Seasonal Mineral Concentration in Diets of Esophageally Fistulated Steers on Three Range Areas

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Abstract

Past analyses of Florida range plants have been hand-plucked, whole-plant samples and have been limited to a few major species sampled at a few times during the year. The objective of this study was to determine if mineral concentrations in hand-plucked samples and the boluses of esophageally fistulated steers changed from summer to winter; changed on different range areas; could be improved by more frequent grazing. Concentration of P and K in diets collected from steers grazing pine-palmetto, transition, and pond areas were not significantly different, but Ca, Mg, and Mn were usually lower on the pond areas. Concentration of Zn was similar in diets from the 3 areas in summer, but was lower on pine-palmetto and transition areas in winter. Concentration of Fe in diets was greater on pond areas than on pine-palmetto areas, while transition areas were intermediate. Concentrations of P, K, Mg, and Mn in diets of fistulated steers declined from summer to winter. Concentrations of P, K, Fe, and Zn were not different between pastures regrazed in winter and grazed only in winter. Most hand-plucked forages declined in mineral concentration from summer to winter. Florida range must be supplemented with complete minerals regardless of season, range site grazed, or grazing management.

South Florida flatwoods range sites are made up of three sub-sites: pine-palmetto (75%), maidencane (Panicum hemitomon) ponds (15%), and their intergrading areas, referred to as transition areas (10%) (Hilmon 1964). Pine-palmetto area soils are usually sandy Spodosols, and their low organic matter (<2%), together with high rainfall (>120 mm annually) result in plants with low mineral concentration. Wiregrass (Aristida stricta) (Hilmon and Lewis 1962, Kirk et al. 1974); chalky bluestem (Andropogon curvula), lop-sided indiangrass (Sorghastrum secundum) (Lewis 1970), and creeping bluestem (Schizachyrium stoloniferum) (Kalmbacker and Martin 1981) were found to be below the mineral level necessary for dry, pregnant cows. Large portions of Florida range are grazed from October to March, and native forage that has accumulated from the previous growing season is weathered and senescent, which further adds to the deficiency problems. Soils of the ponds are often Histosols or other soils with high organic matter content, which is responsible for higher dry matter yield and crude protein characteristics of maidencane. Pond vegetation, because of better soils, may have greater mineral supplying potential than pine-palmetto areas.

Previous plant-mineral research has been based on hand-collected whole plant samples from a few species on pine-palmetto areas. However, range pastures and cattle diets are very diverse. One Florida range pasture contained 109 different species, 42 of which were known to have been eaten by esophageally fistulated steers (Kalmbacker et al. 1984). A total of 26 species were eaten on the pine-palmetto area, 13 species on pond areas, and 15 species were eaten on the transition areas. This complex diet mixture and the variation that occurs within a plant (Kalmbacher 1983) makes it difficult to characterize range-plant mineral concentration.

Use of esophageally fistulated animals is an accepted practice to estimate crude protein, digestibility, botanical composition, etc., of cattle diets (Van Dyne and Torrell 1964, Vavra et al. 1978, Lesperance et al. 1974). Use of fistulated cattle to predict the concentration of P in forage (Hoehne et al. 1967, Langlands 1966, Mayland and Lesperance 1977); and Zn (Little 1975, Mayland and Lesperance 1977), is unreliable because of salivary contamination. Smaller increases due to saliva were found for K, Mn, and Fe (Little 1975, Mayland and Lesperance 1977), while Ca and Mg could be predicted with reasonable error (±9%) (Little 1975).

Objectives of this research were not to predict absolute plant mineral concentration, but to determine if pine-palmetto, maidencane pond, and transition areas were different in their mineral supplying potential by monitoring bolus P, K, Ca, Mg, Fe, Mn, and Zn concentrations. We also wanted to determine if summer-winter grazing improved mineral supplying potential over winter grazing alone.

Materials and Methods

A 16.2 ha native pasture in good-to-excellent condition was divided into two 8.1 ha pastures, each containing 5.7 ha of pine-palmetto area; 1.6 ha of maidencane pond; and 0.8 ha of transition area. Both the available forage and species selected by cattle on all 3 sites have been described (Kalmbacher et al. 1984).

