The Professional Animal Scientist 34:494–504
https://doi.org/10.15232/pas.2017-01715

Case Study: Regional assessment of mineral element concentrations in Idaho forage and range grasses

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ABSTRACT

The objective was to quantify forage mineral concentrations in Idaho and evaluate changes due to seasonality and irrigation. Forage was sampled on rangeland and irrigated pastures in summer and fall from 35 locations in 9 counties and analyzed for Ca, P, K, Mg, S, Na, Zn, Fe, Mn, Cu, Mo, Co, and Se. Statistical analysis was by pasture type using mixed model repeated measures with fixed effects being county, season, and county × season. Location within county was a random effect. Samples were also analyzed by soil type with type of forage, season, and type × season as fixed effects and location within soil type as the repeated random effect. The macrominerals P, Mg, and Na were deficient in rangeland forage, and Na was deficient in irrigated forage. Potassium was deficient on fall rangeland. Deficient trace minerals for both pasture types were Cu, Se, and Zn. Cobalt was deficient on both types of summer pasture. Antagonistic minerals were Mo and Fe. Forage macromineral concentrations declined ($P < 0.05$) from summer to fall for P and K on irrigated pasture and for P, K, and S on rangeland. Iron increased ($P < 0.0005$) from summer to fall on both types of pasture. Clay loam soils had greater ($P < 0.05$) Fe and Co and less Se than did sandy loam soils. Forage sampling confirmed the importance of obtaining duplicate samples for laboratory analyses, especially for Se. Pairing a customized mineral mix to forage deficits is a plausible management option for beef cattle operations in Idaho.

Key words: mineral, forage, rangeland, irrigated pasture

INTRODUCTION

The status of macrominerals and trace minerals in Idaho forage has been investigated previously. Due to issues arising in livestock with white muscle disease in the Pacific Northwest, selenium status in forage crops (predominantly alfalfa) was evaluated in Washington, Oregon, Idaho, northern California, northern Utah, northern Nevada, and western Montana (Carter et al., 1968). However, the level of sampling was rather coarse in this very large geographical area. In central Idaho, along the Salmon, Little Lost, and Big Lost Rivers, selenium was described as being adequate. Subsequent sampling by the same principal scientist (Carter et al., 1970) on high altitude rangeland forage indicated that some of the geographical area along the Salmon River drainage was also deficient in selenium. In the 1970s and 1990s, localized studies of beef cattle mineral nutrition were conducted in Lemhi and Custer counties (Loucks, 1977; Hawkins, 1979). Although this information was valuable and was used within those counties to help develop livestock mineral supplements, access to this information is limited for the larger scientific or production agriculture community. Recognizing a need for more information regarding nutritive quality and mineral content on Idaho rangelands, a 2-yr study of grazed and clipped forage was conducted in southwestern Idaho (Wilson et al., 2011), finding only 4 of 11 minerals tested in clipped forage were adequate during the growing season.

The limited forage mineral sampling done previously in Idaho indicated a need to sample across a larger swath of the state. Our objective was to expand the knowledge of mineral status for irrigated and rangeland pastures at different seasons for different regions of the state. Thus, we hoped to provide improved information to producers and their commercial feed company partners who design mineral supplements to meet forage deficiencies.

One author works for Furst-McNess Company (Rexburg, ID), and one author works for Micronutrients USA LLC (Jerome, ID). Both companies provided support. The other authors declare no conflict of interest. Extension educators contributed equally.

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MATERIALS AND METHODS

General Procedures

In 2016 forage samples were obtained on irrigated pastures and rangeland in 9 of the 44 counties of Idaho with 9 low elevation (720 to 901 m), 14 mid-elevation (1,159 to 1,513 m), and 12 high elevation (1,553 to 1,962 m) locations. There are 10 ecoregions (McGrath et al., 2002) in Idaho (http://ecologicalregions.info/data/id/id_front.pdf), and we obtained forage samples from 6 of those [Northern Rockies Basin and Range (Owyhee and Bannock counties); Snake River Plain (Canyon, Ada, Lincoln, Bingham, and Bannock counties); Columbia Plateau (Idaho county); Idaho Batholith (Custer county); Middle Rockies (Custer and Lemhi counties); and Blue Mountains (Idaho county)]. We did not obtain forage samples from the Northern Rockies ecoregion because it is predominantly timber with minimal cow-calf livestock production. We also did not obtain samples from the Wasatch and Unita Mountains, Central Basin and Range, and the Wyoming Basin ecoregions. These ecoregions are minor inclusions located in extreme southeastern Idaho.

