Effects of Grazing Management on Pasture Production and Phosphorus Content of Forage (A Progress Report)

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Summary

In spring 2001, pastures were grazed at the ISU Rhodes Research and Demonstration Farm to determine the effects of grazing management on pasture productivity and phosphorus (P) content of forage. Treatments included an ungrazed control, summer hay harvest with winter stockpiled grazing, continuous stocking to a residual height of 2 inches, rotational stocking to a residual height of 2 inches, and rotational stocking to a residual height of 4 inches. Forage production was greatest in June and July, decreased in August, and had a slight rebound in September and October before going dormant in November. Phosphorus concentration of forage was at a maximum in May at 0.27% and decreased to 0.11% in November. Ungrazed paddocks had no net uptake of P during the grazing season, while forage harvest stimulated P uptake. Forage growth and P uptake in buffers were unaffected by pasture management strategies that occurred upslope.

Introduction

Phosphorus is an essential nutrient for plant and animal growth. Excess P in the environment has the potential to cause environmental degradation through contamination of surface waters, and represents an economic loss to producers through the need for the purchase of supplement. Well-managed grazing has the potential to increase plant production and nutritional quality and, therefore, should increase accumulation of P in plants and animals.

Materials and Methods

Grazing Treatments

In 2001, three blocks of approximately 6.8 acres were identified in a smooth bromegrass (*Bromus inermis*) pasture at the ISU Rhodes Research and Demonstration Farm. Each block was subdivided into five 1-acre paddocks with an 18-foot wide lane at the uphill side for cattle movement and a 30-foot wide grass buffer area at the base of each paddock. Prior to the initiation of grazing, soil samples were collected to depths of 0 to 2.5 inches and 2.5 to 5 inches to determine soil P and K fertility. Phosphorus was applied in the spring of 2001 so that all paddocks were at an optimum P content (11 - 15 ppm P) or greater. Soils in all paddocks contained an optimum level of potassium (81 - 120 ppm K) or greater; and, therefore, no additional potassium was applied. Urea was applied at a rate of 180 pounds/acre before the start of grazing in the spring and 100 pounds/acre at the initiation of the forage stockpiling period in August to all pastures.

Grazing treatments were randomly assigned to each of the 5 paddocks in each block. Treatments included: an ungrazed control (UG), summer hay harvest with winter stockpiled grazing (HS), continuous stocking to a residual sward height of 2 inches (2C), rotational stocking to a residual sward height of 2 inches (2R), and rotational stocking to a residual sward height of 4 inches (4R). Grazing was initiated on May 29, 2001 with 3 mature cows in each grazed paddock. Grazed paddocks were initially stocked with three mature non-lactating Angus cows with an average body weight of 1445 pounds.

In the continuous stocking system, cattle were removed from the paddocks after sward height decreased to 2 inches. Paddocks were allowed a rest period of 7 to 10 days to limit regrowth and, thereby, simulate continuous stocking. In the rotational stocking systems, cattle were removed from the paddocks after sward height decreased to 2 or 4 inches. Paddocks were allowed rest periods of 35 days to allow plant regrowth, simulating rotational stocking. Forage sward heights were measured with a rising plate meter (8.8 lb/yd^2) twice weekly during the grazing seasons to determine when cattle should be removed. Stocking rates were 199, 153, and 117 cow-days/acre for the 2C, 2R, and 4R treatments, respectively.

First-cutting hay was harvested as small square bales from the HS treatment in June of 2001. Regrowth from the HS paddocks was clipped in early August to initiate forage stockpiling, but yield of clipped forage was inadequate to bale. Each paddock in the HS system was stocked in mid-November and grazed to a residual sward height of 2 inches, allowing 19 cow-days/acre.

Cows were supplemented with salt. However, neither P nor other minerals were provided to cows while stocked on the experimental paddocks.

Forage Sampling

Prior to initiation of grazing, six 16-ft^2 grazing exclosures were placed within each grazed paddock. Each month from May through November, forage sward height was measured with a rising plate meter (8.8 lb/yd^2) and a forage sample was hand-clipped from .30 yd^2 area in six locations in each ungrazed paddock. Simultaneously, forage sward height was measured and a forage sample hand-clipped inside and immediately outside each grazing exclosure in grazed paddocks. Sward heights were measured and forage samples were taken at three locations in the buffer zones, down slope from the paddocks. Hay bales were weighed and core-sampled at harvest.

Forage samples were dried at 140^o F for 48 hours, ground with a Wiley Mill and analyzed for OM and P.

