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RESPONSE OF COASTAL BERMUDAGRASS TO LIMESTONE APPLIED FOR SOIL pH ADJUSTMENT

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Summary

Research from Georgia and Texas shows that 'Coastal' bermudagrass [*Cynodon dactylon* (L.) Pers.] responds to limestone applied to strongly acid soils. The critical pH (1:2 soil:water) at which to lime acid soils for Coastal bermudagrass production may be set at a minimum of 5.6. Maintaining soil pH above 5.6 will improve the calcium content in bermudagrass for livestock consumption. A soil pH above 5.6 will help maintain nutrient use efficiency and prevent accumulation of aluminum (Al^{3+}) that can be toxic to forage plants. Second cutting Coastal bermudagrass contained the most calcium. Hay from this cutting could be stored separately and fed to classes of livestock that have a greater need for calcium such as lactating cows that are superior milk producers. The calcium content in Coastal bermudagrass hay harvested in late summer was lower than other cuttings but should be adequate to maintain dry cows in the mid-term of pregnancy.

Introduction

Coastal bermudagrass was developed and selected from plants growing in acid soil. As a result, it grows and produces reasonable amounts of forage on acid soils. Short-term studies to evaluate response of Coastal bermudagrass to limestone have frequently shown little effect of increasing soil pH on yields. In one or two years of production for hay, Coastal bermudagrass may not deplete the nutrients supplied by limestone in an acid soil. During this same time period, the high rates of nitrogen (N) applied for hay production may not have lowered soil pH sufficiently to hinder bermudagrass yields.

Soils producing Coastal bermudagrass overseeded with ryegrass or small grains for grazing, or as the sole grass for hay, require large quantities of N fertilizer for production of high protein forage. When N fertilizers containing ammonium are applied to warm soils, bacteria convert the ammonium to nitrite, then to nitrate. Acidity is formed during this nitrification process. Thus, N fertilizers increase acidity in soils. The acidifying effect of N fertilizers is most noticeable in sandy, low-buffer-capacity soils such as those in East Texas.

Keywords: Soil acidity / calcium uptake / *Cynodon dactylon* (L.) Pers.

Ammonium forms of N fertilizers vary in the amounts of acidity they produce. Accepted averages indicate that ammonium nitrate and urea N fertilizers create 1.8 lb of calcium carbonate neutralizable acidity for each pound of N nitrified in the soil. Ammonium sulfate produces 5.4 lb of acidity per pound of N nitrified. The requirement of beef cattle for calcium depends on the intensity of milk production in lactating cows and the rate of weight gain of young, growing animals (Table 1). Acid soils are usually low in calcium. Calcium applied as calcium carbonate (limestone) is the normal way to supply calcium to the soil for uptake by forages. The following is a discussion of research on limestone Coastal bermudagrass and the calcium content of this forage in relation to calcium requirements of cattle.

Procedures

Data reported in this paper are from literature and several soils research studies conducted at Overton during the last 12 years. The Overton studies have involved limestone rates and variable limestone effective calcium carbonate equivalence (ECCE) levels. The calcium content of Coastal bermudagrass was evaluated in forage samples collected from the three harvests made the third year after limestone was applied and incorporated into a Lilbert soil. Plant samples were digested in hot sulfuric acid and analyzed for calcium using an atomic absorption spectrophotometer. In a separate study, Coastal bermudagrass yield response to limestone treatments began to occur on a Darco soil during the third year following application of limestone.

Results and Discussion

Graphs in Figure 1, when related to data in Table 1, show that Coastal bermudagrass is deficient in calcium for steers developing at a high rate of gain. The second cutting of bermudagrass treated with the 1.7 tons of limestone/ac three years earlier barely had sufficient calcium to support superior lactating cows. The second cutting of grass contained the most calcium. The last cutting, growing in soil limed with 1.7 t/ac, contains only sufficient calcium to support dry cows or steers on a weight maintenance program.

During the first growth period for Coastal bermudagrass, the soil is cooler. As the soil continues to warm for second growth of bermudagrass, additional calcium carbonate is solubilized by the soil acids. This gives the second-growth grass access to more calcium than was available in the cool soil for the first growth. Bermudagrass for the last cutting was growing during the latter part of the summer. By late summer, continued plant uptake and the mid-summer drought had depleted the limed surface soil of water. As a result, the grass obtained most of its water

from below the limed surface soil. Less calcium was available in this deeper soil depth so the concentration in the plant was much lower. Regular additions of limestone to acid soils producing Coastal bermudagrass is needed to sustain the calcium requirements of beef cattle and to provide for more efficient utilization of plant nutrients by the grass.

