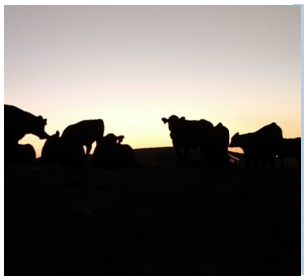

Effects of Grazing Intensity and Advancing Season on Dietary Chemical Composition and In Vitro Organic Matter Digestibility in Steers Grazing Mixed-grass Prairie

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The results of this study demonstrate that forage grazed by beef cattle in the Missouri Coteau increases in fiber and decreases in nitrogen as the season advances. Grazing intensity had little impact on grazed forage nutrient composition. Consequently, previously observed differences in livestock production due to grazing intensity in the Missouri Coteau must be driven by changes in dietary intake or in vivo digestion. Additional research accessing changes in intake and rates of digestion is needed.

Summary

A study was conducted at the CGREC to evaluate the influence of advancing season and grazing intensity on dietary chemical composition and *in vitro* organic matter digestibility (IVOMD) in beef steers grazing mixed-grass prairie in the Missouri Coteau region of south-central North Dakota. Five sampling periods were conducted from mid-May to early September 2015. Twelve ruminal cannulated crossbred steers were used to collect diets, while 188 crossbred steers were used to maintain specific grazing intensities on 12 pastures.

Treatments were light (LT), moderate (MOD), heavy (HVY) and extreme (EXT) grazing intensities. Each treatment was assigned to three pastures. Grazing treatment × sampling period interactions were not present ($P \geq 0.29$) for all variables measured except IVOMD ($P < 0.01$). No main effects of grazing treatment were observed for neutral detergent fiber (NDF), acid detergent fiber (ADF), total nitrogen (N), soluble nitrogen (SN), insoluble nitrogen (IN) and acid detergent insoluble nitrogen (ADIN).

Responses to grazing season were evaluated with linear, quadratic and cubic contrasts. Results indicate increases ($P < 0.001$) in dietary NDF and ADF and decreases ($P < 0.001$) in N, SN, IN and IVOMD with advancing season. No change in ADIN was observed. Only IVOMD showed a treatment × period interaction ($P < 0.01$). These data suggest seasonal factors are a more important driver of grazed masticate forage nutrient composition than the grazing intensities evaluated in this study.

Introduction

Dietary chemical composition of grazed forage, when coupled with forage intake and digestion, are important factors in rangeland-based cattle production systems. We know that as forage matures, dietary crude protein, digestibility and intake often decline, while dietary fiber usually increases (Olson *et al*. 1994, Johnson *et al*. 1998, McCollum *et al*. 1985, Adams *et al*. 1987, Cline *et al*. 2009). Bryant *et al*. (1970) found that if grazing pressure is intense enough to cause low herbage availability, the quality of herbage ingested decreases due to the reduced opportunity for selective grazing. Furthermore, as grazing intensity increases, diet quality decreases (Cook *et al*. 1953, Pieper *et al*. 1959).

Maintaining herds on native grass is common for beef cattle operations to reduce input costs of harvested and purchased feeds. Therefore, modulating cattle stocking rates on pasture is a common management tool used to achieve long-term goals of optimizing forage use, livestock production and agroecosystem sustainability (Derner *et al*. 2008, Biondini *et al*. 1998, Hart *et al*. 1988).

However, information regarding the impact of grazing intensity on forage intake and digestion by cattle grazing mixed-grass prairie is lacking. Hence, our objectives were to evaluate the effects of advancing season and grazing intensity on diet chemical composition and *in vitro* organic matter digestibility (IVOMD) by steers grazing mixed-grass prairie in the Missouri Coteau of south-central North Dakota.

Procedures

Animals

Protocols described in this article were approved by the North Dakota State University Institutional Animal Care and Use Committee. Angus-cross beef steers (n = 188; 705 ± 77.6 pounds initial body weight) were used to establish grazing pressure, and 12 ruminal cannulated steers (600 ± 74.1 pounds) co-grazed with the non-cannulated animals.