Monthly forage dry matter yield and P accumulation in ungrazed paddocks and buffers were calculated as the differences in the masses of these components between beginning and end of each month. Monthly forage dry matter yield and P accumulation in grazed paddocks were calculated as the differences between the masses of these components within the grazing exclosure at the end of each month and outside the grazing exclosure at beginning of each month. Net forage dry matter yield and P accumulation from buffer areas or paddocks with the UG, 2C, 2R, and 4R treatments were the sum of their monthly values. Net forage dry matter yield and P accumulation from paddocks with the HS treatment was the sum of the dry matter and P yield in hay and the monthly values determined with grazing exclosures.

Results and Discussion

Paddocks

At the initiation of grazing in May, mean mass, sward height and P concentration of forage were 1895 lb/acre, 9 inches and 0.27% P across all treatments.

In the ungrazed paddocks, the mass of available forage increased and the sward height decreased during the growing season. The decreased sward height was most likely associated with lodging of the forage as it became overly mature.

Sward heights of forage in paddocks with the HS treatment decreased in June associated with hay harvest. At the initiation and termination of grazing of stockpiled forage in paddocks with the HS treatment, forage masses were 2020 and 1530 lb/acre, representing a 25% forage removal rate during the stockpile grazing period.

Forage sward heights in the grazed paddocks were maximum in May and decreased in June, with the initiation of grazing. By the end of June the swards of all grazed paddocks had reached their prescribed heights.

Mean total forage dry matter production from paddocks with the summer grazing treatments (mean, 4700 lb/acre) were greater ($P<.05$) than paddocks with the UG (3300 lb/acre) and HS (3200 lb/acre) treatments (Figure 1). But, there were no differences in forage production between summer grazing treatments.

In May, the mean concentration of P of forage sampled outside of grazing exclosures was 0.27% and did not differ between treatments (Figure 2). During the months of June and July, forage P concentration averaged 0.20% and 0.17%, respectively, and did not differ across treatments. However, forage P concentrations in paddock with the UG treatment were lower ($P<.05$) than paddocks with other treatments in August (0.13 vs. 0.20%), September (0.18 vs. 0.29%), and October (0.15 vs. 0.19%) In November, forage P concentrations decreased to 0.11% across all treatments. During the entire grazing season, P concentrations of forage inside the grazing exclosures in paddocks with the 2C, 2R, and 4R treatments were higher ($P<.05$) than grazed areas outside the grazing exclosures of their respective paddocks.

In paddocks with the UG treatments, there was no net uptake of P by the forage over the growing season (Figure 3). Phosphorus that was taken up from the soil by the plant during periods of plant growth was later returned to the soil when the plant matter died. Paddocks in which forage was harvested with the HS, 2C, 2R,and 4R treatment had net uptakes of P by the forage over the growing season of 4.3, 9.0, 7.4, and 6.3 lb P/acre. However, because much of the forage produced in grazed paddocks will be consumed by the grazing cattle, P in that forage not removed in animal weight gain would be recycled to the paddocks as manure P.

Hay

A yield of 2720 lb forage dry matter/acre was harvested as hay from paddocks with the HS treatment. The P concentration of this forage was 0.24% P. Therefore, hay harvest represents a removal rate of 6.54 lb P/acre from the system.

Buffers

There were no differences in forage production, P concentration, or P uptake in the buffers associated with grazing management practices in their respective paddocks.

Forage masses were lowest in May at 1822 lb/acre across all treatments. Forage masses increased in June and remained constant for the rest of the summer across all treatments and months. Mean total forage production in the buffers was 3465 lb/acre.

Phosphorus concentration of forage in the buffers was greater in May (0.25%) than other months. Phosphorus concentration of forage in buffers gradually decreased to 0.13% in August, increased again in September to 0.17%, before decreasing to 0.091% in November ($P<.05$). Over the growing season, net loss of P in the buffer areas was 1.24 lb/acre. Therefore, P that was taken up from the soil during periods of plant growth was returned to the soil as the plant material died.

Implications

The uptake of P by forages can be manipulated by pasture management. Forage harvest stimulates plant growth, thereby stimulating uptake of nutrients from the soil. In a grazing system, these nutrients will be primarily recycled to the pasture as manure while the removal of hay being the only method to remove P from the system.

