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Summary

Nebraska Sandhills upland range pastures were used to measure the effects of stocking rate on forage nutrient content in early summer pastures. Stocked pastures had lower CP, in vitro *organic matter digestibility, forage availability, and higher NDF compared with ungrazed pastures. Clipped samples of current year growth had greater CP and* in vitro *organic matter digestibility than diet samples. Observed results indicate early season grazing decreases diet nutrient content and forage availability compared with ungrazed pastures, suggesting that cattle were consuming both current and previous year growth.*

Introduction

Upland range in the Nebraska Sandhills is an excellent resource for grazing cattle. Native upland range is dominated by warm-season grass species. Forage quality increases during the spring, reaching a peak during June, then steadily declines in quality throughout the remainder of the growing season (*1997 Nebraska Beef Cattle Report,* pp. 3-5). Research has shown changes in forage nutrient composition throughout the year but effects of stocking rate on Sandhills upland range were not addressed well. Therefore, the objectives of this research were to determine the effects of stocking rate on diet nutrient quality in early summer pasture, determine if new growth or previous year growth is being consumed, and determine forage production in the Nebraska Sandhills.

Procedure

Twelve, five-acre upland range paddocks at the Gudmundsen Sandhills Laboratory near Whitman, Neb., were used. Paddocks were stocked at 0 (control), 0.22 (light), and 0.33 (heavy) animal unit months per acre resulting in four replications per treatment. A stocking rate of 0.60 AUM/ac is commonly allotted for the entire year, so early in the growing season, before the majority of the growth has occurred, a stocking rate of 0.33 AUM/ac was considered heavy. Each stocked paddock was continuously grazed and all paddocks were sampled weekly during the three week trial in 2013 with the introduction of cattle on May 18 and the removal of cattle on June 8. Ten, 0.25 m^2 quadrats per paddock were clipped at ground level on each sampling date and separated into previous year growth and current year growth. Three esophageally fistulated cows were used to sample each pasture on each date to determine forage quality. Prior to each diet sample collection, cows were withheld from feed, but not water, for 12 hours, then transported to pastures where diets were to be collected. Cows were fitted with solid bottom bags after removal of the esophageal plug and introduced to the pasture, then allowed to graze for about 20 minutes.

Samples were separated into a liquid and fibrous portion for lab analysis. Immediately after separation, diet samples were frozen and stored at -20°C, then lyophilized. Clipped samples were dried in a forced air oven at 60°C for 48 hours. Both diet and clipped samples were ground to pass a 1-mm screen in a Wiley mill. Samples were analyzed for nitrogen, NDF content using the Van Soest et al., (1991) method, and *in vitro* dry matter disappearance using the Tilley and Terry method with the modification of adding 1 g of urea to the buffer then adjusted to *in vivo* values (IVOMD). Results were analyzed using repeated measures in PROC GLIMMIX procedure of SAS (SAS Institute, Inc., Cary, N.C.) with paddock being the experimental unit.

Table 1. Nutrient content of diet samples collected from esophageally fistulated cows comparing collection dates by stocking rate.

	Date					*P*-value		
Item	5/18/2013	5/25/2013	6/1/2013	6/8/2013	SEM[1]	Linear	Quadratic	Cubic
IVOMD								
Control[2]	70.3[c]	76.1[b]	79.8[a]	78.8[a]	1.27	0.02	< 0.01	0.38
Light[3]	73.2[a]	65.1[b]	67.4[c]	66.2[bc]	1.27	0.02	< 0.01	< 0.01
Heavy[4]	71.2[a]	63.2[b]	62.5[b]	63.2[b]	1.27	0.02	< 0.01	0.27
CP								
Control[2]	16.2[b]	20.5[a]	20.5[a]	18.9[a]	1.19	< 0.01	< 0.01	0.50
Light[3]	17.1[a]	10.5[b]	11.1[b]	11.6[b]	1.19	< 0.01	< 0.01	0.01
Heavy[4]	15.7[a]	8.9[c]	8.8[c]	10.8[b]	1.19	< 0.01	< 0.01	0.01
NDF								
Control[2]	54.4[a]	57.9[a]	45.0[b]	42.7[b]	3.44	< 0.01	0.35	0.06
Light[3]	61.2[b]	78.1[a]	74.5[a]	73.2[a]	3.44	< 0.01	< 0.01	0.01
Heavy[4]	68.8[b]	78.3[a]	69.9[b]	76.7[a]	3.44	0.08	0.48	< 0.01