All steers had free access to water and trace mineral salt blocks. Steers were fed dried distillers grains with solubles (DDGS) daily at sunrise at 0.3 percent of their body weight (BW). All animals were weighed every 28 days to determine gains as the grazing season progressed and to adjust the amount of DDGS fed. All steers were implanted with Revalor-G one day before being turned out on pasture.

Experimental Design and Treatments

This study is in conjunction with the long-term grazing intensity research (see Pages 7-27) conducted at the Central Grasslands Research Extension Center (CGREC) on the Missouri Coteau in south-central North Dakota. The study site had been divided into 12 pastures of approximately 30 acres each in 1989. Cattle grazed from May 15 to Sept. 11, 2015.

Patton and Nyren (2014) reported the botanical composition of the plant communities at the study site the year before this study. The most common grasses and sedges in 2014 were Kentucky bluegrass (*Poa pratensis* L.), western wheatgrass (*Pascopyrum smithii* A. Löve.), sun sedge (*Carex inops* Bailey), green needlegrass (*Nassella viridula* [Trin.] Barkworth), obtuse sedge (*Carex obtusata* Lilj.) and blue grama (*Bouteloua gracilis* [Willd. ex Kunth] Lag. ex Griffiths). Common forbs were heath aster (*Symphyotrichum ericoides* [L.] Nesom), common dandelion (*Taraxacum officinale* F.H. Wigg.) and western yarrow (*Achillea millefolium* L.). Buckbrush (*Symphoricarpos occidentalis* Hook.) was the only common shrub.

Steers were stocked at densities so that 65 (LT), 50 (MOD), 35 (HVY) and 20 percent (EXT) of the average annual aboveground biomass remained at the end of the grazing season. Each of the cannulated steers was assigned to a pasture at random, each treatment having three pastures. Animals were removed at the end of the grazing season when forage utilization on half of the pastures had reached desired grazing intensity.

Five 10-day collection periods were conducted for May, June, July, August and September. Sampling periods began with the collection of diet samples. At sunrise, cannulated steers were restrained and subjected to total ruminal evacuation. Ruminal digesta was removed physically from each cannulated steer and the rumen then was double-rinsed with water to assure complete removal of contents.

Steers then were allowed to graze on their assigned pastures for 30 to 45 minutes. Then ruminal masticate samples were removed, labeled and immediately placed on ice. Previously collected ruminal contents were placed back in the animal. All samples then were frozen at minus 4˚ F for later analysis.

Masticate samples were lyophilized (Genesis 25LL, Virtis, Gardiner, N.Y.). Dry matter, ash and crude protein (CP) were determined using AOAC (1990). Neutral detergent fiber and ADF of diet samples were determined using ANKOM procedures (ANKOM, Macedon, N.Y.). Acid detergent insoluble N was calculated as N remaining in the ADF residue. Soluble N was extracted with 0.15 M NaCl according to the procedure of Waldo and Goering (1979). In vitro OM digestibilities (Tilley and Terry 1963) were conducted to determine IVOMD. Masticate forage and ruminal fluid collected from each animal was used for in vitro determinations.

Statistical Analysis

Chemical composition and IVOMD were analyzed as a repeated measures design using a mixed-model approach in SAS (SAS Inst. Inc., Cary, N.Y.). Effects for sampling period, grazing treatment and period × treatment interactions were included in the model.

In the absence of interactions, orthogonal contrasts were used to determine linear, quadratic and cubic responses across the grazing season (sampling period). Sampling period × grazing treatment interactions ($P \leq 0.05$) were detected for IVOMD; therefore, the simple effect means were separated using the LSMEANS statement in SAS. The procedures of SAS were used for all statistical analysis and P-values ≤ 0.05 were considered different.

Results and Discussion

Table 1 shows the effects of grazing intensity and advancing season on chemical composition of diet as well as IVOMD. Neutral detergent fiber and ADF changed with advancing season ($P < 0.01$). These results coincide with Olson *et al*. (1994) for south-central North Dakota, Johnson *et al*. (1998) for western North Dakota and McCollum *et al*. (1985) for south-central New Mexico.

Nitrogen (percent of OM) decreased significantly ($P < 0.01$) as the season advanced. Typically, forage masticate N concentration declines with increasing forage maturity

Table 1. Effects of grazing intensity and advancing season on dietary chemical composition and *in vitro* OM digestibility (IVOMD) in steers grazing mixed-grass prairie.

