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SEASONAL CHANGES IN FORAGE QUALITY OF C-3 GRASSES ON SAGEBRUSH GRASSLANDS

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ABSTRACT

Annual and perennial grasses growing in the semiarid, west-central North American continent mature by early to midsummer. Forage mineral concentrations in these C-3 grasses decrease curvilinearly as the season advances from day of year (DOY) 75 to 300. Total digestible dry matter (TDDM) and digestible cell wall (DCW) decrease linearly with DOY while neutral detergent fiber (NDF) increases curvilinearly. By midsummer; energy, N, P, and Zn usually become deficient for ruminant nutrition.

KEYWORDS

Cattle, *Bromus tectorum*, *Poa sandbergii*, *Agropyron desertorum*, *Agropyron riparium*, *Stipa comata*, *Sitanion hystrix*, *Elymus cinereus*

INTRODUCTION

Sagebrush grasslands occupy 43 million-ha in semiarid, west-central North America, with 20 million occurring on each of the Columbia Plateau (including the Snake River Plain) and Great Basin. Many of these rangelands have burned and reverted to winter- annual grasses or have been artificially seeded to perennial bunch grasses. Precipitation ranges from 230 to 460 mm annually, occurring mainly in winter and spring. Forage yields range from 500 to 3000 kg/ha (Murray et al., 1978). Mineral uptake and forage quality are dependent upon temperature and available soil water, but are largely controlled by physiological maturity of the plant. Mineral concentration and forage quality data can be used to predict animal performance and to develop resource management plans. The objective of this study is to mathematically describe changes in forage quality occurring over the season.

EXPERIMENTAL

Site: Studies were conducted on the Saylor Creek Experimental Range of south central Idaho near Glenns Ferry (42°54' N, 115° 24' W). This site is typical of the Snake River Plain and Columbia Plateau. Elevation is 950 m and annual precipitation ranges from 130 to 480 mm. Most precipitation falls as snow or rain in winter and spring. Winter temperatures range from -25 to 15 °C while summer temperatures range from 6 to 36°C. Soil on this site is a Truesdale fine sandy loam, a coarse-loamy, mixed, mesic *Haploxerollic Durorthid.*

Vegetation: Summer drought forces most plants to mature by June or July. Shallow-rooted annuals and perennials, like *Bromus tectorum* and *Poa sandbergii*, mature before the deeper-rooted perennials like *Agropyron desertorum, Agropyron riparium, Stipa comata, Sitanion hystrix* (genomically classified as *Elymus elymoides*) and *Elymus cinereus* (Genomically classified as *Leymus cinereus*). Cattle will graze both annual and perennial grasses even after the grasses mature. Herbage quality changes during the season as plants mature.

Sampling, analysis, and equation development: Trends in mineral concentrations, mineral ratios, and forage quality were determined for the above grasses. Plants were sampled at random from mid-March to early October over a seven-year period. Forage data were variously transformed and regressed against DOY. Equation forms having best fit (highest correlation coefficient) were selected for each nutrient.

RESULTS AND DISCUSSION

Young plants have high nutrient concentrations. However, these values decrease as plants mature, being diluted by continued production of cellulose and lignin. This reduces elemental nutrient concentrations in maturing plants. Curvilinear reduction in nutrient levels within winter annual plants precedes that in perennials by as much as two to three weeks. Rates of reduction, however are quite similar amongst the seven species. In general, equations across species for select elements and elemental ratios are:

$$\text{N, mg/g} = -10 + 4207/\text{DOY}$$
$$\text{P, mg/g} = -0.89 + 375/\text{DOY}$$
$$\text{K, mg/g} = -6.3 + 3020/\text{DOY}$$
$$\text{S, mg/g} = -0.38 + 168.7/\text{DOY}$$
$$\text{Zn, mg/g} = -0.7 + 2044/\text{DOY}$$
$$\text{Cu, mg/g} = 2.42 + 730/\text{DOY}$$
$$\text{K/(Ca + Mg)} = 0.33 + 233/\text{DOY}$$
$$\text{N/S} = 25.4 - 0.08\ \text{DOY}$$
$$\text{Ca/P} = 0.67\ e^{0.103\text{DOY}}$$

Forage N (crude protein = N x 6.2) concentrations should be about 15 mg/g for lactating cattle, 16 for weight gain, and 14 for maintenance. Beyond DOY 200, forage N levels do not satisfy these animal requirements. Phosphorus follows a similar pattern in that plant P concentrations after DOY 150 are less than 2.8 needed for lactation and 1.8 mg/g required for maintenance. A better measure of P requirement is the Ca/P value. Forage Ca/P should be <2 but can be as high as 7 in presence of sufficient vitamin D (Mayland and Wilkinson, 1996). Potassium is adequate in early season, but by DOY 200, levels fall below those of 6 to 8 mg/g likely required for growing stocker cattle (Mayland and Wilkinson, 1996). Sulfur requirements are best expressed in the N/S ratio which should be between 10 and 15. These grasses contain adequate N/S during most of the season.

Herbage Zn concentrations decline below 20 to 30 mg/g by midsummer. This concentration is insufficient for animal growth as evidenced by increased weight gain in both cows and calves supplemented with Zn (Mayland et al., 1980). These grasses contain adequate levels of Cu, Mn and Fe for animal requirements. Elemental ratios like N/S, Zn/Ca, and Zn/Cu decline linearly with time. Plant Fe concentrations are generally scattered. Concentrations in excess of 300 mg Fe/g are generally considered exogenous to plants and indicate soil contamination (Mayland and Wilkinson, 1996). While not measured in this study, Si levels are expected to increase with DOY, increasing risk of urolithiasis to steers (Mayland and Wilkinson, 1996).

A K/(Ca+Mg) ratio in excess of 2.2 indicates increasing risk of grass tetany in ruminants. We found this ratio to decline curvilinearly with time. In this area, grass tetany occurs infrequently in late April to mid May coinciding with increased risk predicted for *Elymus cinereus*. Our experience is that this specie, while a valuable feed, poses greater risk of grass tetany to grazing ruminants than other grasses tested.

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Energy values, like DCW and TDDM, decline linearly with time (Olsen el al., 1974)). The antiquality component, NDF, increases with plant maturity. Expected apparent dry matter digestibility or total digestible nutrients (TDN) are about 130 units lower than TDDM due to lost metabolic matter in feces (Murray et al., 1978).

$$\text{DCW, mg/g} = 970 - 2.05\text{DOY}$$
$$\text{TDDM, mg/g} = 1050 - 1.647\text{DOY}$$
$$\text{NDF, mg/g} = -70 + 6.27\text{DOY} - 0.01243(\text{DOY})^2$$

SUMMARY

Both annual and perennial bunch grasses on sagebrush-bunchgrass rangelands are important to grazing animals. Nitrogen (crude protein), energy, P, and Zn decline with increasing maturity of herbage and thus limit productivity of calves and lactating cows. Benefits have been shown when supplementing available forage with N, P, Zn, and energy. Documenting changes in herbage quality is useful in livestock management. Perennial species would provide a more stable yield, have a longer green-feed period, and produce more usable forage. An improved overall management strategy might be to move growing calves to more productive irrigated pasture by midsummer while continuing to graze maturing rangeland grasses with dry, mature cows.

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