[1]Standard error of the least squares mean.
[2]Non-stocked paddock (0 AUM/ac).
[3]Light stocking rate paddock (0.22 AUM/ac).
[4]Heavy stocking rate paddock (0.33 AUM/ac).
[a-c]Means within rows lacking common superscript differ ($P < 0.05$).

Table 2. Nutrient content of clipped sample current year growth comparing collection dates by treatment.

	Date					*P*-value		
Item	5/18/2013	5/25/2013	6/1/2013	6/8/2013	SEM[1]	Linear	Quadratic	Cubic
IVOMD								
Control[2]	71.5^{b}	77.3^{a}	73.2^{b}	76.6^{ab}	2.74	0.03	0.30	0.03
Light[3]	69.3^{b}	74.5^{a}	75.3^{a}	76.6^{a}	2.74	0.03	0.30	0.03
Heavy[4]	72.2	72.8	73.2	74.8	2.74	0.03	0.30	0.03
CP								
Control[2]	19.2^{a}	17.6^{a}	16.7^{a}	14.0^{b}	1.49	< 0.01	0.90	0.86
Light[3]	19.5^{ac}	18.8^{a}	16.4^{b}	16.4^{bc}	1.49	< 0.01	0.90	0.86
Heavy[4]	19.7^{a}	17.7^{ab}	17.0^{b}	15.6^{b}	1.49	< 0.01	0.90	0.86
NDF								
Control[2]	76.1	71.7	73.4	66.4	4.50	0.43	0.20	0.74
Light[3]	81.1	86.1	84.2	80.3	4.50	0.43	0.20	0.74
Heavy[4]	78.5	81.6	80.7	81.3	4.50	0.43	0.20	0.74

[1]Standard error of the least squares mean.
[2]Non-stocked paddock (0 AUM/ac).
[3]Light stocking rate paddock (0.22 AUM/ac).
[4]Heavy stocking rate paddock (0.33 AUM/ac).
[a-c]Means within rows lacking common superscript differ ($P < 0.05$).

Table 3. Nutrient content of diet samples from esophageally fistulated cows comparing stocking rate on each date.

Item	Control[1]	Light[2]	Heavy[3]	SEM[4]	*P*-value
IVOMD					
5/18/2013	70.3	73.2	71.2	1.88	0.12
5/25/2013	76.1^{a}	65.1^{b}	63.2^{b}	1.88	< 0.01
6/1/2013	79.8^{a}	67.4^{b}	62.5^{c}	1.88	< 0.01
6/8/2013	78.8^{a}	66.2^{b}	63.2^{b}	1.88	< 0.01
CP					
5/18/2013	16.2	17.1	15.7	2.08	0.50
5/25/2013	20.5^{a}	10.5^{b}	8.9^{b}	2.08	< 0.01
6/1/2013	20.5^{a}	11.1^{b}	8.8^{b}	2.08	< 0.01
6/8/2013	18.9^{a}	11.6^{b}	10.8^{b}	2.08	< 0.01
NDF					
5/18/2013	54.4^{a}	61.2^{ab}	68.8^{b}	4.24	< 0.01
5/25/2013	57.9^{b}	78.1^{a}	78.3^{a}	4.24	< 0.01
6/1/2013	45.0^{b}	74.5^{a}	69.9^{a}	4.24	< 0.01
6/8/2013	42.7^{b}	73.2^{a}	76.7^{a}	4.24	< 0.01

[1]Non-stocked paddock (0 AUM/ac).
[2]Light stocking rate paddock (0.22 AUM/ac).
[3]Heavy stocking rate paddock (0.33 AUM/ac).
[4]Standard error of the least squares mean.
[a-c]Means within rows lacking common superscript differ ($P < 0.05$).

