Missouri Fertilizer and Lime Council

Enhancing Macronutrient Concentrations in Stockpiled Tall Fescue with Phosphorus Fertilization

Final Report

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Abstract

Tall fescue (*Festuca arundinacea*) is a popular cool season grass used for beef production. Stockpiling tall fescue pasture is recommended for extending the grazing season and reducing winter-feeding costs. Our previous work indicated that stockpiled tall fescue leaves had low concentrations (< 0.2%) of P and magnesium (Mg) in late winter even after applications of 25 lbs P/acre. The objective of this study was to determine if high rates of P fertilization would maintain leaf P and Mg concentrations above the target 0.2% required by lactating beef cows throughout the stockpiling period. Leaf concentrations of P, Mg, and calcium (Ca) were higher with P fertilization than those of the untreated controls. The 200 lbs P/acre treatment maintained leaf P and Mg concentrations at or above the target 0.2% level during the first year of the experiment. The leaf concentrations of P, Mg, and potassium (K) declined from October to February with all treatments. The decrease in leaf concentrations of phloem mobile elements like P, Mg, and K may be the result of nutrient remobilization from leaves to roots during the late fall and early winter as strategy to provide support for next springs growth.

Introduction

Tall Fescue (*Festuca arundinacea*) is a popular cool season grass used for beef production. Stockpiling tall fescue is recommended for extending the grazing season and reducing winter-feeding costs. The hardy nature of tall fescue and its ability to maintain growth with the onset of cooler temperatures as well as its wide range of adaptability for soil types and climatic conditions make it excellent forage for stockpiled systems (19,18,13).

Tall fescue persists with little or no management owing to its adaptability, nevertheless on many soils yields can be enhanced by fertilization. Gerrish et al. (8) increased yields of stockpiled tall fescue up to 35% with nitrogen (N) fertilization. Although Archer and Decker (1,2) stimulated growth and crude protein (CP) of tall fescue with N fertilization, overall forage quality was not affected. More recently, Singer et al. (17) found that a late season application of N increased the quality and quantity of stockpiled tall fescue. These researchers pointed out, however, that harvests delayed beyond October could incur losses to quality as well as yield.

In Missouri, the majority of pasture soils are low in plant available phosphorus (P) (9). Forage production on such soils may impact the nutrient concentrations of stockpiled tall fescue leaves. Studies in Tennessee and West Virginia found that nutrient concentrations in tall fescue leaves declined through the winter months (4,14,15,6,7). Previous work by Reinbott and Blevins (12,13) indicated that P fertilization improved nutrient concentrations in tall fescue leaves in southwest Missouri. However there are no reports of fertilization on improvement of nutrient quality of stockpiled tall fescue.

Currently beef producers compensate for nutrient deficiencies in forages by supplementing the diets of livestock grazing in winter and early spring. Managing pastures in a practical and cost effective manner that improves the nutrient concentrations in tall fescue leaves would benefit beef producers in regions with low soil P. Therefore the objective of this research is to improve the nutrient concentrations of stockpiled tall fescue during winter and early spring with P fertilization.

Setting Up a Stockpiled Tall Fescue Field Study

The two-year study was conducted on an established tall fescue pasture at the University of Missouri Southwest Research Center near Mt. Vernon, Missouri (37º 04'N 93º 53'W elevation 1150 ft) on a Creldon silty clay loam (fine, mixed, active, mesic, Oxyaquic, Fragiudalf). The site was typical of southwest Missouri in that the soil is low in plant available P, 7 lbs/acre Bray I, and had the following test results: pH 5.3; O.M.2.8 %; Ca 2748 lbs/acre; Mg 280 lbs/acre; and K 446 lbs/acre.

Treatments. In August the forage was removed from the pasture and 10' x 25' plots with 5' alleys were laid out in six replicate blocks. Treatments consisted of 0, 50, 100, and 200 lbs P/acre in the form of triple super phosphate (46% P_2O_5). Each treatment was randomly applied to plots in all six blocks and the entire area received 100 lbs N/acre in the form of ammonium nitrate. In August of the second year of the experiment, the forage was again removed and a 100 lbs N was applied. At the end of each year, soil samples were taken to determine the changes in soil P.

