by the interactive factors at the plant-animal interface and their influence on the quantity and quality of forage consumed by the grazing animal. The exact relations at the plant-animal interface remain largely conceptual and qualitative. The objectives of this study were to evaluate the influence of grazing pressure on forage intake and digestibility and liveweight gain of cattle grazing Coastal bermudagrass.

Procedure

Coastal bermudagrass was oversown with 'Mt. Barker' subterranean clover and 'Marshall' ryegrass and grazed from February to September. Four contiguous pastures, situated on a Darco soil and varied in size, were grazed at four levels of grazing pressure to obtain the desired quantities of available forage (Table 1) as well as the mean grazing pressures (lb forage dry matter/100 lb animal liveweight).

Each pasture was continuously grazed with a grazing herd consisting of two yearling esophageal and rumen fistulated Brahman steers, four F-1 Brahman x Hereford cows and their Simmental-sired suckling calves, and five Brahman crossbred stocker calves. Cows with fall-born (October and November) calves were used until July 12 when the calves were weaned, and then replaced by cows with spring-born (February and March) calves. A put-and-take, variable stocking rate, using cow and calf pairs or dry cows as regulators, was employed to maintain the desired levels of available forage.

The diet of cattle at each grazing pressure level was determined by collection of esophageal extrusa samples from the esophageal fistulated steers present in each pasture at approximately 2-week intervals. To avoid altering the grazing behavior due to fasting (Sidahmed et al., 1977) extrusa samples were collected during peak grazing periods without previously restricting the animals from feeding. The extrusa samples were analyzed for proportion of leaf and stem material, was well as neutral detergent fiber content (NDF) of dietary leaf and stem material by a modification of the procedures of Goering and Van Soest (1970). This paper will present the NDF content of the diet as a whole, based on the dietary leaf/stem proportions and their respective NDF contents.

Intake digestibility trials began on June 21 (trial 1), August 15 (trial 2), and September 19 (trial 3). Esophageal extrusa was soaked in a solution of either La or Yb and administered through a gelatin capsule as a pulse dose particulate marker for estimating fecal output (FO). Fecal grab samples were collected serially post-dose for 5 days. The fecal samples were ground to pass a 2 mm screen in a Wiley mill. The esophageal extrusa from the fistulated steers and fecal samples from each animal were analyzed for indigestible NDF (INDF) content. The INDF content was defined as the organic matter insolubles in a neutral detergent solution after a 6-day in vitro fermentation. The INDF concentration was expressed as a fraction of the organic matter content (OM) of the extrusa and fecal samples. The INDF of esophageal extrusa collected from the fistulated steers at each grazing pressure level was used as the extrusa INDF for the cows and calves at that grazing pressure level. Organic matter digestibility (OMD) was calculated as:

$$OMD = 1 \quad \frac{\text{INDF of estrusa OM}}{\text{INDF of fecal OM}}$$

Samples of the Yb- and La-labelled extrusa administered to each animal and fecal samples were analyzed for market concentration, on an OM Basis, by neutron-activation. Estimates of daily FO were computed by fitting a one-compartment, time-dependent non-linear regression model to the marker concentration of the fecal samples as obtained serially post-dose. Organic matter intake (OMI) was calculated as:

$$OMI = \frac{FO}{1\text{-}OMD}$$

The effects and interaction of grazing pressure level, trial, date, and class of cattle were analyzed using the General Linear Model procedure of the Statistical Analysis System (SAS, 1982).

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.

Results and Discussion

The NDF content of the diet of the fistulated steers differed ($P<0.01$) among the grazing pressure levels as increased grazing pressure level decreased the NDF content (Table 2). In addition, differences ($P<0.01$) existed among the measurement dates. The NDF content of the diet at the H, MH, and ML fluctuated in response to changes in the sward. The decrease in NDF content of the diet noted September 4 for the H, MH, and ML occurred after forage growth was initiated by rainfall. The stability of NDF content of the diet at the L was reflective of the greater amount of forage available per animal; thereby, allowing a similar diet to be selected throughout the study. Further, the absence of a change in NDF content of the diet at the L indicated a