Major soils on the pine-palmetto areas were Ona and Snyrna fine sands (sandy, siliceous, hyperthermic Typic and Arenic Haplauquods, respectively). Soil on the pond was a Samsula muck (sandy, siliceous, silicdyic, hyperthermic, Terri Medisaprists), and on the transition area, a Basinger fine sand (sandy, siliceous, hyperthermic, spodic Psammaquent). Flatwoods, transition and pond soils are ranked lower to higher, respectively, in fertility primarily because of an increase in soil organic matter content.

Both pastures were burned in January 1980. One pasture was grazed from 16 June to 26 August 1980 (referred to as 'summer pasture'), the re-grazed between 15 January and 18 March 1981 (referred to as 'winter-regrowth-pasture'). The second pasture was grazed between 12 January and 15 March 1981 (referred to as
Results and Discussion

Effect of Season and Previous Grazing

Diets of cattle grazing the summer pasture had higher ($P<0.01$) $K$ concentrations than diets of cattle grazing winter-only or winter-regrowth pastures (Table 1). Concentrations of $P$ in diets were greater ($P<0.01$) on the summer than the winter-regrowth pasture, but there was no ($P>0.05$) difference in $P$ concentration in diets from the summer vs winter only pasture. There was no difference in concentrations of $P$ and $K$ when the winter-regrowth and winter-only pastures were compared.

During winter, frost is common in sub-tropical Florida (26°N), and the winter of 1981 was colder than normal. Mean low was 1.8°C vs. 9.5°C for the 36-year average (Dantzman and Hodges 1980). Grass was weathered and senescent, and grazing of regrowth from previously grazed summer pasture (3-month-old regrowth) did not enhance $P$ and $K$ concentration over the pasture grazed only in winter (10-month-old forage).

Deficiency of $P$ has been reported and recognized in Florida (Kirk et al. 1974, Lewis 1974), but deficiency of $K$ has not received much attention. Creeping bluestem (Kalmbacker and Martin 1981) was reported as being deficient in $K$ for dry-pregnant cows. Fistulated steers in this study received no $K$ in their mineral supplement, yet values for $K$ from the forage collected from steers in winter were still deficient in $K$ (NRC 1976) (Table 1).

Iron, $Ca$, and $Zn$ concentrations (mean effect means) were not significantly different in diets eaten on the summer, winter-only, or winter-regrowth pastures (Table 1). However, there were two significant pasture (season) x area interactions for $Ca$ (Table 2), which will be discussed. Because main effect means for the pastures were not different, and since cattle graze all 3 areas in the same pastures on commercial ranches, it is expected that seasonal and regrazing effects on diet $Ca$ would be nominal.

Diets from the summer pasture were higher ($P<0.01$) in $Mg$ concentration than those from the winter-only and winter-regrowth pasture, but there was no significant difference between winter-regrowth and the winter-only pasture (Table 1). A significant pasture (season) x area interaction was found for $Mg$ (Table 2), and this will be discussed as an effect of range areas. The concentrations of $Mn$ in diets were significantly higher ($P<0.05$) on both summer and winter regrowth pastures when they were compared to the winter-only pasture, but summer and winter regrowth pastures were not different in diet $Mn$ (Table 1).

Effect of Range Areas

There was no difference in $P$ and $K$ concentration of esophageally fistulated steer diets grazing on the 3 range areas. Phosphorus on the pine-palmetto area averaged 0.26%; the transition area, 0.21%; and the pond 0.20%. Potassium on these respective areas averaged 0.44%, 0.43%, and 0.43%.

Steer diets on the summer and winter-only pasture pond areas

<table>
<thead>
<tr>
<th>Pasture</th>
<th>$P$</th>
<th>$K$</th>
<th>$Ca$</th>
<th>$Mg$</th>
<th>$Mn$</th>
<th>$Zn$</th>
<th>$Fe$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td>0.24</td>
<td>0.68</td>
<td>0.29</td>
<td>0.11</td>
<td>47</td>
<td>21</td>
<td>89</td>
</tr>
<tr>
<td>Winter only</td>
<td>0.21</td>
<td>0.28</td>
<td>0.29</td>
<td>0.08</td>
<td>40</td>
<td>22</td>
<td>102</td>
</tr>
<tr>
<td>Summer</td>
<td>0.24</td>
<td>0.69</td>
<td>0.29</td>
<td>0.11</td>
<td>47</td>
<td>21</td>
<td>89</td>
</tr>
<tr>
<td>Winter regrowth</td>
<td>0.20</td>
<td>0.34</td>
<td>0.30</td>
<td>0.08</td>
<td>46</td>
<td>23</td>
<td>99</td>
</tr>
<tr>
<td>Winter only</td>
<td>0.21</td>
<td>0.29</td>
<td>0.29</td>
<td>0.081</td>
<td>40</td>
<td>23</td>
<td>99</td>
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<td>0.08</td>
<td>46</td>
<td>22</td>
<td>102</td>
</tr>
</tbody>
</table>