Results

Diet samples had significant treatment x date interactions ($P < 0.01$; Table 1) for CP, NDF, and IVOMD. A quadratic effect was observed ($P < 0.01$) for diet IVOMD for control and heavy treatments with a cubic effect ($P < 0.01$) for the light stocking rate. Diet CP increased quadratically ($P < 0.01$) for the control treatment and showed a cubic effect ($P < 0.01$) for light and heavy treatments. Dietary NDF decreased linearly ($P < 0.01$) for control treatment and showed a cubic effect ($P < 0.01$) for light and heavy treatments. However, there were no treatment x date interactions ($P > 0.05$) in clipped samples. Clipped samples CP content decreased linearly ($P < 0.05$; Table 2) across all dates for each treatment and a cubic effect was shown for IVOMD ($P < 0.05$) of current year growth across all dates for all treatments. Diet samples collected in control stocking rate paddocks had greater IVOMD ($P < 0.05$) compared with those collected in light and heavy stocking rate paddocks on collection dates 2, 3, and 4 (Table 3). Diet samples collected in light stocking rate paddocks had greater IVOMD ($P < 0.05$) than heavy stocking rate on June 1. Diet samples collected in control stocking rate paddocks had greater CP ($P < 0.05$) than light and heavy stocking rates on dates 2, 3, and 4. Light and heavy stocking rates showed no difference in CP ($P > 0.05$) for each sampling date. Diet samples collected from control stocking rate paddocks had lower NDF ($P < 0.05$) than light and heavy stocking rates on dates 2, 3, and 4. These data suggest that stocking rate has a significant effect on the quality of the diet, helping to explain the treatment x date interaction in diet quality that was observed. When cattle were introduced into the paddock, they were able to select a diet greater in quality. As the grazing season progressed, cattle in the stocked paddocks consumed a diet lower in quality than the control paddocks, indicating that previous year growth was being consumed. Control stocking rate paddocks did reach a peak in diet quality in early June and then decreased in diet quality, likely due to plant maturation, which is in agreement with previous work (*1997 Nebraska Beef Cattle Report,* pp. 3-5).

For the clipped samples, no differences occurred for previous year growth for CP, NDF, and IVOMD among treatments ($P > 0.05$) with overall means of 5.2%, 82.0%, and 50.8%, respectively. Current year growth did not differ among treatments for CP, NDF, and IVOMD ($P > 0.05$) with overall means of 17.4%, 71.7, and 68.7%, respectively. However, CP ($P < 0.01$) and IVOMD ($P < 0.02$) content of current year growth increased linearly as stocking rate increased. Current growth was greater in CP and IVOMD ($P < 0.01$; Table 4) than diet sample and previous year growth on all dates.

(Continued on next page)

Neutral detergent fiber was greater ($P < 0.01$) in clipped samples versus diet samples. These results occur because cattle are selective and there are differences between collection methods. Current year growth increased linearly for all treatments ($P < 0.01$; Table 5). Control paddocks had greater current year forage availability versus stocked pastures ($P < 0.01$; Table 6) for all but the first sampling date. Stocking rate affects forage quality and, therefore, diet quality in early summer as well as forage availability.

The NRC model was used in a hypothetical example to compare performance of cows consuming either the control pasture or heavily stocked pasture. A 1,200 lb March calving cow producing 25 lb of milk at peak lactation, consuming an estimated 2.4% of her body weight was used in the analysis. Diet quality from control pastures exceeded both energy and protein requirements of the animal. However, heavily grazed pastures had much lower diet quality, which resulted in both a negative energy and protein balance by the end of the second week in the pasture. By the final sampling date which occurred after three weeks of grazing, the quality of the diet increased for the heavy stocked pasture which resulted in the animals maintaining body condition. Cattle grazing upland range early in the growing season initially consume diets high in quality but as pastures are grazed, diet quality decreases. Hence, producers trying to graze upland range early in the growing season need to understand the effects of grazing on diet quality and manage accordingly by rotating through pastures more frequently or delaying the start of grazing.

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Table 4. Nutrient content of esophageal diet sample versus live and dead clipped samples.

