Lime or Phosphorus: Which is Best to Limit Broomsedge in Tall Fescue Pastures?

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Abstract
Most Missouri tall fescue (Schedonorus arundinaceus (Schreb.) Dumort.) pastures grow on acidic, low-phosphorus (P) soils. These conditions favor increases in broomsedge (Andropogon virginicus L.), a grass that is unpalatable for livestock. Three management strategies, 1) liming, 2) P fertilization, and 3) liming plus P fertilization, were evaluated for limiting broomsedge in tall fescue pastures. An established tall fescue pasture containing broomsedge was selected in southwest Missouri (soil pH 4.6, 6 lb/acre Bray I P). Lime was applied at 0x, 0.5x, 1x, and 2x the soil test recommendation (x = 3.67 ton/acre). Plots were treated with 0 or 50 lb P/acre. Plant counts for tall fescue and broomsedge were estimated over the next 3 years. Without P fertilization, broomsedge doubled over a 3-year period. Phosphorus fertilization effectively maintained broomsedge at the initial level. The P treatment doubled the tall fescue count in 3 years following treatment, but without P, tall fescue counts remained at the initial level. Broomsedge increased nearly threefold without lime. Tall fescue more than doubled with the two highest lime treatments in 3 years. The 0x lime treatment resulted in no increase in tall fescue. Lime and P combined limited broomsedge increase to the greatest degree and produced the greatest increase in tall fescue. Increased vigor of tall fescue resulting from improved soil fertility likely influenced the increase in tall fescue and limited further encroachment of broomsedge. Applying lime and P could improve pastures by encouraging growth of desirable grasses and discouraging increases in common weeds like broomsedge.

Broomsedge (Andropogon virginicus L.), a native, perennial, warm season, C4 grass, can be found in the eastern, midwestern, and southern US (see map on USDA Plants Database website). Although it is a native species, it has been called an important “invasive weed” in pastures (Griffin et al., 1988). When it takes over pasture land, it provides little grazing, except in the early spring, and has long been considered very low-quality forage (Dustman and van Landingham, 1930).

Early research found that in several pastures in the Ozarks, mid-summer forage sample P concentration of broomsedge was 40% lower than that of switchgrass (Panicum virgatum L.), 49% lower than that of big bluestem (Andropogon gerardii Vitman), and 69% lower than that of orchardgrass (Dactylis glomerata L.) (Ehrenreich et al., 1960). One reason for the success of broomsedge in Ozark soils may be its ability to grow in low plant-available P conditions.

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Conversions: For unit conversions relevant to this article, see Table A.

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Setting Up the Study to Limit Broomsedge in a Tall Fescue Pasture

An established tall fescue pasture with a diverse plant community was selected at the University of Missouri Southwest Research Center at Mt. Vernon for this study in summer 2005.

In Missouri and many other states, broomsedge flourishes on acidic, low-pH soils. Dr. Monroe Rasnake, long time Extension Agronomist at the University of Kentucky, has stated that “Some will swear it (the problem with broomsedge encroachment into pastures) is a soil pH (liming) problem, others have blamed the problem on low soil test P levels” (Rasnake, 2004). Even now, there is considerable debate in the grazingland community about broomsedge encroachment and growth in tall fescue pastures: Is it a problem of low soil P or low soil pH?

Our interest in developing this research project on broomsedge resulted from observation of pastures used in a previous cow-calf grass tetany study (Lock et al., 2002) in pastures adjacent to the present study. Some of the pastures on low-P soil in the previous study had been treated with P fertilization annually from February 1999 to February 2001, which increased the soil Bray I P from 6 to 30 lb/acre. Other pastures received no P treatments, and their soil test Bray I P levels remained at 6 lb/acre (Lock et al., 2002). These pastures, with and without added P, received the same rates of N and K. The tall fescue pasture on the left side of Fig. 1 clearly demonstrated an invasion of broomsedge by late summer 2003 following termination of the previous experiment in 2001. On the right side of Fig. 1 is the tall fescue pasture that had P fertilization treatments with minimal broomsedge invasion in contrast to the low-P pasture. Therefore, it is evident that on the low-P, low-pH soil, P fertilization prevented broomsedge invasion of the tall fescue pasture in that previous study. The invasion of a pasture may be different from limiting broomsedge already established in a tall fescue pasture. Therefore, the current study was designed to determine which management practice was best for limiting the increase of an established population of broomsedge in a tall fescue pasture growing in a soil with low plant available P and low pH: 1) P fertilization, 2) liming, or 3) both P fertilization and liming.

