UTILIZATION OF RUMEN EVACUATION AND IN SITU METHODOLOGYTO STUDY MINERAL ELEMENT CHARACTERISTICS OF *BROMUS INERMIS*

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ABSTRACT

Mineral element characteristics of *Bromus inermis* were determined in 2 week intervals from May 15 to October 15 in a four-year study. Clipped samples were separated to leaf and stem fractions. In year 4, 3 ruminally fistulated cows were used to determine diet selection 6 times during the growing season, and were used to determine in situ mineral disappearance of clipped grass. Based on rumen evacuation and in situ methodology elemental concentrations in *Bromus inermis* exhibited seasonal flux and in the conditions of this study cows did not select a diet different from clipped samples in elements other than Fe and P.

KEY WORDS

Mineral content, Forage, In situ

INTRODUCTION

Determining concentration of elements in clipped or harvested forage is relatively simple; however, determining relationship of clipped sample to actual intake and bioavailability of those elements is more difficult (Spears, 1994). The objective of our study was to determine relationships between clipped samples and estimates of mineral element intake and availability during the growing season using rumen evacuation and in situ techniques.

METHODS

Forage samples were collected at two-week intervals from May 15 to October 15 in 1991 through 1994 Nebraska, Gage County, 7.2 km south of Virginia, Nebraska.

Three plots were randomly set. The plots were subdivided into 11 sub-plots. Each of the sub-plots was assigned to one of 11 clipping times at two-week intervals beginning May 15. Forage samples were clipped 10 cm above ground. Samples were separated into leaf and stem fractions. Regrowth was analyzed as whole plant.

Samples of leaves and stems from each plot, and collection time were divided in half and placed in the two rumen fistulated cows for estimates of in situ disappearance (Wilkerson et al., 1995). Bags containing cotton were treated like bags containing forage and were used to adjust for element migration into the bag.

Three ruminally fistulated cows were used to determine diet selection six times from May 15 through October 15 (regrowth). A feeding and re-evacuating procedure was used to determine the rate, total output and composition of saliva by each cow, a constant rate of saliva disappearance from the rumen was assumed. Cows were allowed to graze for 1 hr, and evacuated a third time. Total contents were removed and weighed.

RESULTS AND DISCUSSION

Concentrations of Cu, Fe and Ca were higher ($P<.05$) in the leaves than in stems during each of the 4 yr. Zinc and P were not different ($P>.10$) and Mn was lower in leaves compared to stems ($P<.05$). Leaf and stem Cu, Zn, Fe, Ca and P were different between years ($P<.05$) and leaf and stem Cu and Zn increased during the same years. As the plant matures, leaf Cu remains constant until September 15 and then decreases ($P<.05$) and stem Cu decreases (Table 1). Leaf Zn gradually increased during the grazing season ($P<.05$) while stem Zn gradually decreased. Phosphorus concentration decreases in the leaf and stem as the plant matures. Leaf and stem Mn, Fe and Ca increased ($P<.05$) with increasing maturity.

Dry matter remaining in the in situ bags after 24 hours of ruminal incubation was increased ($P<.05$) with an increase in maturity. Total quantity (mg) of each element placed in the in situ bag was determined using a sub-sample of the leaf, stem and used to determine percentage of original element that remained in the in situ bag after 24 in the rumen. When data were pooled across harvest times (maturity), statistical differences ($P<.05$) were not detected for Cu, Fe, or P, between leaves and stems. There were differences for Zn and Mn ($P<.05$), with leaves having a greater extent of element disappearance for Zn and stems for Mn. A greater percentage of Ca disappeared from leaves than stems.

As maturity increased, less of the original Cu, Zn, Mn, Fe and Ca in leaves disappeared ($P<.05$; Table 2). There were no differences for P ($P>.10$) disappearance. A lower percentage of Cu, Zn and Ca disappeared in the stems as maturity increased ($P<.05$; Table 2). No differences were detected for Fe or P disappearance in stems. Rate of saliva output and element composition of saliva was determined prior to the diet selection for each cow. Saliva composition was not different ($P>.10$) between sampling d but was different between cows. Therefore, elemental contribution of the saliva from an individual cow was deducted from her selected diet. Saliva output ranged from 3.7 to 8.5 kg/h, without accounting for saliva flow out of the rumen. It was assumed to be a constant rate and would be the same for a cow eating clipped grass or grazing. As expected, saliva P was high enough to alter the calculated P content of the diet DM.

The Ca concentration increased in leaves as the plant matured and remained constant in the stem (Table 1). However, in situ disappearance decreased in both the leaf and stem. Phosphorus disappearance was not different ($P>.20$) between leaf and stem and was between 88% and 99% removed from the bag after 24 hours. The mean elemental concentrations of the clipped leaves and stems are similar ($P>.10$) to the diet selected by the beef cows. However, the mean assumes half leaves and half stems and does not account for an increase in stems as the grass matures. The exceptions are Fe, where the cows tended to select a diet with a higher concentration ($P<.10$) and P, where selected diets were 2 times higher than the clipped grass ($P<.05$).

Estimated forage intake was 11.2 kg/d (1.9% BW). Using the June intake (11.2 kg) multiplied by Cu concentration of the selected diet on June 15 (6.02 mg/kg; Table 1), multiplied by in vitro Cu disappearance (66.3% - average of leaves and stems; Table 2) we estimated the cows consumed 67.4 mg of Cu of which 49 mg were rumen soluble. This procedure can be used to determine intake of elements at other times. Based on these calculations the grass at this location is either at the low end of the adequate range or is considered deficient for Cu, with the exception of regrowth in the fall (NRC, 1984). According to the rumen solubility in situ, Cu solubility further decreases this level. However, cows at the location maintained, with no Cu supplementation, Cu concentrations of 60-80 mg/kg dry matter in the liver during the year. And reproductive performance in the herd as measured by percentage pregnant ranged from 88% to 95% (Hickok, et al., 1996).