Values for this element depend on pasture and/or range site, see accompanying tables. **For vertical comparison, significant differences $P<0.05$. NS not significant.
usually contained less Ca and Mg than pine-palmetto and transition areas (Table 2). An increase in diet Ca and Mg resulted from regrazing pond areas in the winter, and this resulted in the significant interactions for both Ca and Mg. Diet Ca and Mg from pine-palmetto and transition areas of the winter-only-pasture were higher than Ca and Mg in diets from those respective areas on winter-regrowth pasture. Calcium and Mg concentrations in diets from the pond of the winter-regrowth pasture were higher than concentrations of these elements on the pond of winter-only pasture.

Manganese concentrations in diets tended to be highest on the pine-palmetto area, followed by Mn in diets from the transition with the pond area lowest (P<0.05) (Table 2). This was found to be true on the summer pasture and the winter-regrowth-pasture, but the 3 areas on the winter-only-pasture were similar in Mn concentration.

Concentrations of Zn in diets from the summer pasture were not different on the 3 areas and averaged 21 ppm (data not in table). On the winter-regrowth and winter-only-pastures, Zn was usually lower on the pine-palmetto (18 ppm), while pond (26 ppm) and transition areas (24 ppm) were higher (Table 2).

Iron concentrations in diets from the pond tended to be higher than concentrations of Fe found in diets from other areas, but there were no significant differences. Main effect means for the 3 areas were: pine-palmetto, 90 ppm; transition, 96 ppm; and pond, 103 ppm.

It was anticipated that the pond area, because of the organic soils, would have had greater mineral-supplying potential, but this was not found to be true. Zinc was the only element that was found in greater concentration in diets collected from steers grazing the pond as compared with Zn in diets from pine-palmetto and transition areas. Concentration of P and K in diets was similar on the 3 areas, but Ca, Mg, and Mn were lower on the pond than on pine-palmetto and transition areas.

Copper concentration was determined in diet samples from fistulated steers, but because of the trace amounts present, we felt that any response due to area or pasture could be masked by salivary contaminations of Cu. Therefore, Cu concentration of diet samples has not been presented.

**Mineral Concentration in Hand-collected Forage**

Mineral concentration in hand-plucked grasses averaged 0.08% P, 0.34% K, and 0.10% Mg in summer, but declined to 0.05% P, 0.17% K, and 0.07% Mg in winter. Average summer and winter concentrations of Ca, Mn, Cu, and Zn were 0.19 and 0.17% Ca, 39 and 32 ppm Mn, 3 and 3 ppm Cu, and 14 and 15 ppm Zn, respectively. Average Fe concentration in grasses was 46 ppm in summer and 76 ppm in winter. Kalmbacker and Martin (1981) found that concentrations of P, K, and Mg in creeping bluestem were higher (P<0.05) in October before frost when compared with concentrations after frost and weathering in January and February. In the same study Fe concentrations in creeping bluestem increased in January and February. Creeping bluestem and chalky bluestem were two grasses that together made-up more than 40% of steer diets on pine-palmetto areas in summer and winter (Kalmbacker et al. 1984). A decline in concentration of P, K, and Mg in these plants is indicative of the decline in P, K, and Mg that was observed in summer and winter diets (Table 1).

Forbs and grass-like plants such as: Carex and Juncus spp, *Lacnanthes caroliniana*, *Polygonella* spp, *Xyris* spp and *Rhexia* spp, averaged 0.09% P, 0.33% K, 0.46% Ca, and 0.22% Mg in summer. Kalmbacker et al. (1984) found that these plants comprised 20% of the dry matter of steer diets on pine-palmetto areas and 1% of the diet from pond areas. Concentrations of minerals in these plants declined in winter to 0.03% P, 0.10% K, 0.21% Ca, and 0.08% Mg. The forbs and grass-like plants made up only 6% of the pine-palmetto area diet in winter, but on pond areas they were found to make-up 47% of the winter diets (Kalmbacher et al. 1984). Shrubs like saw palmetto (*Serenoa repens*) and gallberry (*Flex glabra*) were found to make up 6% and 39% of pine-palmetto area diets in summer and winter, respectively (Kalmbacher et al. 1984).