Coastal was selected from bermudagrass cultivars growing in acid soil, so it was inadvertently selected to be tolerant to moderate levels of soil acidity. As the concentration of soil acidity increases and plant nutrients made more available by liming become depleted, Coastal bermudagrass will respond to limestone (Fig. 2). The soil pH at which the response of Coastal bermudagrass to limestone treatment will occur is unpredictable and varies by soil and location (Table 2). From data in Table 2, it appears that the response of Coastal bermudagrass to limestone applied to acid soils cannot be predicted based on soil pH alone. Research on this problem will continue in search of other soil factors that can reliably be used to predict the response of hybrid bermudagrass to limestone treatment. Based on the data presently available, maintenance of soil pH above 5.6 should eliminate most situations where Coastal bermudagrass has suffered a yield decline due to soil acidity. Where ryegrass, cereal forages or cool-season annual legumes are to be grown in the bermudagrass sod, the soil pH needs to be near 6.2 to obtain highest production of these forages.

Table 1. Calcium requirement of beef cattle in percent of the minimum daily dry matter requirement (NRC 1984).

Class	Calcium
	%
Dry cows, middle third of pregnancy	.19
Lactating cows, average production, 3.5 month calf	.29
Lactating cows, superior production, 3.5 month calf	.43
Steers, weight maintenance	.17
Steers, high gain rate	.75

Table 2. Coastal bermudagrass response to limestone.

Scientist	Year	State	Soil	Low pH	Critical pH	Response
						%
Jackson	1961	GA	Tifton	4.3	5.1	+ 23
Jackson	1961	GA	Tifton	4.0	5.1	+ 50
Jackson	1961	GA	Rains	4.3	5.6	+ 11
Adams	1967	GA	Cecil	4.4	4.8	+ 9
Adams	1967	GA	Cecil	4.0	5.4	+300
Haby	1969	TX	Boy	5.2	---	0
Eichhorn	1981	LA	Ruston	4.9	---	- 7
Young	1984	TX	Darco	4.7	5.9	+ 25
Young	1984	TX	Nacogdoches	4.8	5.5	+ 11
Haby	1992	TX	Darco	5.2	5.6	+ 27