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Table 1
Elemental concentration of clipped samples for *Bromus inermis* leaves and stems and diet selection during the growing season.

Time	Cu[g]	Zn	Mn	Fe	Ca	P
Leaves						
May 15	9.28^{a}	21.5^{a}	54^{a}	122^{a}	.425^{a}	.252^{a}
June 1	8.83^{a}	23.1^{a}	57^{a}	122^{a}	.472^{a}	.231^{ab}
June 15	11.30^{b}	30.4^{ab}	57^{a}	144^{b}	.521^{ab}	.222^{ab}
July 15	9.27^{a}	31.2^{b}	65^{a}	164^{c}	.671^{bc}	.205^{bc}
Aug. 15	8.88^{a}	28.5^{ab}	106^{b}	176^{cd}	.726^{cd}	.176^{c}
Sept. 1	9.79^{ab}	25.6^{ab}	121^{bc}	165^{c}	1.064^{e}	.182^{c}
Sept. 15	6.59^{c}	30.6^{ab}	144^{cd}	192^{d}	.928^{ef}	.184^{c}
Oct. 1	5.00^{d}	32.6^{b}	149^{cd}	188^{d}	.871^{df}	.181^{c}
Oct 15[h]	4.48^{d}	35.9^{b}	175^{d}	190^{d}	.791^{cd}	.200^{bc}
Stems						
May 15	7.84^{a}	29.4^{a}	83^{ab}	83^{a}	.201	.334^{a}
June 1	6.16^{b}	25.7^{ab}	62^{a}	79^{a}	.182	.269^{b}
June 15	5.97^{b}	29.8^{a}	73^{a}	96^{ab}	.155	.215^{c}
July 15	4.39^{c}	27.2^{ab}	106^{bc}	93^{ab}	.185	.162^{d}
Aug. 15	3.69^{cd}	26.4^{ab}	165^{d}	106^{bc}	.222	.150de
Sept. 1	3.10^{cd}	32.6^{a}	138^{cd}	93^{ab}	.236	.140^{e}
Sept. 15	3.20^{cd}	29.6^{a}	195^{ef}	107^{bc}	.264	.123^{ef}
Oct. 1	2.53^{d}	19.2^{b}	197^{f}	121^{c}	.253	.106^{f}
Oct 15[h]	2.37^{d}	21.8^{ab}	207^{f}	123^{c}	.288	.091^{f}
Diet selection[i]						
May 15	8.78^{b}	22.4^{b}	57.5^{b}	178^{bc}	.325^{b}	.364
June 15	6.03^{bc}	18.8^{b}	39.1^{b}	129^{b}	.370^{b}	.348
July 15	6.41^{bc}	39.9^{cd}	52.0^{b}	186^{bc}	.507^{bc}	.224
Aug. 15	5.19^{c}	28.8^{bc}	45.0^{b}	168^{bc}	.617^{c}	.103
Sept. 15	4.91^{c}	17.9^{b}	210.6^{c}	490^{cd}	.652^{cd}	.485
Oct. 15[h]	13.27^{d}	48.3^{d}	177.0^{c}	803^{d}	.834^{d}	.456

[a,b,c,d,e,f] Means in a column within a section (leaves, stems, diet selection) with different superscripts are different (P<.05).
[g] Cu, Zn, Mn, and Fe in mg/kg; Ca and P in percent of DM.
[h] Oct. 15 is regrowth.
[i] Adjusted for elements contained in saliva.

Table 2
Mean percentage of the original element disappearing in *Bromus inermis* leaves and stems after 24 h of in situ digestion by time of year (maturity)

Time	Cu	Zn	Mn	Fe	Ca	P
Leaves						
May 15	68.4^{a}	71.3^{a}	95.0^{a}	93.8^{a}	85.2^{a}	92.7
June 1	72.7^{a}	71.0^{a}	93.5^{a}	93.4^{a}	81.8^{ab}	92.1
June 15	72.8^{a}	60.8^{ab}	86.4^{b}	88.5^{a}	81.4^{ab}	93.4
July 15	66.5^{a}	67.8^{a}	86.2^{b}	88.5^{a}	82.5^{a}	91.9
Aug. 15	57.4^{a}	49.2^{ab}	85.2^{b}	83.7^{a}	75.0^{b}	91.6
Sept. 15	18.2^{b}	55.6^{ab}	81.7^{b}	86.7^{a}	62.2^{c}	88.5
Oct. 1	4.5^{b}	31.8^{b}	83.8^{b}	60.7^{b}	60.4^{c}	88.7
Stems						
May 15	64.2^{a}	68.5^{a}	92.0^{ab}	78.2	59.1^{a}	92.9
June 1	65.7^{a}	56.8^{a}	89.8^{a}	91.8	51.4^{b}	92.9
June 15	60.2^{a}	38.7^{b}	89.6^{a}	78.4	45.1^{bc}	95.7
July 15	58.4^{ab}	44.1^{ab}	93.5^{ab}	70.2	48.9^{b}	90.5
Aug. 15	57.9^{ab}	57.1^{a}	93.0^{ab}	57.8	40.9^{c}	90.0
Sept. 15	51.0^{b}	21.2^{b}	94.2^{ab}	76.9	44.4^{bc}	88.7
Oct. 1	51.1^{b}	30.7^{b}	96.1^{b}	83.1	40.3^{c}	99.4

[a,b,c] Means in a column within a section (leaves or stems) with different superscripts are different (P<.05).