Response of Ryegrass to Rates of Limestone and Phosphorus

V. A. HABY, J. V. DAVIS, AND A. T. LEONARD

Summary

Ryegrass response to limestone and phosphorus was evaluated on a strongly acidic (pH 4.5) Lilbert loamy fine sand testing low in phosphorus, calcium, and magnesium and very low in potassium. Limestone treatments of 0, 600, and 3,400 lb/A were applied in early July 1983. Phosphorus treatments were applied at this same time at rates of 0, 30, 61, 92, 123, 245, and 491 lb P_2O_5/A. The existing stand of Coastal bermudagrass was mowed to a 2-inch length and Marshall ryegrass was seeded in rows 9 inches apart in November.

The first harvest of ryegrass was clipped April 16, 1984 and the second was taken May 22, 1984. Limestone increased ryegrass yields from 1,135 to 2,701 and 3,346 lb/A at the 0.3 and 1.7 tons/A rate, respectively, the first cutting and from 1,647 to 1,818 and 2,032 lb/A the second cutting. Phosphorus increased ryegrass yields from 3,677 lb to 5,023 lb/A over the two harvests.

Introduction

According to soil test summaries, the percentage of soils testing below pH 5.2 was 2 percent in 1967, but had increased to 12 percent testing below pH 5.0 in 1982. Liming these very strongly acidic soils to near neutrality may cause reduced crop yields. Soils containing sufficient exchangeable aluminum, when limed, can produce hydroxy aluminum precipitates, which, along with soluble aluminum, present effective and extensive surfaces to precipitate added phosphorus, making it unavailable to plants. Large applications of phosphorus can overcome deficiencies by saturating these new reactive

KEYWORDS: Lilbert loamy fine sand/limestone-phosphorus interactions/soil pH.

surfaces. This study was designed to evaluate the extent of phosphorus fixation, to calibrate the phosphorus soil test to ryegrass response, to determine the residual effect of limestone and phosphorus applications, and to study the interactions of limestone and phosphorus as they affect grass response.

Procedure

A Lilbert loamy fine sand was selected for this study. It is an East Texas benchmark soil, which means that it occupies a large acreage. This soil was selected because it had a surface 6-inch depth pH of 4.5, phosphorus, calcium, and magnesium levels of 8,200, and 30 ppm, respectively, and a very low 60 ppm potassium level. Three rates of limestone 0, 0.3, and 1.7 tons/A were applied as major plots in a split-plot statistical design. Phosphorus rates of 0, 30, 61, 92, 123, 245, and 491 lb of P_2O_5/A were applied over the limestone treatments as split plots. Eight replications of each treatment were applied. Nitrogen and potash were applied as urea and muriate of potash at rates of 150 and 260 lb/A, respectively, in 1983. The existing grass was mowed and all treatments were roto-till incorporated. Two harvests of Coastal bermudagrass were made in 1983.

Marshall ryegrass (30 lb/A) and Mt. Barker subterranean clover (20 lb/A) were each seeded into one-half the research area (four replications) on Nov. 4, 1983. The ryegrass was fertilized on Dec. 6, 1983 and Feb. 3, 1984 with 60 lb N/A from urea. The sub clover was not fertilized.

Ryegrass yields were evaluated statistically by analysis of variance using MSUSTAT on a microcomputer.

Results and Discussion

The severe cold temperatures in mid-to-late December 1983 killed the young sub clover seedlings and the Coastal bermudagrass. The Coastal bermudagrass was resprigged over the plot area on May 25, 1984, and the remaining growing season was devoted to managing the plot area to get the Coastal bermudagrass to recover to a full stand. Therefore, no yield data are available for this grass in 1984. A reasonable stand of Coastal bermudagrass was obtained and limestone and phosphorus treatments will be evaluated by Coastal bermudagrass yields in 1985.

Marshall ryegrass survived the winter cold and produced up to 3 tons of ovendry grass in the highest lime-

TABLE 1. RESPONSE OF RYEGRASS TO LIMESTONE RATES APPLIED TO A pH 4.5 LILBERT LOAMY FINE SAND

Limestone	Yield, dry weight		
Rate	Harvest 1	Harvest 2	Total
Tons/A		Pounds/Acre	
0	1,135 a[1]	1,647 a	2,783 a
0.3	2,701 b	1,818 a	4,518 b
1.7	3,346 b	2,032 a	5,378 c

[1]Yield data within columns followed by the same letter are not significantly different, statistically, at the 95 percent probability level.