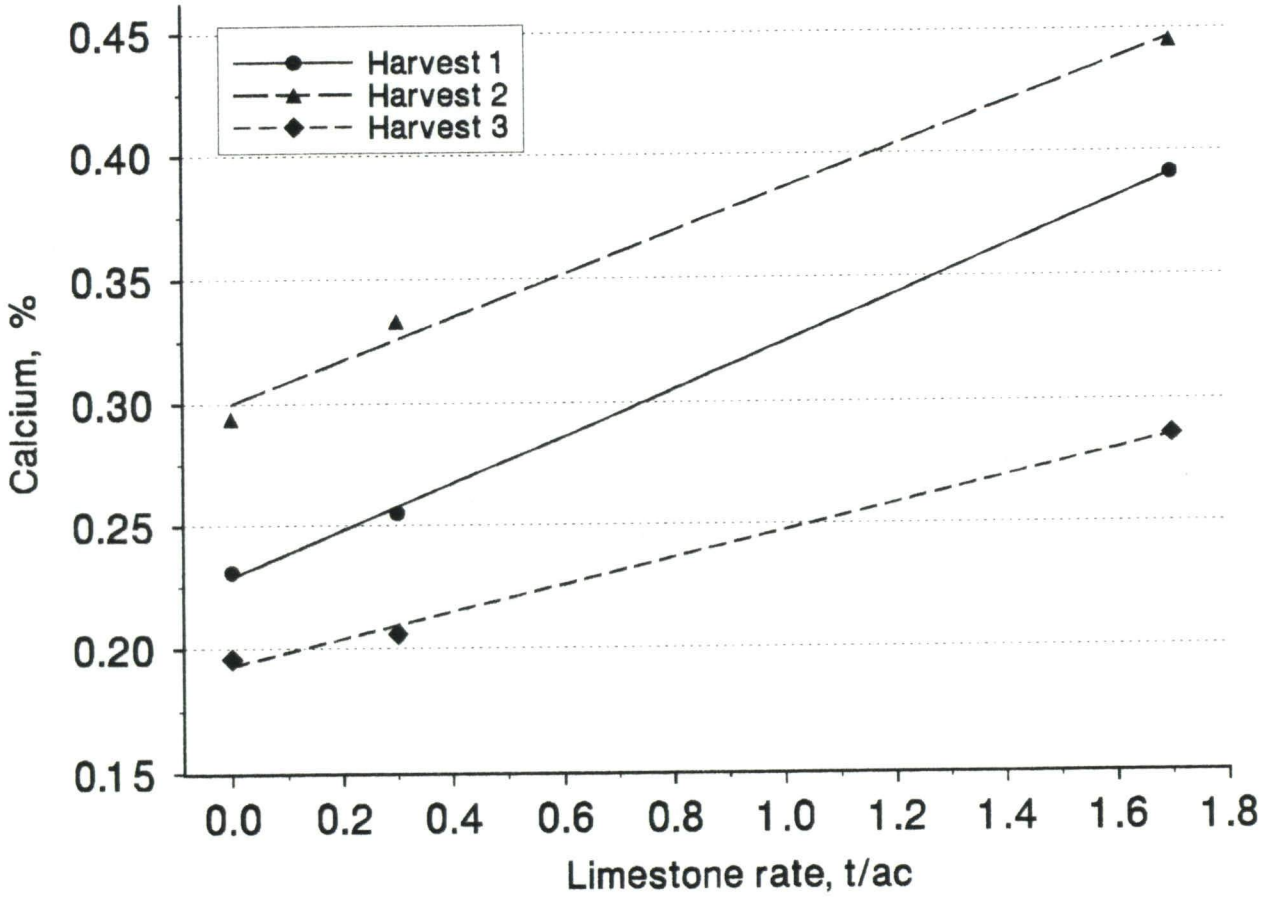

Fig. 1. Effect of limestone applied three years earlier on the calcium percentage of Coastal bermudagrass hay at three harvests.

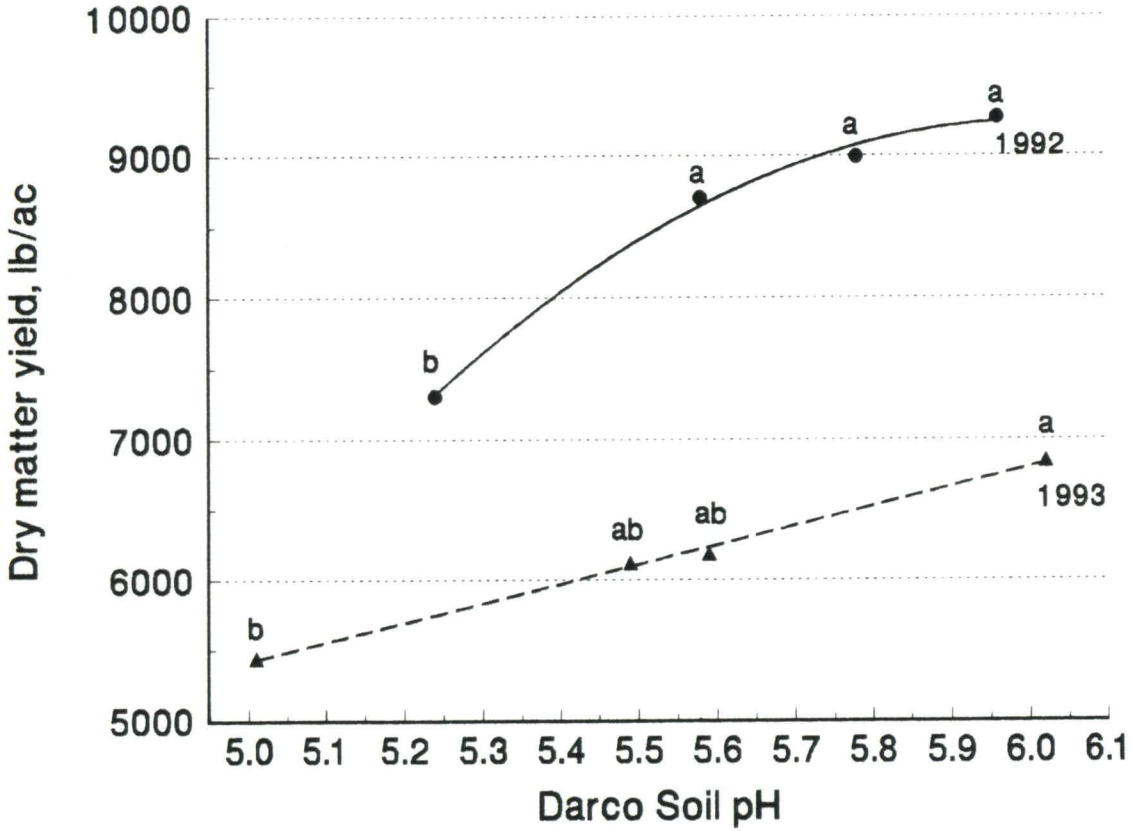

Fig. 2. Effect of soil pH on Coastal bermudagrass yields (Limestone rates were 0, 1, 2, and 3 t/ac)