Harvests and Mineral Analyses. Beginning in mid-October through April of both years, twenty of the most recently collared leaves were harvested from each plot. All samples were oven dried, ground, and digested in nitric acid with a microwave accelerated digestion system (5). Digested samples were filtered, diluted, and analyzed for nutrient content. Potassium was determined by flame ionization, Ca and Mg by atomic absorption, and P by colorimetric analysis. In November of the first year ten of the most recently collared leaves were measured for each plot.

Statistical Analysis. The experiment was a completely randomized blocks design analyzed as a split-split plot in time model with repeated measures. This model was used to test for statistical significance of P treatment effects as well as interactions with month using PROC MIXED in SAS version 9.1 (16). Main plot consisted of P treatment; harvest date was considered the split plot and year the split-split plot. Fertilization treatment was a fixed effect factor and year, month, and block were treated as random factors.

Macronutrients in Stockpiled Tall Fescue Leaves

Leaf Growth in Response to P Fertilization. In fall of the first year of this study, P fertilization produced remarkable tall fescue leaf growth (Fig. 1). Leaf growth exhibited an increasing response to all P treatments, with the leaves from the 200 lb P treatment being twice as long as those from the untreated control plots (Fig. 2). It is possible that the Creldon soil in this pasture, with high concentrations of aluminum, manganese, and iron may be influenced by high rates of P fertilization, in that P could ameliorate the toxic effects of these metals.

Phosphorus. Across all months of fall, winter and spring, leaf P concentrations were higher with P fertilization treatments compared to the untreated controls (Fig.3). With all treatments, leaf P levels decreased from October to February in the first year of the study. This trend is also seen in the second year of the study, except the decline lasted until March. The drop in leaf P concentrations in late winter and early spring may be the result of remobilization of P for utilization the following spring.

Leaves from untreated control plots had P concentrations that were well below the 0.2% required by grazing lactating beef cows (10). During the first year both the 100 and 200 lb P treatments produced leaf P concentrations above the 0.2% critical level each month. However, in the second year all P treatments were at or below this level in mid February and

March. Insufficient forage P could result in reduced milk production and in turn lower calf weaning weights. This is an important consideration for producers in areas were soil P levels are low.

Magnesium. Magnesium concentrations of tall fescue leaves were higher with P fertilization treatments compared to control plots and the leaf Mg declined from October to March for both years (Fig.4). In the second year, there was a slight increase in Mg concentrations from December to February for all treatments. Control plots had leaf Mg levels below the 0.2% value required for the diets of lactating beef cows for winter months of both years (10). Again, as with leaf P concentrations, the two highest P treatments maintained Mg levels at or above the critical 0.2% level for the first year. During the second year both of the highest P treatments had two months were the leaf Mg values fell below this level (December and March). Perhaps one of the more notable findings from these data is that leaf Mg concentrations of stockpiled tall fescue can be improved through P fertilization. While the effects of high P treatments did not carryover to the second year, producers would only have to worry about supplementation for one or two months as opposed to several in the late winter and early spring. Therefore, beef producers might be able to reduce incidences of grass tetany by improving the amount of available P in their soils.

Calcium. Tall fescue leaf concentrations of Ca were lower in this study than in previous studies conducted in this area (McClain and Blevins, unpublished). However, the P fertilization treatments produced higher leaf Ca concentrations than those of untreated controls (Fig. 5). Both the 50 lb P treatments and the controls had leaf Ca concentrations below the 0.3% required by grazing lactating beef cows (10). While most efforts for alleviating the incidence of grass tetany have focused on improving Mg in the forage, it should be noted that leaf Ca concentrations are also important and might be a larger factor in occurrence grass tetany in southwest Missouri. Also, Ca deficient forage can lead to “milk fever” in grazing cattle. Although this metabolic disorder is less common in beef cows it should still be considered in managing a beef herds health.

