

Phosphorus, Crude Protein, and Digestible Dry Matter Concentrations of Forage Selected by Grazing Beef Cattle

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Summary and Implications

Phosphorus (P) is an essential nutrient for beef cattle, but over-supplementation of P may have negative environmental and economic impacts. The P concentration in forage selected by grazing cattle may be sufficient to meet the nutritional requirements without supplementation. Similarly, the crude protein (CP) and *in vitro* digestible dry matter (IVDDM) concentration of forage selected by grazing cattle may be greater than available forage. This study was conducted to determine the P, CP, and IVDDM concentrations of forage selected by beef cattle grazing cool-season grass pastures. Fifteen fall-calving Angus cows were managed by either continuous or rotational stocking in 30-acre smooth bromegrass pastures, replicated twice. In July and August, one ruminally fistulated steer was placed in each pasture for one week. On two consecutive days at the end of each week, fistulated steers were ruminally evacuated, allowed to graze for 2 h, and sampled for forage selected during grazing. Forage samples were hand-clipped at ground level and from the upper half of the forage sward in pasture areas adjacent to the areas being grazed. A subsample of the ground-clipped forage was placed in the rumen and allowed to soak for 2 h following sampling of selected forage to correct the P, CP, and IVDDM concentrations in the selected forage for salivary P, CP, and IVDDM absorbed by selected forage. Hand-clipped and selected forage samples were analyzed for P, CP and IVDDM concentrations. Phosphorus concentrations in the available forage did not differ by month. However, P concentrations of available forage in continuously stocked pastures (0.22%) tended to be greater than in rotationally stocked pastures (0.20%). The P concentration of selected forage (0.39%) was almost twice as high as the available forage. Available forage in pastures managed by continuous stocking had greater CP and IVDDM concentrations than did forage in rotationally stocked pastures in both months. Results of this study show that cattle grazing cool-season grass pastures are able to select forage with an adequate crude protein and P concentrations to meet their nutrient requirement without supplementation.

Introduction

Phosphorus (P) is an essential nutrient for beef cattle. However, over-supplementation of P may have negative environmental and economic impacts. It has been shown

that cattle are able to select forage with higher crude protein (CP) and *in vitro* digestible dry matter (IVDDM) of a higher quality than is available in the average forage sward. The P concentration in forage selected by grazing cattle may be sufficient to meet the nutritional requirements without supplementation.

The objective of the current study was to determine the IVDDM, CP, and P concentrations of forage selected by grazing cattle.

Materials and Methods

Fifteen fall-calving Angus cows (mean BW = 1369 lbs.) were managed by either continuous or rotational stocking (5 paddocks) in 30-acre smooth bromegrass pastures, replicated twice. Pastures were stocked from mid-May to Mid-October 2007. In July and August, one ruminally fistulated steer was placed in each pasture for one week. Only two fistulated steers were available. Therefore, block one pastures were grazed by fistulated steers during the first week and block two was grazed during the second week of each month. On two consecutive days at the end of each week, fistulated steers were ruminally evacuated, allowed to graze for 2 h, and a sub-sample of forage selected by steers was collected from the rumen. While fistulated steers were grazing, forage samples were hand-clipped to ground level and from the upper half of the forage sward from twelve 0.25m² locations adjacent to grazed areas. Forage sward height was measured with a rising plate meter (8.8 lb/yd²) at ground clipped locations. A subsample of the ground-clipped forage was placed in the rumen and allowed to soak for 2 h following sampling of selected forage to correct the P, CP and IVDDM concentrations in the selected forage for salivary P, nitrogen and IVDDM absorbed by selected forage (Adjusted Selected Forage = Selected Forage – (Rumen Soaked Forage – Ground Clipped Forage)). Ground-clipped samples represented available forage. Forage from the upper half of the sward was sorted into live and dead material. Hand-clipped forage samples were dried for 48 hours at 60°C. Selected forage was freeze dried. All samples were ground to 1mm. Hand-clipped and selected forage samples were analyzed for P, CP and IVDDM concentrations.