	Grazing Intensity (TRT)[1]					Grazing Period (PD)[2]						*P*-value[3]					
Item	LT	MOD	HVY	EXT	SEM[4]	1	2	3	4	5	SEM[5]	TRT	PD	TRT × PD	L	Q	C
No. of observations	15	15	15	15	-	12	12	12	12	12	-	-	-	-	-	-	-
OM, %	81.3	82.2	80.6	82.3	1.49	74.6	82.4	83.9	83.7	83.2	3.08	0.83	0.05	0.44	0.02	0.02	0.16
	Percentage of OM																
NDF	67.5	69.6	70.7	65.6	2.05	58.4	69.9	67.5	70.7	75.2	3.81	0.34	<0.01	0.89	<0.0	0.32	0.01
ADF	38.5	40.2	41.5	36.1	1.85	37.2	38.5	37.1	39.5	43.1	4.05	0.25	<0.01	0.87	0.17	0.33	0.44
CP	18.7	17.7	17.8	19.6	0.63	29.9	18.3	16.9	14.9	12.3	0.86	0.18	<0.01	0.63	<0.0	<0.01	<0.0
N	2.99	2.84	2.85	3.14	0.10	4.78	2.92	2.70	2.38	1.97	0.14	0.18	<0.01	0.63	<0.0	<0.01	<0.0
Soluble N	0.70	0.73	0.69	0.82	0.06	1.08	0.81	0.66	0.57	0.55	0.09	0.36	<0.01	0.29	<0.0	0.03	0.73
Insoluble N	2.28	2.11	2.16	2.32	0.08	3.70	2.11	2.05	1.81	1.42	0.12	0.22	<0.01	0.59	<0.0	<0.01	<0.0
ADIN	0.48	0.42	0.44	0.47	0.04	0.52	0.37	0.47	0.44	0.45	0.06	0.77	0.26	0.93	0.70	0.31	0.15
IVOMD	60.4	62.6	63.4	60.6	2.62	75.9	70.3	62.1	52.8	47.6	3.35	0.82	<0.01	0.01	0.97	0.97	0.14

[1]LT = light, MOD = moderate, HVY = heavy and EXT = extreme grazing intensities.

[2]Grazing period collections were 1 (May 11 to 22), 2 (June 10 to 19), 3 (July 8 to 17), 4 (Aug. 5 to 14) and 5 (Sept. 2 to 11).

[3]Significance level of the F-test for treatment (TRT), period (PD), treatment by period (TRT × PD), linear (L), quadratic (Q) and cubic (C) effects for items.

[4]Standard error of mean for grazing intensity, n = 15. Most conservative standard error mean values were used.

[5]Standard error of mean for grazing period, n = 12. Most conservative standard error mean values were used.

associated with advancing season. Such was the case in our study and the work of others within the region (Olson *et al*. 1994, Johnson *et al.* 1998, Cline *et al.* 2009).

Soluble N and IN decreased significantly ($P < 0.01$). McCollum *et al*. (1985) also found that N, SN and IN decreased with advancing grazing season. In the present study, ADIN was not impacted by advancing season. However, Cline *et al*. (2009) observed an increase in ADIN from late June to mid-November.

For IVOMD, a sampling period × grazing intensity interaction was observed ($P = 0.01$; Table 1). In vitro OM digestibility decreased from May to September ($P < 0.05$) at all grazing intensities. In May, IVOMD was similar across all grazing intensities ($P > 0.05$). In June, LT and MOD had greater IVOMD ($P < 0.05$), compared with HVY, while EXT was similar to all grazing intensities (75.7, 73.4, 62.9 and 69.1 ± 2.8 percent, respectively).

In July, LT had the lowest and HVY the greatest IVOMD ($P < 0.05$). In August, LT had similar ($P > 0.05$) IVOMD, compared with all other grazing intensities, while MOD was lower ($P < 0.05$) than HVY. In September, IVOMD was 52.5, 44.9, 50.3 and 42.8 ± 5.1 percent ($P > 0.05$) for LT, MOD, HVY and EXT grazing intensities, respectively.

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