Mineral concentrations and availability of forages for grazing livestock in the Northern Great Plains

INTERIM PROGRESS REPORT

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Introduction

Matching animal requirements for minerals to available supply from a base diet forms the basis for designing appropriate supplementation programs. Availability of minerals must be stressed because it encompasses dietary concentration, digestibility and potential antagonistic relationships with other dietary nutrients. Understanding the various factors that affect availability is essential if livestock producers are to minimize production bottlenecks due to mineral deficiencies in a cost-effective manner. This project is designed to help increase the understanding of mineral availability of forages in the Northern Great Plains and to provide information to producers regarding base mineral supply to grazing cattle. This information could then be used to help formulate relevant, cost effective mineral supplementation programs for North Dakota producers.

Project objectives:

A. To compare the influence of grazing system with respect to seasonal changes on the nutritive value of native range in western North Dakota.

B. To evaluate the effect of increasing intake of a forage and forage type on mineral metabolism.

C. To evaluate the effect of maturity, water, nitrogen and growing degree days on the chemical composition of leaf and stem tissue of a cool-season grass.

Materials and Methods

Three experiments have been previously conducted that address varies aspects of mineral nutrition of grazing cattle. Collectively these studies address seasonal/maturity changes in nutritive quality of native range/pasture plants in western North Dakota, the effect of forage intake on mineral bioavailability, and the effects of water stress, soil fertility and grazing management on mineral concentrations of grasses. The limiting factor in each of these experiments is the high cost of nutrient, particularly mineral, analyses.

Objective A. The first experiment is being conducted at the Manning ranch of the Dickinson Research Extension Center (L. Manske). In 1983, two grazing systems were established in replicated pastures. Grazing management included a 4.5 month seasonlong system and a 4.5 month rotational grazing system (3 pastures grazed twice in succession each year). Grazing management in each system has remained constant since they were originally initiated. Although forage samples have been collected each year, samples from only 3 years have been selected for complete nutrient analysis. Selected years received relatively normal precipitation (76 to 124% of long term average precipitation). In addition, years were selected to assess long term changes due to grazing system (1983, 1989 and 1995).

Objective B. In the second experiment (E. Grings), two animal trials focused on determining the effect of dry matter intake on mineral bioavailability from forages. In the first trial, 24 steers were allotted to one of 4 treatments consisting of one of two forages fed at two levels of intake for 91 days. Subsamples of plasma, internal organs, skeletal muscle, and rib were collected for analysis of mineral concentrations. A second trial was conducted to determine the apparent absorption and retention of minerals in steers fed at two levels of intake. After 90 days of receiving their respective diets, fecal and urine subsamples were retained for mineral analysis. After removal from the crates, steers were slaughtered, body tissues weighed and subsamples collected for mineral analysis as in the first experiment.

Objective C. In the third experiment (J. Karn), Russian wildrye plots were established in a rain out shelter. Diploid and tetraploid genotypes and 10 and 134 kg/ha N levels were randomly established within four replicates of two water levels (50 and 100% of normal precipitation). Samples were collected at four stages of maturity beginning in May and ending in June. After collection, samples were separated into leaf, stem and head portions according to the presence of each. Mineral analyses will be conducted on plant tissue of each class as in first experiment (objective A).

Results and Discussion (Interim Progress Report)

Objective A. Labor has been (and continues to be) expended in the location, collation and processing of forage samples. These tasks should be completed by the end of this year. Second year funding will be used to analyze these samples in a commercial laboratory next summer. Pending reports on nutrient concentrations, results will be analyzed and final reports generated.

Objective B The hays fed contained the following nutritional composition:

	Alfalfa	Wheatgrass
	------------% DM basis---------------	
Crude protein	16.7	8.8
Acid detergent fiber	43.2	40.9
Neutral detergent fiber	51.6	63.1
Calcium	1.33	0.45
Phosphorus	0.24	0.12
Magnesium	0.30	0.14
Potassium	2.76	1.73
Sodium	0.12	0.06
	------------ppm, DM basis---------------	
Iron	426	143
Zinc	17	20
Copper	7	2
Manganese	30	29
Molybdenum	3.6	1.3

Liver and kidney weights were affected by the type of hay fed. Steers fed alfalfa had greater liver and kidneys weights than did steers fed wheatgrass hay. This was probably related to the increased nutrient flow to the organs of alfalfa-fed steers. Hot carcass weight did not differ between alfalfa- and wheatgrass hay-fed steers, therefore the increased organ weights were not due simply to increased body mass in the alfalfa-fed steers. Total tissue weight is important to the evaluation of nutrient status as a larger organ can store more minerals and there may be differences in total tissue mineral levels as well as mineral per unit of weight.

So far, liver and kidney copper and zinc concentrations have been analyzed. Hay source influenced liver and kidney copper levels, with concentrations being greater in alfalfa-fed animals. This is related to the increased copper concentrations in the alfalfa hay. Tissue copper levels were not affected by intake level of hay. Within a hay source there was no correlation between copper intake and tissue concentrations. Copper intakes ranged from 14 to 95 mg/d. Liver copper concentrations ranged from 10 to 62 mg/kg dry tissue weight. Liver copper concentrations of less than 20 mg/kg are often considered to be an indication of copper deficiency. Thirteen animals on this studies had liver copper concentrations of less than 20 mg/kg. These thirteen animals had copper intakes encompassing the full range of copper intakes.

Zinc concentrations in liver tended to be affected by hay type even though intakes of zinc were similar between hays groups. The relationship between hay type and tissue zinc concentrations was greater when expressed on a total liver weight basis because of the increased liver weight in alfalfa-fed steers. In kidney, concentrations of zinc did not differ with hay type, but because kidney weight was greater for the alfalfa-fed steers, total kidney zinc was greater in alfalfa-fed steers. This may indicate greater bioavailability of zinc from alfalfa than from grass hay.

Further evaluation of other tissue mineral levels will aid in evaluating bioavailability of minerals. Interrelationships between minerals in the body are complex and tissue concentrations of one mineral can be influenced by that of another. The full complement of analyses will aid in our interpretation of the data. Tissue mineral analysis is scheduled to be completed by October 1999.

Objective C. Samples (384) were submitted to a commercial laboratory for nutrient analysis in May, 1999. Communications with laboratory suggests analyses should be complete by October, 1999. Second year funding will be used to analyze the remaining samples (127) in the summer of 2000. Pending complete reports on nutrient concentrations, results will be analyzed and final reports generated.

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