Item	Diet[1]	Live[2]	Dead[3]	SEM[4]	*P*-value
IVOMD					
5/18/2013	70.4[a]	71.0[a]	50.3[b]	1.07	< 0.01
5/25/2013	66.5[b]	74.8[a]	53.2[c]	1.99	< 0.01
6/1/2013	69.1[b]	73.9[a]	49.7[c]	2.17	< 0.01
6/8/2013	68.4[b]	76.0[a]	49.6[c]	2.38	< 0.01
CP					
5/18/2013	16.1[b]	21.0[a]	6.9[c]	1.12	< 0.01
5/25/2013	13.5[b]	18.4[a]	5.4[c]	1.54	< 0.01
6/1/2013	13.6[b]	16.8[a]	5.5[c]	1.48	< 0.01
6/8/2013	13.8[b]	15.7[a]	5.2[c]	1.64	< 0.01
NDF					
5/18/2013	59.4[b]	78.6[a]	82.9[a]	3.18	< 0.01
5/25/2013	77.4	79.8	78.7	3.06	0.62
6/1/2013	63.2[b]	79.4[a]	83.3[a]	4.81	< 0.01
6/8/2013	64.6[c]	76.0[b]	83.0[a]	6.02	< 0.01

[1]Mean diet collection for all treatments using esophageally fistulated cows.
[2]Mean clipped sample for all treatments current year forage growth.
[3]Mean clipped sample for all treatments for previous year forage growth.
[4]Standard error of the least squares mean.
[a-c]Means within rows lacking common superscript differ ($P < 0.05$).

Table 5. Nebraska Sandhills upland range forage availability comparing collection date by treatment.

	Date					*P*-value		
Item	5/18/2013	5/25/2013	6/1/2013	6/8/2013	SEM[1]	Linear	Quadratic	Cubic
Current year forage availability, lb/ac								
Control[2]	46.4[d]	84.5[c]	149.3[b]	202.1[a]	14.18	< 0.01	0.94	0.05
Light[3]	28.6[b]	24.4[b]	49.7[a]	52.3[a]	14.18	< 0.01	0.94	0.05
Heavy[4]	39.3	42.6	58.3	42.4	14.18	< 0.01	0.94	0.05
Previous year forage availability, lb/ac								
Control[2]	1087.1[a]	599.8[b]	533.5[b]	440.9[b]	191.80	< 0.01	0.03	0.01
Light[3]	809.5[a]	236.9[b]	547.1[a]	181.5[b]	191.80	< 0.01	0.03	0.01
Heavy[4]	907.8[a]	556.7[b]	440.9[bc]	303.6[c]	191.80	< 0.01	0.03	0.01

[1]Standard error of the least squares mean.
[2]Non-stocked paddock (0 AUM/ac).
[3]Light stocking rate paddock (0.22 AUM/ac).
[4]Heavy stocking rate paddock (0.33 AUM/ac).
[a-c]Means within rows lacking common superscript differ ($P < 0.05$) .

Table 6. Nebraska Sandhills upland range forage availability comparing treatment by date.

Date	Control[2]	Light[3]	Heavy[4]	SEM[1]	*P*-value
Current year forage availability, lb/ac					
5/18/2013	46.4	28.6	39.3	19.23	0.24
5/25/2013	84.5[a]	24.4[b]	42.6[b]	19.23	< 0.01
6/1/2013	149.3[a]	49.7[b]	58.3[b]	19.23	< 0.01
6/8/2013	202.1[a]	52.3[b]	42.4[b]	19.23	< 0.01
Previous year forage availability, lb/ac					
5/18/2013	1087.1	809.5	907.8	224.21	0.23
5/25/2013	599.8[a]	236.9[b]	556.7[a]	224.21	< 0.01
6/1/2013	533.5	547.1	440.9	224.21	0.23
6/8/2013	440.9	181.5	303.6	224.21	0.23

[1] Standard error of the least squares mean
[2] Non-stocked paddock (0 AUM/ac)
[3] Light stocking rate paddock (0.22 AUM/ac)
[4] Heavy stocking rate paddock (0.33 AUM/ac)
[a-c]Means within rows lacking common superscript differ ($P < 0.05$)