TABLE 2. THE NEUTRAL DETERGENT FIBER (NDF) CONTENT OF THE DIET OF STEERS GRAZING COASTAL BERMUDAGRASS AT FOUR GRAZING PRESSURE LEVELS

	Grazing pressure level			
Date	High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	NDF percent			
June 24[1]	64.67 ± 3.28[3]	65.94 ± 4.15	69.42 ± 2.01	70.38 ± 3.32
July 15[2]	62.05 ± 0.68	69.23 ± 4.16	70.02 ± 6.48	73.07 ± 1.65
Aug. 2[1]	61.58 ± 3.57	70.44 ± 2.08	72.48 ± 3.78	72.53 ± 1.83
Aug. 20[1]	63.08 ± 4.06	68.72 ± 1.53	69.85 ± 4.08	72.53 ± 3.85
Sept. 4[2]	49.73 ± 1.68	66.23 ± 2.70	66.22 ± 5.46	72.80 ± 1.69
Sept. 19[1]	60.77 ± 3.67	70.94 ± 3.07	71.80 ± 2.40	72.25 ± 3.96
Mean	60.87	68.69	70.20	72.18

[1]N = Six samples/grazing pressure level.
[2]N = Four samples/grazing pressure level.
[3]Values are mean ± Standard deviation.

more mature sward that did not exhibit an increase in forage growth with added rainfall.

Differences ($P<0.01$) in OMD of the diet existed among grazing pressure levels, trials, and classes of cattle (Table 3). Part of any differences among classes of cattle may be the result of using the INDF content of the diet of the fistulated steers to calculate the OMD of the diet by the lactating cows and suckling calves. Neglecting grazing pressure levels, bermudagrass consumed by the fistulated steers had the highest mean OMD, with the diet selected by the suckling calves having the lowest mean OMD of the diet. The slightly depressed OMD of the diet consumed by the suckling calves may be the result of lactose depressing cellulose digestibility (Bailey and Orskov, 1974). The seasonal decline in OMD of the diet measured at the MH, ML, and L was reflective of the increase in dietary stem material and NDF content.

The OMI differed among grazing pressure levels ($P<0.05$), trials ($P<0.01$), and class of livestock ($P<0.001$) (Table 4). The fistulated steers at the H, MH, and L had a greater OMI at trial 2 than trials 1 and 3. However, the lowest OMI for the fistulated steers at ML occurred at trial 2. The fistulated steers at the ML had the greatest season-mean OMI, while the MH steers had the lowest season-mean OMI. The OMI by the suckling calves declined through the season except for those at the H which had an increase in OMI at trial 2. The lower OMI by the suckling calves during trial 2 and 3, as compared to trial 1, resulted from the calves younger age and probable greater milk consumption due to dams' stage of lactation. The season-mean OMI by suckling calves increased as grazing pressure level increased.

The OMI by lactating cows increased from trial 1 to trial 2, and declined thereafter except for the lactating cows at the H which decreased in OMI throughout the season. The increase in OMI by lactating cows at MH, ML, and L was reflective of the replacement of the fall-calving cows with spring-calving cows which were at an earlier stage of lactation. From trial 2 to trial 3, the decline in OMI by lactating cows at all grazing pressure levels corresponded to a period of declining OMD of the diet. In addition, the continuous decline in OMI by lactating cows at the H resulted from increased competition for forage at this grazing pressure level.

The ADG of cattle in this study differed ($P<0.01$) among grazing pressure levels, periods and class of livestock (Tables 5, 6, 7). The ADG of stocker calves (Table 5) declined as the season progressed and tended to

TABLE 3. THE ORGANIC MATTER DIGESTIBILITY (OMD) OF THE DIET BY FISTULATED STEERS, SUCKLING CALVES, AND LACTATING COWS GRAZING COASTAL BERMUDAGRASS AT FOUR GRAZING PRESSURE LEVELS