Potassium. Leaf K concentrations decreased from October to February in plots from all treatments (Fig. 6). During the first year, leaf K concentrations were higher with P fertilization treatments compared to control plots, however in the second year there was no difference across P treatments. For all P treatments the leaf K concentrations remained below 0.3% from December through April. Cases of grass tetany have been associated with high K concentrations of the forage (21). Therefore, the second year’s data would suggest a reduced risk of grass tetany based on the leaf K concentrations.

Soil Test Results. Soil samples taken after the first year, indicated that much of the P fertilizer added to plots was “sorbed” most likely by aluminum, iron, and manganese present in this Creldon soil (Table 1). The build up in Bray II levels is a good indication of how important P is in forage production in this area. While the higher P treatments did improve the Bray I soil P it is most likely that over time these levels will return to normal. Improving soil P might help producers alleviate several nutrient disorders seen in livestock as well as improving forage yield and quality.

Conclusions

Phosphorus fertilization improved the nutrient concentrations in stockpiled tall fescue leaves compared to controls. The higher rates of P fertilization maintained P and Mg leaf concentrations at or above the requirements for lactating beef cows in late winter and early spring. The results show a decline in nutrient concentrations in tall fescue leaves in late fall and winter, and an increase as spring growth begins. The drop in leaf nutrient concentrations between October and February may result from nutrient remobilization from leaves to rhizomes and roots during late fall and winter as a storage mechanism. Leaching of nutrients from leaves is another possibility. In alfalfa it is well established that N stored as amino acids and soluble proteins in tap roots is used to support early spring growth (3,20). Remobilizing nutrients to the underground structures of the plant is a strategy tall fescue might employ to have nutrient pools available for spring growth when nutrient acquisition is slow.

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Figures

Figure 1. Experimental plots of stockpiled tall fescue in 0 and 200lbs P/acre.

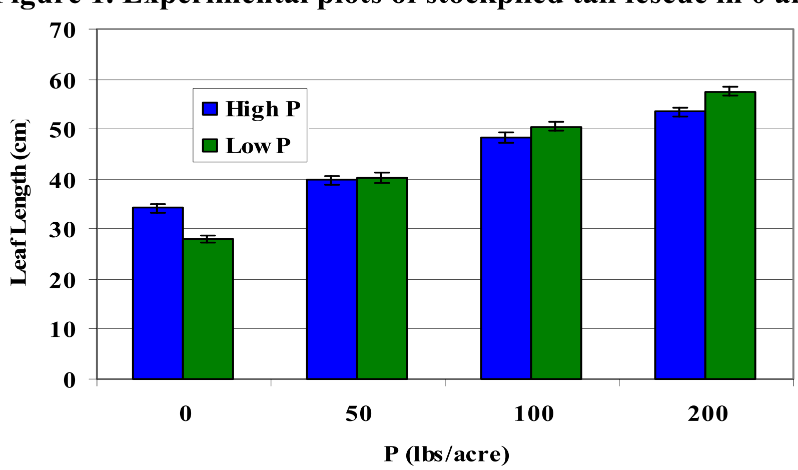

Figure 2. Leaf length (cm) of the most recently collared tall fescue leaves in November 2003 following P fertilization. Means± S.E. (n = 10) for each plot.