We did not have the budget to do extensive sampling at each location. With our limited budget, our purpose was not to extensively sample at a particular location but to sample across multiple locations (replicates) within 9 counties and look at the variability across sites. We sampled at 35 locations spread across Idaho to investigate how forage mineral profiles vary by season and type of forage. Many of these survey studies across a state have only obtained one forage sample per location (e.g., Mathis and Sawyer, 2004). Our main purpose in obtaining duplicate samples at each location was to validate laboratory analyses that were conducted. If we had chosen to do extensive forage sampling for each location (e.g., n = 10 duplicate forage samples), our funding would have accommodated sampling a maximum of 1.5 counties. This would have defeated the main reason for doing this research.

Duplicate samples were obtained from the 35 different locations (Figure 1) for the summer, corresponding to the peak of the growing season (June to August), and fall, corresponding to dormancy (October to November). At these northern latitudes with short growing seasons, the time of forage sampling matched typical production practices. Cattle typically move to range pastures in mid to late May and remain there until late October. Samples were analyzed for Se at the South Dakota Agricultural Laboratories (Brookings, SD) using fluorometric procedures (Olson et al., 1975; Koh and Benson, 1983; Palmer and Thiex, 1997; AOAC International, 2016). Forage mineral concentrations for Ca, P, Mg, K, Na, Fe, Zn, Cu, Mn, Mo, S, and Co were analyzed at Ward Laboratories Inc. (Kearney, NB) using inductively coupled atomic plasma analysis. Preceding the analysis of Co by inductively coupled atomic plasma analysis, samples were prepared using a microwave closed vessel digestion (EPA, 2007).

At each sampling location, duplicate samples were clipped within a 40 × 40 cm quadrat frame with all range grasses or irrigated pasture grasses (annual and perennial) and palatable forbs clipped to ground level and pooled for each sample. Any shrubs present for replicate samples were omitted from the sample (n = 2). Only one sample contained a palatable half shrub (parsnip flowered buckwheat; *Eriogonum heracleoides* Nutt.), from which the current year's plant leaders were clipped. Replicate samples were located within 6 m of each other and were chosen to best represent the dominant vegetation in the sampling location as well as to stay within the same soil type. Species composition for each quadrat was estimated by ocular means on a dry-weight basis, but individual species were not analyzed for mineral concentrations—only the composite sample for each quadrat. The goal was for extension educators from each county to determine sampling locations from 3 dominant range soil types (at different locations) and 2 dominant irrigated pasture soil types (at 2 different locations). Soil maps from the Natural Resources Conservation Service were used when needed to assist with sample stratification across the available soil types for each county. Some counties did not have either irrigated pasture (Idaho county) or rangeland (Ada, Bingham, and Canyon counties) in appreciable quantity to permit sampling for both types of forage. In these cases, sampling was reduced accordingly to only include the dominant forage type (irrigated or rangeland). Also, extension educators in 3 counties felt that either rangeland (Lemhi county) or irrigated (Canyon and Custer counties) pasture soil types needed an additional sampling location to represent dominant soil types within the county. At each sampling location, soil texture was verified in the field using accepted soil texturing techniques (NRCS; https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/edu/?cid = nrcs142p2_054311). Dominant soil types encountered were sandy loam (n = 6), clay loam (n = 5), sandy clay loam (n = 4), silty clay loam (n = 4), and silty loam (n = 4). Sandy clay loam soils were only present on irrigated ground, and silty loam soils were only present at high elevations.

Dominant perennial grasses in irrigated pastures included orchardgrass (*Dactylis glomerata* L.), tall fescue [*Lolium arundinaceum* (Schreb.) S.J. Darbyshire], Kentucky bluegrass (*Poa pratensis*), smooth brome (*Bromus inermis*), ryegrass (*Lolium* L.), western wheatgrass [*Pascopyrum smithii* (Rydb.) A. Love], and quackgrass [*Elytrigia repens* (L.) Nevski]; dominant forbs included alfalfa (*Medicago sativa*), white clover (*Trifolium repens* L.), red clover (*Trifolium pretense*), plantain (*Plantago* L.), dandelion (*Taraxacum* F.H. Wigg.), wild carrot (*Daucus carota*), and field bindweed (*Convolvulus arvensis*). At one irrigated pasture location, wet meadow sedges (*Carex* spp.) were abundant. Dominant perennial grasses in rangeland pastures included bluebunch wheatgrass [*Pseudoroegneria spicata* (Pursh) Á. Löve], Sanberg bluegrass (*Poa secunda* J. Presl), pubescent wheatgrass (*Thinopyrum intermedium*