	Grazing pressure level (GPL)			
	High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	OMD percent			
Fistulated Steers				
trial 1	59.0 ± 9.5[1 2]	59.4 ± 3.6	57.3 ± 4.2	57.0 ± 2.3
trial 2	43.2 ± 7.8	59.9 ± 3.7	51.5 ± 1.6	52.2 ± 4.0
trial 3	57.8 ± 7.7	38.7 ± 8.0	45.2 ± 5.0	53.0 ± 5.2
Mean	53.3	52.7	51.3	54.1
Suckling Calves				
trial 1	59.6 ± 3.5[3]	60.9 ± 3.9	60.4 ± 3.9	60.8 ± 2.9
trial 2	42.2 ± 5.6	51.7 ± 5.1	43.6 ± 5.7	48.3 ± 4.8
trial 3	52.1 ± 6.9	43.3 ± 6.1	44.3 ± 3.0	46.3 ± 2.7
Mean	51.3	51.9	49.4	51.8
Lactating Cows				
trial 1	62.7 ± 2.9[4]	62.7 ± 2.5	61.1 ± 3.1	57.9 ± 3.4
trial 2	47.6 ± 7.0	52.8 ± 4.3	46.4 ± 4.5	50.4 ± 5.3
trial 3	44.5 ± 6.3	46.3 ± 6.5	47.5 ± 3.4	48.7 ± 4.4
Mean	51.6	53.9	51.7	52.3

[1]N = Four samples from each of two steers/GPL/date.
[2]Values are mean ± Standard deviation.
[3]N = Four samples from each of four calves/GPL/date.
[4]N = Four samples from each of four cows/GPL/date.

TABLE 4. THE ORGANIC MATTER INTAKE (OMI) BY FISTULATED STEERS, SUCKLING CALVES, AND LACTATING COWS GRAZING COASTAL BERMUDAGRASS AT FOUR GRAZING PRESSURE LEVELS

	Grazing pressure level			
	High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	OMI (lb OM/100 lb BW)			
Fistulated Steers[1]				
trial 1	0.69 ± 0.39[4]	1.08 ± 0.53	2.96 ± 0.85	1.57 ± 0.19
trial 2	2.24 ± 0.30	2.44 ± 0.85	2.31 ± 0.36	2.63 ± 0.50
trial 3	1.58 ± 0.86	0.95 ± 0.39	2.93 ± 0.45	1.46 ± 0.30
Mean	1.50	1.49	2.73	1.89
Suckling Calves [2]				
trial 1	1.60 ± 0.49	1.56 ± 0.56	1.78 ± 0.63	1.07 ± 0.66
trial 2	1.12 ± 0.38	1.03 ± 0.45	0.98 ± 0.27	0.88 ± 0.32
trial 3	0.62 ± 0.08	0.86 ± 0.26	0.61 ± 0.09	0.83 ± 0.06
Mean	1.11	1.15	1.12	0.93
Lactating Cows[3]				
trial 1	1.77 ± 0.60	1.43 ± 0.44	2.05 ± 0.99	1.34 ± 0.27
trial 2	0.82 ± 0.09	2.59 ± 0.75	2.83 ± 0.61	1.92 ± 0.78
trial 3	0.62 ± 0.17	1.18 ± 0.34	1.51 ± 0.33	1.82 ± 0.18
Mean	1.07	1.73	2.13	1.69

[1]Two steers/grazing pressure level.
[2]Four calves/grazing pressure level.
[3]Four cows/grazing pressure level.
[4]Values are mean ± Standard deviation.

TABLE 5. THE AVERAGE DAILY GAIN OF WEANED STOCKER CALVES GRAZING CLOVER-RYEGRASS-BERMUDAGRASS AT FOUR GRAZING PRESSURE LEVELS

	Grazing pressure level (GPL)			
Date	High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	Pound/animal/day[1]			
Feb. 23 to Mar. 29	2.40 ± 0.46[2]	3.00 ± 0.70	2.88 ± 0.37	3.08 ± 0.31
Mar. 20 to May 23	0.24 ± 0.46	1.2 ± 0.48	1.4 ± 0.18	1.7 ± 0.59
May 23 to June 16	1.0 ± 0.18	1.4 ± 0.42	1.8 ± 0.51	2.0 ± 0.77
June 16 to July 12	0.79 ± 0.59	1.7 ± 0.51	1.3 ± 0.46	1.5 ± 0.48
July 12 Aug. 10	-2.4 ± 0.95	0.40 ± 0.44	1.0 ± 0.31	1.0 ± 0.35
Aug. 10 to Sept. 26	-0.02 ± 0.57	0.55 ± 0.68	1.0 ± 0.33	0.90 ± 0.81
Mean Feb. 23 to Sept. 26	0.51	1.2	1.5	1.8

[1]N = Gain of five animals/GPL/date.
[2]Values are mean ± Standard deviation.