Limiting Broomsedge in a Tall Fescue Pasture

In plots that were not treated with P fertilization, the broomsedge count doubled over the 3-year period (Fig. 2 a),
whereas that of tall fescue remained unchanged (Fig. 2 b). This result indicates that low soil P conditions favored the growth of the broomsedge over the tall fescue in a pasture. On the other hand, the P fertilization treatment produced broomsedge counts that remained at the initial level after the 3-year experiment. Tall fescue count increased in plots that received P application (Fig. 2 b). The tall fescue count doubled with the 50 lb/acre P treatment; however, without P fertilization, tall fescue counts remained at the initial level after 3 years. A previous study showed significant yield increases with P applications in tall fescue plots with low soil test P near the area of the present study although plant counts were not conducted in the earlier study (Reinbott and Blevins, 1997).
Broomsedge counts increased from 25 to 57% in plots that did not receive lime over the 3-year period (Fig. 3a). Broomsedge count in the two highest lime treatments did not differ from the initial broomsedge count. The tall fescue count doubled with the two highest lime treatments, while the 0x lime treatment resulted in no increase in the tall fescue count after the 3-year study (Fig. 3b). It was not surprising that the tall fescue count increased in response to the lime treatments based on the low initial soil pH. It is well known that the optimum soil pH for growing tall fescue ranges from 5.5 to 7.0 (Belesky and West, 2009). Our previous study in an adjacent field showed that tall fescue yield responded to lime application; therefore, one might expect a population increase as well (Hamilton et al., 2012).

Broomsedge increased almost threefold in plots that did not receive lime or P over the 3-year period (Fig. 4a). Broomsedge count in the two highest lime treatments did not differ from the initial broomsedge count. The tall fescue count doubled with the two highest lime treatments, while the 0x lime treatment resulted in no increase in the tall fescue count after the 3-year study (Fig. 4b). It was not surprising that the tall fescue count increased in response to the lime treatments based on the low initial soil pH. It is well known that the optimum soil pH for growing tall fescue ranges from 5.5 to 7.0 (Belesky and West, 2009). Our previous study in an adjacent field showed that tall fescue yield responded to lime application; therefore, one might expect a population increase as well (Hamilton et al., 2012).
been shown to negatively impact the broomsedge population (Butler et al., 2006; Peters and Lowance, 1974).

Invasive pasture weeds, like broomsedge, which cause a loss of about $2 billion in the United States (DiTomaso, 2000), not only result in a direct cost to producers when spraying and mowing are necessary control measures, but they also decrease the quality and quantity of forage. Increased vigor of tall fescue resulting from improved soil fertility likely influenced the increase in tall fescue and static growth of broomsedge observed in this study. Hence, enhancing the overall soil fertility by applying lime and P could provide an alternative for improving pastures by encouraging the growth of good quality grasses and legumes and discouraging encroachment or spread of common pasture weeds, like broomsedge.

References


Table 1. Soil test results (0- to 6-inch depth) obtained from 10 composited samples from each experimental plot in September 2008.

<table>
<thead>
<tr>
<th>Treatment†</th>
<th>pH</th>
<th>NA‡ meq/100g</th>
<th>Bray I P</th>
<th>Ca</th>
<th>Mg</th>
<th>K</th>
<th>CEC§ meq/100g</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 P-0x Lime</td>
<td>5.0</td>
<td>4.7</td>
<td>4.2</td>
<td>1544.5</td>
<td>171.0</td>
<td>248.0</td>
<td>9.6</td>
</tr>
<tr>
<td>0 P-1/2x Lime</td>
<td>5.5</td>
<td>3.3</td>
<td>4.2</td>
<td>1880.2</td>
<td>152.0</td>
<td>190.3</td>
<td>8.8</td>
</tr>
<tr>
<td>0 P-1x Lime</td>
<td>5.8</td>
<td>2.3</td>
<td>5.2</td>
<td>2014.5</td>
<td>138.3</td>
<td>213.3</td>
<td>8.2</td>
</tr>
<tr>
<td>0 P-2x Lime</td>
<td>6.4</td>
<td>1.3</td>
<td>4.8</td>
<td>2628.5</td>
<td>147.3</td>
<td>196.2</td>
<td>8.8</td>
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<tr>
<td>50 P-0x Lime</td>
<td>5.0</td>
<td>4.9</td>
<td>10.7</td>
<td>1440.2</td>
<td>131.8</td>
<td>166.8</td>
<td>9.3</td>
</tr>
<tr>
<td>50 P-1/2x Lime</td>
<td>5.5</td>
<td>3.2</td>
<td>7.3</td>
<td>1926.3</td>
<td>141.0</td>
<td>200.0</td>
<td>8.8</td>
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<tr>
<td>50 P-1x Lime</td>
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<td>2.5</td>
<td>8.0</td>
<td>2108.2</td>
<td>153.0</td>
<td>181.3</td>
<td>8.6</td>
</tr>
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<td>50 P-2x Lime</td>
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<td>1.4</td>
<td>20.3</td>
<td>2525.7</td>
<td>133.5</td>
<td>170.3</td>
<td>8.5</td>
</tr>
</tbody>
</table>

†Treatment: P = phosphorus.
‡NA = neutralizable acidity.
§CEC = cation exchange capacity.
¶ x = 3.67 ton/acre.