Results and Discussion

Sward height of forage in the vicinity of where fistulated steers were grazing during the forage selection period in July was greater (P<0.05) in the continuously stocked pasture than in the rotationally stocked pasture (Table 1). Forage sward heights were lower (P<0.05) in August than in July, but did not differ between

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treatments in August. Available forage mass did not differ between grazing treatments or months.

Phosphorus concentrations in the available forage did not differ by month (Table 2). However, P concentrations of available forage in continuously stocked pastures (0.22%) tended to be greater than in rotationally stocked pastures (0.20%). Phosphorus concentration of adjusted selected forage (0.39%) was almost twice as high as the available forage (0.21%) and was higher than live forage clipped from the top half of the sward (0.29%).

The CP concentration of available forage was greater ($P < 0.05$) in August than in July (Table 3) in both grazing treatments. Available forage in pastures managed by continuous stocking had greater ($P < 0.05$) CP concentrations than did forage in rotationally stocked pastures in both months. Crude protein concentration was also greater ($P < 0.05$) in top half live and top half dead forage in August than in July. The CP concentration of forage selected by cattle did not differ by month, but tended ($P = 0.06$) to be greater in continuously stocked pastures than in rotationally stocked pastures.

In Vitro digestible dry matter concentration of available forage was greater ($P < 0.05$) in July than in August (Table 4). *In Vitro* digestible dry matter concentration of forage selected by cattle was greater ($P < 0.05$) in July than in August.

In the current study, cattle managed by either rotational or continuous stocking were able to select forage with a greater P, CP and IVDDM concentrations than that of the available forage. On average, forage P concentration of selected forage was 87% greater than that of available forage; however, there was a great amount of variability (Standard Deviation = 69%) in the ability of cattle to select forage of greater P concentration. Crude protein

concentration of selected forage was 44% (Standard Deviation = 19%) greater than that of available forage. *In Vitro* digestible dry matter of selected forage was 8.8% (Standard Deviation = 6.7%) greater than that of available forage.

Crude protein and P concentrations of available forage were adequate to meet the nutritional requirements for maintenance of a beef cow with a 1200 lb mature body weight (5.99% CP, 0.12% P), assuming adequate forage availability. Crude protein and P concentrations of selected forage were sufficient to meet the nutritional requirements of the same cow at peak lactation (10.69% CP, 0.21% P).

Results of this study show that cattle grazing cool-season grass pastures are able to select forage with an adequate crude protein and P concentrations to meet their nutrient requirement without supplementation.

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Table 1. Forage sward height and mass of available forage and mass of top half live and dead forage in pastures managed by continuous or rotational stocking in July and August.

| | July | | August | | Trt | Mth | Trt x Mth |
|-------------------------------|-------------------------|---------------------|---------------------|---------------------|-----|-----|-----------|
| | Continuous Stocking | Rotational Stocking | Continuous Stocking | Rotational Stocking | | | |
| | Forage Sward Height, cm | | | | | | |
| Available Forage ¹ | 19.3 ^a | 14.1 ^b | 12.2 ^c | 12.9 ^{bc} | .07 | .05 | .05 |
| | Forage Mass, kg/ha | | | | | | |
| Available Forage | 2823 | 2386 | 1819 | 2558 | NS | NS | .08 |
| Top Half Live | 502 | 438 | 245 | 204 | NS | .05 | NS |
| Top Half Dead | 260 | 239 | 319 | 180 | NS | NS | .09 |

^{abc}Values within a row with different superscripts differ ($P < 0.05$).

¹Available forage = clipped to ground level, Top Half Live = green forage hand clipped and sorted from the upper half of the available forage sward, Top Half Dead = brown forage hand clipped and sorted from the upper half of the available forage sward.