TABLE 6. THE AVERAGE DAILY GAIN OF SUCKLING CALVES GRAZING CLOVER-RYEGRASS-BERMUDAGRASS AT FOUR GRAZING PRESSURE LEVELS

	Grazing pressure level (GPL)			
Date	High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	Pound/animal/day[1]			
Feb. 23 to Mar. 29	3.43 ± 0.35[2]	3.34 ± 0.66	3.23 ± 0.46	3.30 ± 0.29
Mar. 29 to May 23	1.7 ± 0.35	2.40 ± 0.35	2.40 ± 0.15	2.79 ± 0.09
May 23 to June 16	1.0 ± 0.51	1.5 ± 0.44	2.42 ± 0.13	2.77 ± 0.46
June 16 to July 12	0.51 ± 0.64	1.2 ± 0.73	1.3 ± 0.22	1.90 ± 0.48
July 12 to Aug. 10	1.1 ± 0.35	2.20 ± 0.18	2.24 ± 0.26	2.93 ± 0.48
Aug. 10 to Sept. 26	0.64 ± 0.40	1.80 ± 0.31	1.9 ± 0.59	2.46 ± 0.18
Mean	1.4	2.1	2.2	2.64

[1]N = Gain of four suckling calves/GPL/date.
[2]Vlaues are mean ± Standard deviation.

increase as grazing pressure was reduced. As displayed in Table 6, the suckling calves on the reduced grazing pressure levels had a greater ADG than those suckling calves on the high grazing pressure levels. The ADG of fall-born suckling calves decreased with advancing date in the study until weaning on July 12. Similarly, the spring-born suckling calves showed a decline in ADG during the study period. The ADG of the lactating cows (Table 7) decreased as grazing pressure was increased. No definite seasonal trend in ADG was evident for the fall-calving cows, while a decline in ADG was noted for the spring-calving cows.

The results of this study indicated that the NDF content of the diet tended to decrease as the grazing pressure level was increased; however, the OMD of the diet was greatest at the MH and L. The OMI measured was greatest at the ML and lowest at the H for the fistulated steers and lactating cows, while a theorized increased milk production with reduced grazing pressure level resulted in a trend of declining OMI by suckling calves as grazing pressure level was lowered. A restriction in nutrient intake from forage or milk reduced the ADG of stocker calves, lactating cows and suckling calves at the high levels of grazing pressure. The reported trends reflect the interactive nature of factors at the plant-animal interface and their consequential effect on animal performance.

TABLE 7. THE AVERAGE DAILY GAIN OF LACTATING COWS GRAZING CLOVER-RYEGRASS-BERMUDAGRASS AT FOUR GRAZING PRESSURE LEVELS

	Grazing pressure level (GPL)			
Date	High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	Pound/animal/day[1]			
Feb. 23 to Mar. 29	-0.09 ± 0.51[2]	-0.37 ± 0.57	0.26 ± 0.59	0.86 ± 0.07
Mar. 29 to May 23	-1.3 ± 0.04	0.70 ± 0.57	0.84 ± 0.33	2.1 ± 0.68
May 23 to June 16	0.73 ± 0.90	-0.09 ± 0.88	0.92 ± 1.0	0.95 ± 0.84
June 16 to July 12	-0.62 ± 2.1	-0.15 ± 1.8	-0.09 ± 0.42	-0.33 ± 1.3
July 12 to Aug. 10	-3.59 ± 0.77	-0.02 ± 0.86	0.33 ± 0.62	0.73 ± 0.95
Aug. 10 to Sept. 6	-3.96 ± 1.9	-2.22 ± 1.8	-1.3 ± 0.29	-2.53 ± 0.68
Mean	-1.6	-0.33	0.35	0.59

[1]N = Gain of four lactating cows/GPL/date.
[2]Values are mean ± Standard deviation.

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