Acknowledgments

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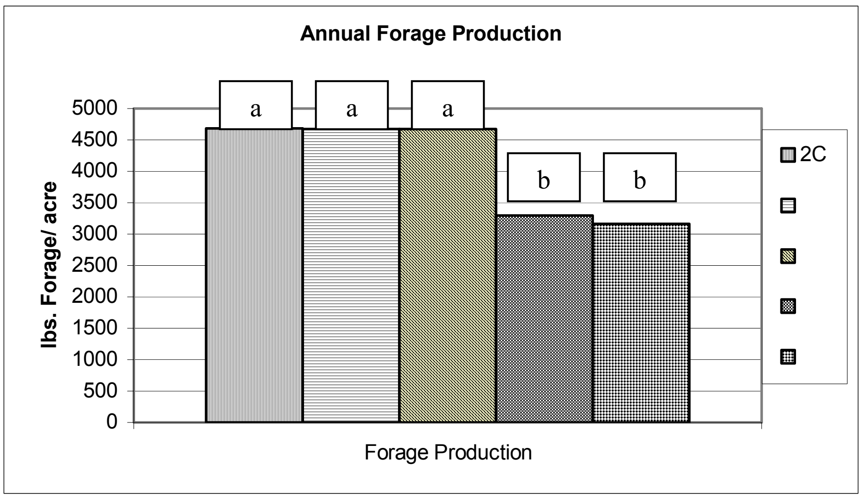
Figure 1.



Different letters represent significance at p<.05.

Figure 2.

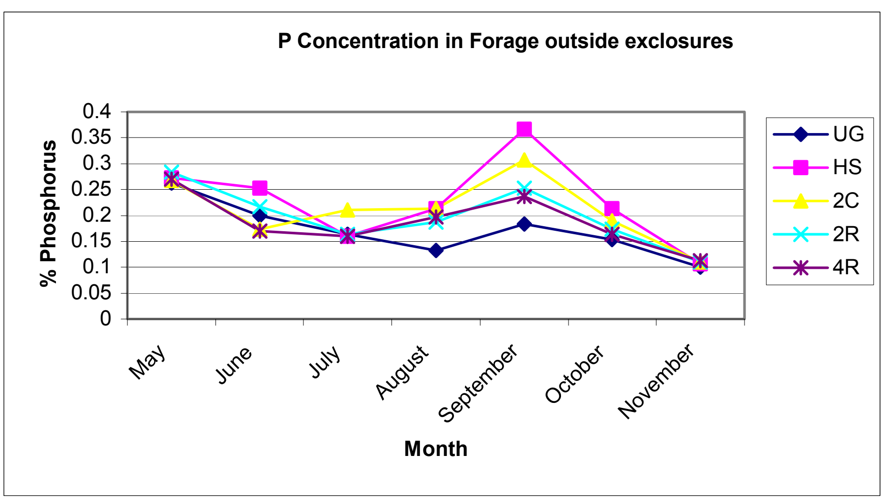
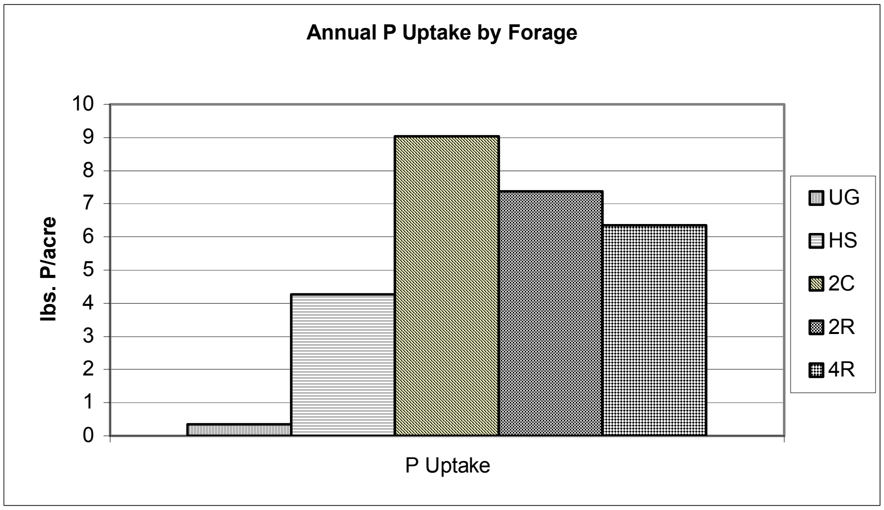


Figure 3.


Annual P Uptake by Forage
10
9
8
7
6
5
4
3
2
1
0
lbs. P/acre
P Uptake
UG
HS
2C
2R
4R