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Table 2. Phosphorus concentrations of available, top half live, top half dead, and adjusted selected forage in pastures managed by continuous or rotational stocking in July and August.

| | July | | August | | Trt | Mth | Trt x Mth |
|-------------------------------|---------------------|---------------------|---------------------|---------------------|-----|-----|-----------|
| | Continuous Stocking | Rotational Stocking | Continuous Stocking | Rotational Stocking | | | |
| | Phosphorus, % | | | | | | |
| Available Forage ¹ | 0.235 | 0.200 | 0.210 | 0.205 | .08 | NS | NS |
| Top Half Live | 0.278 | 0.223 | 0.333 | 0.318 | .05 | .05 | NS |
| Top Half Dead | 0.175 | 0.165 | 0.140 | 0.128 | NS | .05 | NS |
| Adjusted Selected | 0.363 | 0.455 | 0.378 | 0.355 | NS | NS | NS |

¹Available forage = clipped to ground level, Top Half Live = green forage hand clipped and sorted from the upper half of the available forage sward, Top Half Dead = brown forage hand clipped and sorted from the upper half of the available forage sward, Adjusted Selected = actual P concentration of forage selected by cattle calculated as [%P of selected forage – (%P in a subsample hand clipped sample soaked in rumen – %P in available forage)].

Table 3. Crude protein concentrations of available, top half live, top half dead, and adjusted selected forage in pastures managed by continuous or rotational stocking in July and August.

| | July | | August | | Trt | Mth | Trt x Mth |
|-------------------------------|---------------------|---------------------|---------------------|---------------------|-----|-----|-----------|
| | Continuous Stocking | Rotational Stocking | Continuous Stocking | Rotational Stocking | | | |
| | Crude Protein, % | | | | | | |
| Available Forage ¹ | 8.9 | 7.8 | 10.0 | 9.0 | .05 | .05 | NS |
| Top Half Live | 14.2 | 12.4 | 17.5 | 16.1 | .08 | .05 | NS |
| Top Half Dead | 4.9 | 5.8 | 7.5 | 6.4 | NS | .05 | .08 |
| Adjusted Selected | 13.0 | 11.3 | 14.6 | 12.2 | .06 | NS | NS |

¹Available forage = clipped to ground level, Top Half Live = green forage hand clipped and sorted from the upper half of the available forage sward, Top Half Dead = brown forage hand clipped and sorted from the upper half of the available forage sward, Adjusted Selected = actual CP concentration of forage selected by cattle calculated as [%CP of selected forage – (%CP in a subsample hand clipped sample soaked in rumen – %CP in available forage)].

Table 4. *In Vitro* digestible dry matter (IVDDM) of available, top half live, top half dead, and adjusted selected forage in pastures managed by continuous or rotational stocking in July and August.

| | July | | August | | Trt | Mth | Trt x Mth |
|-------------------------------|--|---------------------|---------------------|---------------------|-----|-----|-----------|
| | Continuous Stocking | Rotational Stocking | Continuous Stocking | Rotational Stocking | | | |
| | <i>In Vitro</i> Digestible Dry Matter, % | | | | | | |
| Available Forage ¹ | 48.3 | 53.3 | 47.1 | 44.2 | NS | .05 | .05 |
| Top Half Live | 50.8 | 53.9 | 53.7 | 54.4 | NS | NS | NS |
| Top Half Dead | 42.1 | 47.2 | 36.1 | 39.7 | .05 | .05 | NS |
| Adjusted Selected | 52.3 | 57.9 | 50.4 | 48.9 | NS | .05 | .05 |

¹Available forage = clipped to ground level, Top Half Live = green forage hand clipped and sorted from the upper half of the available forage sward, Top Half Dead = brown forage hand clipped and sorted from the upper half of the available forage sward, Adjusted Selected = actual CP concentration of forage selected by cattle calculated as [%IVDDM of selected forage – (%IVDDM in a subsample hand clipped sample soaked in rumen – % IVDDM in available forage)].