TABLE 2. RESPONSE OF RYEGRASS TO PHOSPHORUS RATES APPLIED TO AN 8 PPM, LOW PHOSPHORUS, LILBERT LOAMY FINE SAND

Phosphorus	Yield, dry weight		
rate	Harvest 1	Harvest 2	Total
lbs P_2O_5/A		Pounds/Acre	
0	2,097 a[1]	1,580 a	3,677 a
30	2,105 a	1,685 ab	3,790 a
61	2,209 a	1,766 abc	3,975 ab
92	2,417 a	1,769 abc	4,186 abc
123	2,637 a	2,065 bc	4,702 bc
245	2,441 a	1,791 abc	4,232 abc
491	2,852 a	2,171 c	5,023 c

[1]Yield data within columns followed by the same letter are not significantly different, statistically, at the 95 percent level.

stone and phosphorus treated plots. Yield data were taken on April 16, and May 22, 1984. Ryegrass responses to limestone treatments are presented in Table 1.

Dry matter yield was increased nearly 1,600 lb/A at the first harvest by application of 0.3 tons of limestone per acre, and by an additional 650 lb when the limestone rate was increased to 1.7 tons per acre. Ryegrass responses to limestone rates were not significantly different at the second harvest, but total yields were. A total ryegrass response of 1,735 lb was produced by the 0.3 ton rate of limestone, compared to nearly 2,600 lb of grass produced by the 1.7 ton per acre rate. The 0.3 ton rate of limestone reduced the toxic effects of the pH 4.5 Lilbert soil during the first season, but was not enough limestone to completely overcome the acidity. In addition, the 0.3 ton rate of limestone will not have the lasting effect, especially where high rates of nitrogen are applied to Coastal bermudagrass.

Ryegrass yield responses to phosphorus rates are shown in Table 2.

Dry matter yield continued to increase as the phosphorus rate increased up to 491 lb P_2O_5/A, but the ryegrass yield response at this high rate was not significantly greater, statistically, than the 4,186 lb/A yield at the 92 lb P_2O_5/A rate.

Yield results in Tables 1 and 2 are averages over all phosphorus rates and limestones rates, respectively, and do not reflect the differences which occurred due to individual treatments. These differences are illustrated in Figures 1 and 2. Generally, the application of agricultural limestone is thought to increase the efficiency of fertilizers, and this can be seen in Figure 1. One example to point out is the effect of the 0, 0.3, and 1.7 ton rates of limestone on the response of ryegrass to the 123 lb rate of P_2O_5. Grass yield at the zero limestone and 123 lb P_2O_5/A rate was 2,920 lb of DM/A. When the limestone rate was increased to 0.3 ton/A, yield increased to 5,107, and at 1.7 tons of limestone/A, yield increased to 6,078 lb of ryegrass/A. When adequate phosphorus was applied (245 and 491 lb P_2O_5/A) the 0.3 ton/A limestone rate appeared to be sufficient for the first year of production.

Figure 2 illustrates the same data by comparing the effect of fertilizer phosphorus on the efficiency of limestone. When an inadequate rate of limestone was applied, the efficiency of that limestone for grass production was improved as the rate of fertilizer phosphorus increased. This response is indicated by the bars representing the 0.3 ton/A rate of limestone. As the rate of P_2O_5 increased from 0 to 123 lb/A, grass yield increased from 3,450 lb to 5,107 lb. At the 491 lb P_2O_5/A rate, 0.3 tons of limestone helped produce 5,624 lb ovendry grass per acre.