Saw palmetto, which was eaten in both seasons contained 0.11% P, 0.45% K, 0.10% Ca, and 0.12% Mg in summer, and 0.08% P, 0.19% K, 0.15% Ca, and 0.15% Mg in winter. Shrubs were less affected by cold than grasses and forbs, and their foliage remained alive through winter.

Comparison of mineral concentrations in forage collected from steers (Table 1) was found to be several times higher than concentrations found in hand-collected forages. This again indicates that forage collected from esophageally fistulated cattle cannot provide absolute estimates of the mineral concentration because of increases from salivary contamination. Since forage was collected from the steers on a day-to-day basis and because cattle were allowed to graze on one area at each collection, trends in the mineral status of the samples should reflect relative differences in the forage that were due to changes in the plant community, soils, or plant maturity.

**Conclusions**

Bolus levels of P and K were not different on the 3 range areas, and pond areas were lower in Ca, Mg, and Mn. Concentrations of P, K, Mg, and Mn in diets declined from summer to winter (Ca and Fe remained the same), while Zn declined only on the pine-palmetto and transition area. In both summer and winter, hand

| Table 2. Calcium, Magnesium, and Zinc content (on a dry matter basis) of forage collected from esophageally fistulated steers grazing in the winter and summer on three areas, Oxa, FL 1980-81 |
|-----------------|-----------------|-----------------|
| Pasture         | Range area      | Transition      |
| Summer & winter | Pine-palmetto   | Pond            |
| average†        | 0.37 a‡         | 0.30 b          |
| Summer          | 0.38 a          | 0.31 a          |
| Winter regrowth | 0.27 ah         | 0.26 b          |
| Winter only     | 0.36 a          | 0.32 a          |
| Winter regrowth | 0.31 a          | 0.26 b          |
| Summer†         | 0.13 a‡         | 0.12 a          |
| Winter only     | 0.10 a          | 0.09 a          |
| Winter regrowth | 0.09 a          | 0.08 b          |
| Summer & winter | 0.32 a          | 0.33 b          |
| regrowth average† | 52 a‡      | 47 a            |
| Winter only     | 18 b‡           | 24 a            |
| winter regrowth | 26 a            |                 |

† no significant pasture X range area interaction.
‡ means on a line followed by the same letter are not significantly different (Duncan's least significant difference test, P<0.05)
§ for vertical comparison, significantly different, P<0.05. NS not significant.
plucked samples were below the levels of all minerals (except Fe and Mn) needed for maintenance of dry-pregnant cows (NRC 1976). These data indicate that flatwoods range with soils similar to those of this study need complete mineral supplementation regardless of season, grazing management, or amount of pine-palmetto, pond, and transition areas in the pasture.

Literature Cited


POSITION AVAILABLE


RANK: Assistant or associate professor. This position and other similar research positions do not have tenure.

LOCATION: Texas A&M University Agricultural Research and Extension Center, Vernon, Texas.

MINIMUM QUALIFICATIONS: Ph.D. in Range Science or closely related field with research experience in nutrition of grazing beef animals. Two or more years post-doctoral research experience preferred.

STANDARDS: Competitive with other States and consistent with experience of candidate.

CLOSING DATE FOR APPLICATIONS: Applications will be received until June 1, 1984 or until a suitable candidate is found.

DUTIES AND RESPONSIBILITIES: The scientist will develop a research program which addresses nutritional problems of grazing animals with the primary emphasis on beef animals. It is expected that a significant research program will be developed in cooperation with scientists at the Texas Experimental Ranch. Opportunities exist to develop research on stockers at the Spur Research Station and on grazing animals with cooperator producers in the Rolling Plains.

FACILITIES: The Vernon Research Center consists of a modern research facility with a staff of 40 including 10 Ph.D. members. A nutrition laboratory and a laboratory technician are available at Vernon. The Texas Experimental Ranch consists of approximately 7,000 acres of native range and is available for research with some constraints on stressing animals. The Spur Research Station consists of 1400 acres of range and cultivated land. Several large ranches in the area provide an opportunity to develop cooperative research programs.

TO APPLY: Send a resume, official transcript, and three letters of recommendation to:

Dr. Earl C. Gilmore, Jr.
Resident Director of Research
Texas A&M Research and Extension Center
P.O. Box 1658
Vernon, Texas 76384

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