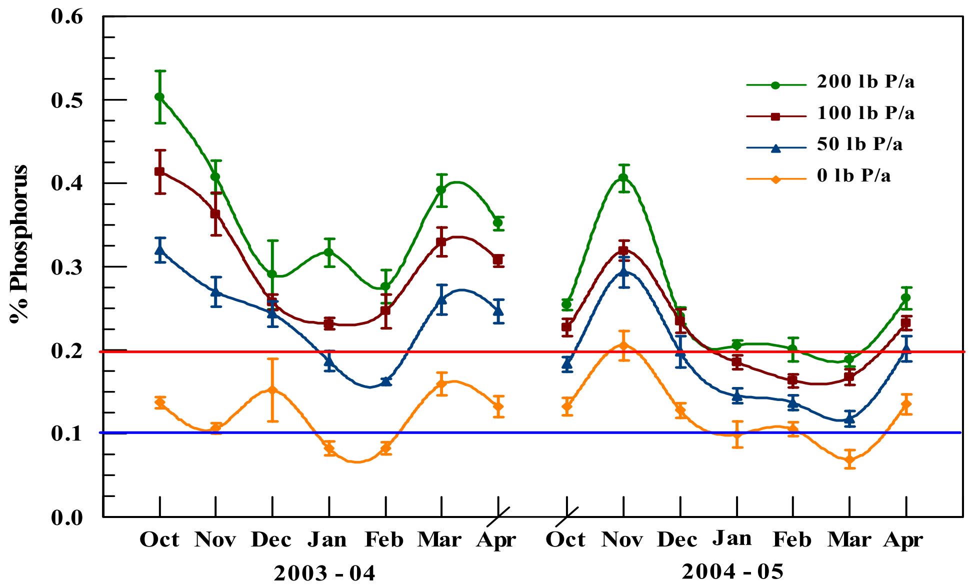

Figure 3. Phosphorus concentrations of stockpiled tall fescue leaves treated with 0, 50, 100, or 200 lbs P/acre. Means ± S.E. (n = 6) for each month.

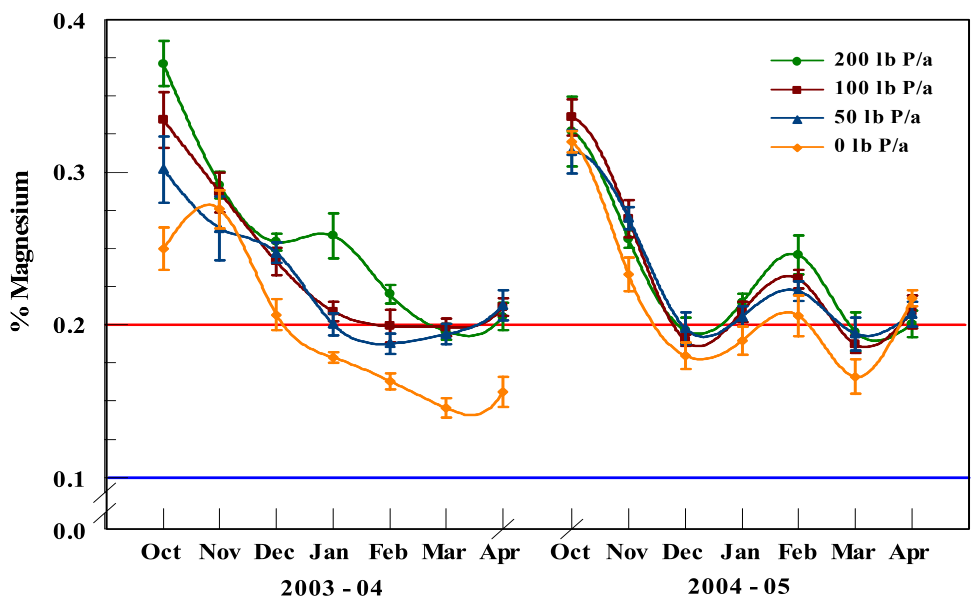

Figure 4. Magnesium concentrations of stockpiled tall fescue leaves treated with 0, 50, 100, or 200 lbs P/acre. Means ± S.E. (n = 6) for each month.

