Phosphorus Effects on Magnesium Uptake by Forage Grasses

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Liming and phosphorus (P) fertilization both increase P concentrations in forage grasses. Texas research also shows that increased P availability leads to higher concentrations of magnesium (Mg) in forage grasses, which may help prevent grass tetany in cattle.

MAGNESIUM is the fourth most abundant cation in the body. Approximately 65 percent of total body Mg is contained in bone. One-third of the Mg in bone is combined with P. Beef cow requirements for Mg are 21, 22, and 18 g/day during early, mid, and late lactation, respectively.

Deficiencies of Mg in the beef cow can occur as a result of low Mg concentrations in forage or supplement. A severe deficiency is associated with the acute metabolic disorder hypomagnesemic tetany, commonly referred to as grass tetany. Grass tetany is most likely to occur in beef cows during initial stages of lactation while grazing forages containing less than 0.2 percent Mg. This research evaluated the effect of P on Mg uptake by annual ryegrass.

Texas Studies

Limestone containing 3.6 percent Mg was applied to whole plots on a pH 4.5 Lilbert loamy fine sand at rates of 0, 600, and 3,400 lb/A (0, 22 and 122 lb Mg/A, respectively). Phosphorus was applied to split plots at rates of 0, 31, 61, 92, 123, 245, and 491 lb P_2O_5/A. Treatments were replicated eight times. These treatments were roto-tilled into a Coastal bermudagrass hay meadow in mid-summer of 1983. A duplicate application of P was surface-applied in June the following year. No additional lime or P treatments were applied after this time. Nitrogen (N), potassium (K), and sulphur (S) were applied uniformly to maintain grass production. Bermudagrass yields were taken in 1983, 1985, and 1986, and ryegrass harvests were made in 1984, 1986, and 1987.

Results

Lime and P rates both significantly increased soil test P levels (**Figure 1**) and must be considered when evaluating the effect of P on Mg uptake in this study. In 1985, soil test P in the 0- to 6-inch soil layer was measured at 38, 40, and 55 ppm, respectively, in response to a total application of 982 lb P_2O_5/A at limestone rates of 0, 600, and 3,400 lb/A. Soil pH was 4.51, 4.65, and 6.19, respectively, in response to the three lime rates. In 1987, with no additional limestone or P applied, soil pH values were 4.5, 4.49, and 4.61. Residual soil P values were lower and similar across lime rates in 1987.

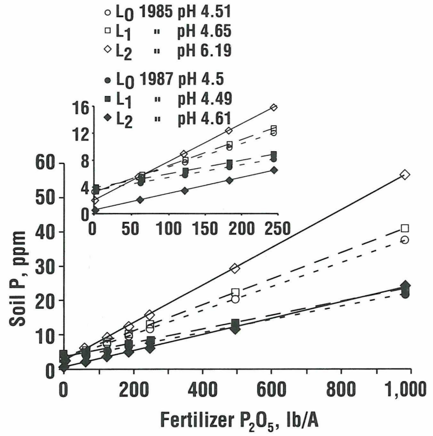

Figure 1. Residual soil P, 2 and 4 years after limestone treatment. L_0 = none, L_1 = 600, and L_2 = 3,400 lb lime/A.

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A detailed view of residual soil P levels affected by P_2O_5 rates from 0 to 245 lb/A is shown with an expanded y-axis superimposed within **Figure 1**. Soil P at the high rate of lime declined significantly between 1985 and 1987 as pH decreased from 6.19 to 4.6. Acidity caused by continued high N application rates and increased uptake of P by larger ryegrass dry matter yields in these limed plots contributed to the decreased levels of residual soil P when compared to the lime check plots (**Figure 2**).

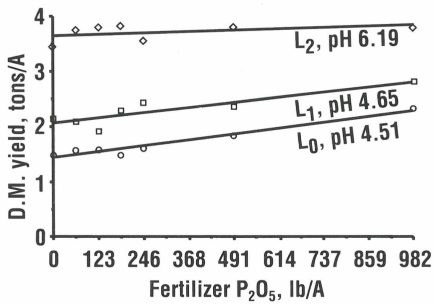

Figure 2. Response of annual ryegrass in 1986 to the interactions of limestone and P fertilizer rates.

The concentration of P and Mg in the ryegrass increased as the level of applied P increased (**Figure 3**). Still, the Mg concentration in all ryegrass samples was well below the adequate forage dietary level (0.2 percent) for beef cattle. Magnesium uptake was associated with P uptake in 'Marshall' ryegrass during 1986 (**Figure 4**). The impaired uptake of Mg in many strongly acid soils is caused by high levels of exchangeable aluminum (Al). Aluminum saturation percentages approximating 70 percent are often associated with Mg nutritional problems in plants. Phosphorus fertilization is known to produce a "lime effect" in acid soils by precipitating exchangeable Al. Higher P fertility may have also produced more extensive root growth to explore the soil for nutrients.

Summary

Proper liming of an acid soil with a dolomitic (Mg) limestone increased soil Mg and increased available soil P levels. Adequate fertilization with P also raised the soil test P level and resulted in increased plant uptake of P. Although these data show that increased P uptake can increase the plant uptake of Mg, the level of Mg in ryegrass remained quite low due to low levels of extractable Mg in the soil. Cattle grazing ryegrass with low Mg concentrations will still need supplemental Mg provided in a mineral mixture to lower susceptibility to grass tetany. ■

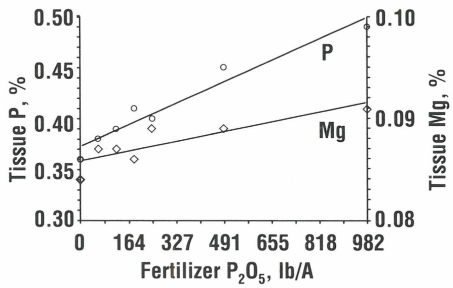

Figure 3. Phosphorus and Mg concentrations in annual ryegrass in 1986 and after P fertilization 2 and 3 years earlier.

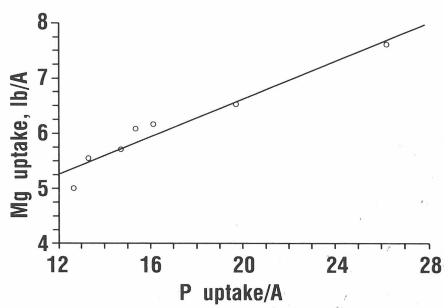

Figure 4. Correlation of the mean uptake levels of P and Mg in annual ryegrass tissue in 1986. (r^2 = 0.86)