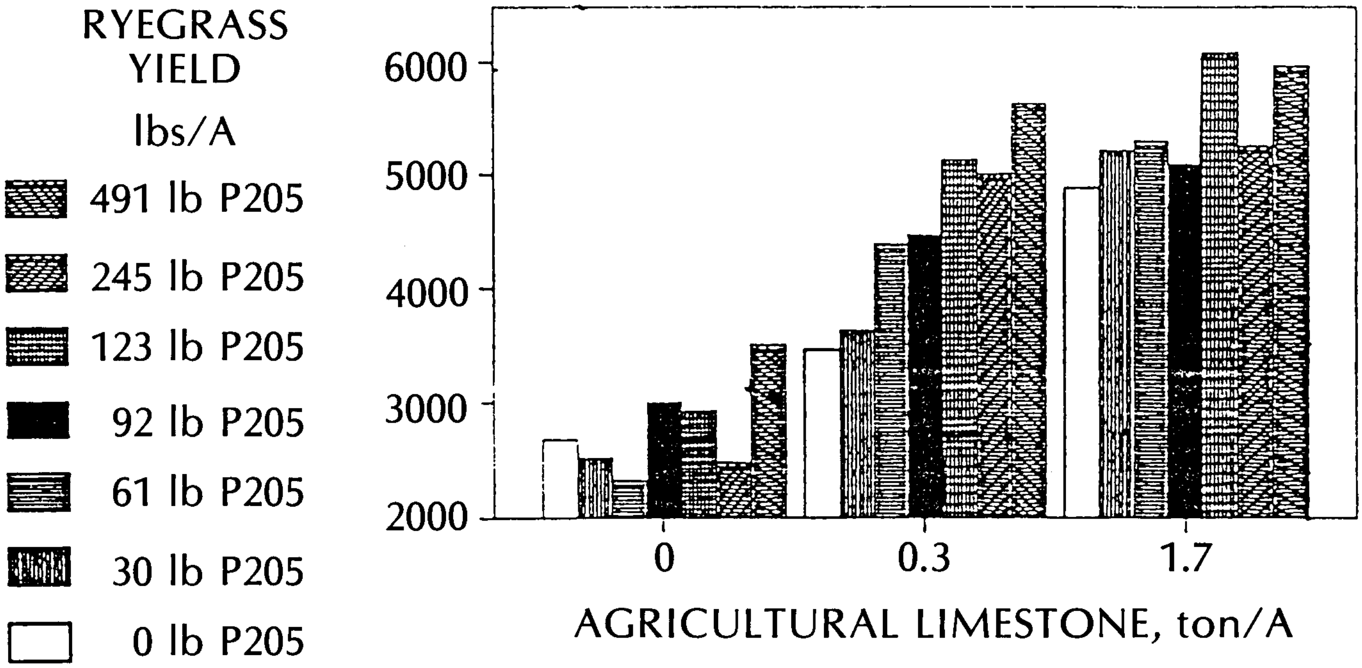

FIGURE 1. Agricultural limestone increases fertilizer phosphorus efficiency.

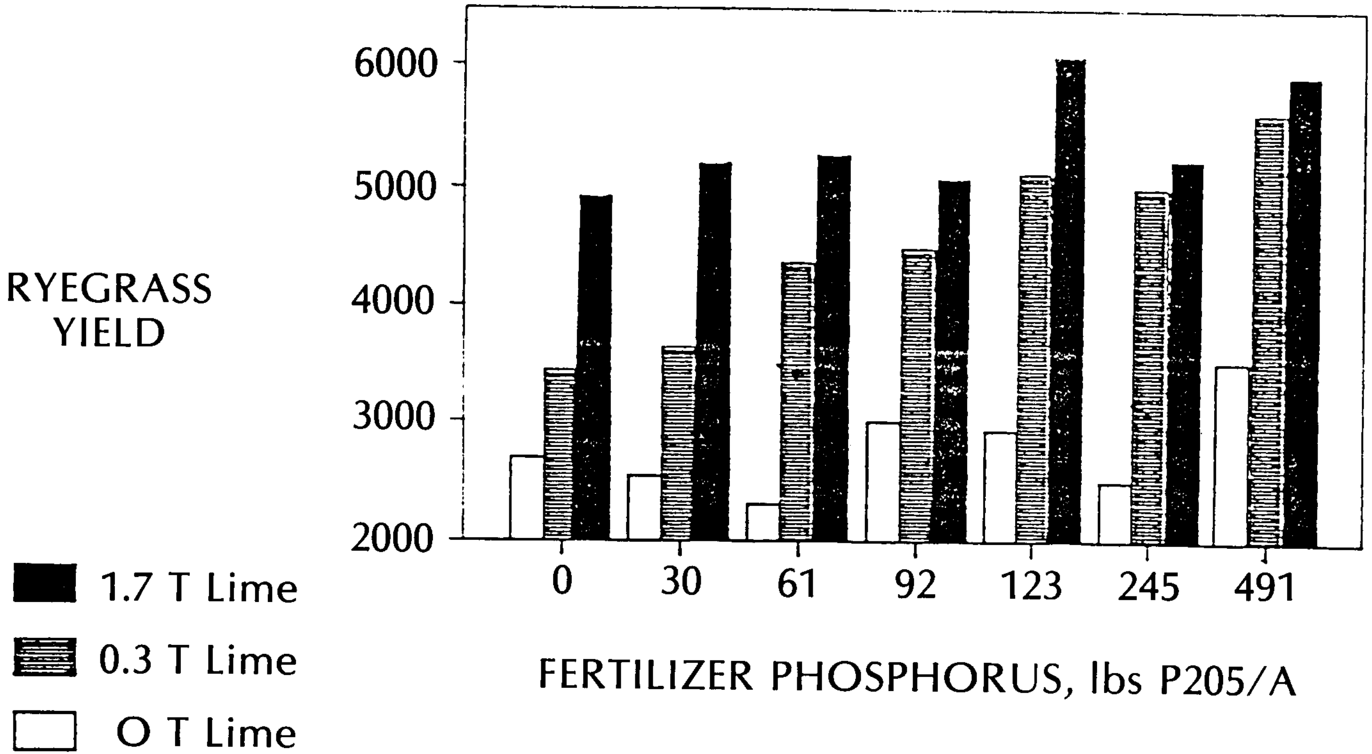

Figure 2. Fertilizer phosphorus increases limestone efficiency.