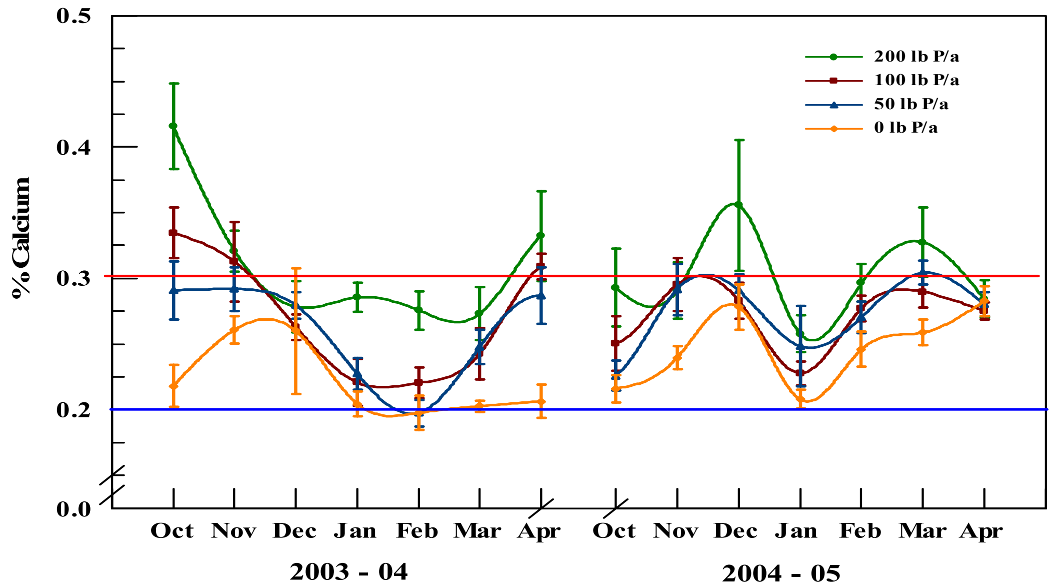

Figure 5. Calcium concentrations of stockpiled tall fescue leaves treated with 0, 50, 100, or 200 lbs P/acre. Means ± S.E. (n = 6) for each month.

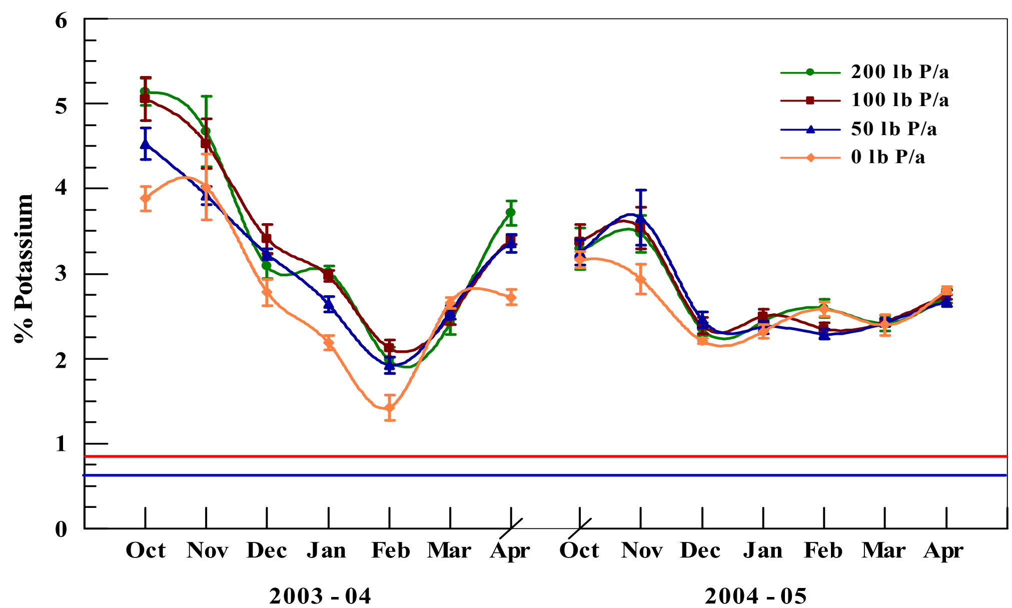

Figure 6. Potassium concentrations of stockpiled tall fescue leaves treated with 0, 50, 100, or 200 lbs P/acre. Means ± S.E. (n = 6) for each month.

Table 1. Soil test results following completion of the first year. Means (n = 6) for all plots.

P (lbs/Ac)	pHs	N.A. (meq/100g)	% O.M.	Bray I P (lbs/Ac)	Bray II P (lbs/Ac)	Ca (lbs/Ac)	Mg (lbs/Ac)	K (lbs/Ac)	CEC (meq/100 g)
0	5.55	1.92	2.87	7.17	22.83	1743.2	259	330.3	7.78
50	5.28	2.58	3.00	16.33	42.33	1810.5	245	292.0	8.50
100	5.33	2.67	2.97	23.50	61.33	1932.5	257	297.3	8.93
200	5.23	2.92	2.92	68.83	175.50	1857.0	264	277.8	9.02