TEXAS

Alfalfa Response to Boron at Variable Soil pH on Coastal Plain Soils

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Alfalfa is not a common forage on Coastal Plain soils of the southern U.S., but recent advances in the development of grazing tolerant varieties have increased interest in alfalfa production in the region.

In one study, growth response of alfalfa (var. Alfagraze) to residual and applied levels of B was measured. Tests were run on a Darco loamy fine sand (thermic, Grossarenic Paleudult) at varying soil pH levels.

Alfalfa was overseeded into the sod of Coastal bermudagrass at a 27-inch row spacing. Prior to the alfalfa study, specific plots had received 0, 1, and 2 tons/A of calcitic limestone with an effective calcium carbonate equivalent (ECCE) of 64 or 100 as part of a 4-year study of clover response to limestone and B. The limestone contained 4 percent magnesium (Mg). Annual B rates for clover were 0, 1, and 2 lb/A, applied as 14.3 percent Granubor®.

Significant advances in the soil fertility and fertilizer requirements of alfalfa are being developed through research on the acid, Coastal Plain soils of east Texas. Research is continuing to determine relationship of variable levels of soil boron (B) and pH for best yield response under these conditions.

To adjust soil pH for alfalfa production following the clover research, an additional 2 and 4 tons/A of ECCE 64 and 100 limestone was applied (annual split applications) to appropriate plots. Lime-stone was left on the soil surface except for the final 1 and 2 ton/A rates that were lightly disked into the surface 1.5 inch depth of soil in fall of 1992, immediately before seeding alfalfa. Boron rates were maintained at the same level as for clover for the first year of research on alfalfa.

Yield of alfalfa was lower than expected, even for the seedling year, so the B rate was increased to 2 and 4 lb/A for the second and third years of the study. Phosphorus (P) was applied to all plots at a rate of 125 lb P_2O_5/A in 1992 and 1993 and 80 lb/A in 1994. Potassium (K) application was maintained above 300 lb

Alfalfa response to four different treatments is shown in this photo. Area at upper left received no limestone or B. Lower left received 2 tons/A of ECCE 62 limestone and no B. Lower right received 2 lb/A B annually, but no limestone. Upper right recived 4 tons/A of ECCE 100 limestone and an annual B rate of 4 lb/A.

K_2O/A each year. Sulfur (S) and Mg were applied annually at rates of 60 and 30 lb/A, respectively. Nitrogen (N) was applied at rates varying from 80 to 100 lb/A annually in an attempt to allow the bermudagrass to compete with the alfalfa. Because of the effect of applied N on decreasing pH of the surface soil, samples were collected from the 0- to 2-inch and 2- to 6-inch depths. Soils were analyzed for hot-water-soluble B, 1:2 soil:water pH, and DTPA levels of manganese (Mn).

Seventy-six percent of the variability in alfalfa yield was attributed to soil pH, soil B, applied B, and soil Mn. Estimated yields at varying levels of hot-water-soluble soil B and pH in the 2- to 6-inch soil depth, with applied B at 2 lb/A and soil Mn at 7.4 parts per million (ppm), are indicated in **Table 1**. Yields were increased by increasing B levels at all levels of soil pH and, conversely, by increasing pH at all levels of soil B. At pH 5.7, alfalfa yield was increased over 400 percent by raising the soil B level from 0.3 to 0.7 ppm. Although the rate of response to increasing soil pH declined at higher pH, the exponential response of alfalfa to soil B continued to increase as soil pH was increased. Alfalfa dry matter yield at the 27-inch row spacing was increased by 7.0 tons/A at the highest soil pH and residual level of B compared to levels of these variables in check treatments. This amounts to an increased growth efficiency approaching 740 percent due to increasing soil pH and levels of soil B. Alfalfa yields were continuing to increase at pH 7.7 with soil B at 0.7 ppm.

Alfalfa response data for increasing rates of applied B at variable soil pH were generated using the same regression equation (not shown) as for **Table 1**, but with soil pH increasing from 6.0 to 8.0 and soil B at a constant 0.5 ppm (**Table 2**). The estimated yields increased at decreasing rates as both variable soil pH and applied B levels were raised. Alfalfa yield was maximized at 3 lb/A of applied B under the conditions set for this regression equation. Yield was increased greater than 400 percent with the 3 lb/A B rate at pH 8 compared to pH 6.0 in the 2- to 6-inch soil depth. At the same level of applied B and with soil pH at 6.5, yield was increased only 246 percent.

TABLE 1. Estimated response of alfalfa to soil pH_W and hot water-soluble B in the 2- to 6-inch depth of a Darco loamy fine sand with applied B at 2 lb/A and soil Mn at 7.5 ppm in 1994.

Soil pH	Soil B, ppm 0.3	0.4	0.5	0.6	0.7
	D.M., tons/A				
5.7	0.97	1.17	1.90	3.15	4.94
6.2	2.05	2.24	2.98	4.23	6.01
6.7	2.93	3.14	3.86	5.16	6.91
7.2	3.64	3.84	4.57	5.82	7.60
7.7	4.16	4.36	5.08	6.34	8.13

TABLE 2. Estimated response of alfalfa to soil pH_W in the 2- to 6-inch depth and to B applied to a Darco loamy fine sand with hot-water-soluble B at 0.5 ppm and DTPA extractable Mn at 7.5 ppm in 1994.

Soil pH	Applied B, lb/A 0	1	2	3	4
	D.M., tons/A				
6.0	1.10	1.98	2.57	2.85	2.83
6.5	2.06	2.94	3.53	3.81	3.80
7.0	2.84	3.72	4.31	4.59	4.58
7.5	3.43	4.32	4.90	5.18	5.17
8.0	3.84	4.72	5.31	5.59	5.58

Acid soils of the Coastal Plain usually need to be limed for economic alfalfa

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temporarily, but were inadequate to relieve pressure from the disease through grain fill. Chloride alone reduced crop injury from the disease for about 5 weeks, but was not different from the check at season's end. Chloride and fungicides applied as a combination at topdress, or sequentially at topdress, gave significant relief from crop injury due to leaf rust for most of the growing season and improved yields over treatments not using both products. Sequential fungicide applications (Bayleton 2 oz/A followed by Tilt 4 oz/A) did not give leaf protection equal to combination or sequential treatments with Cl and fungicide.

Leaf rust infestations of the magnitude observed in this study are the exception rather than the rule, occurring only every 4 or 5 years. The topdress Cl and fungicide strategy which was employed in this study has the potential to allow farmers to scout fields and make applications of Cl fertilizer and/or fungicide as needed to deal with a major disease problem in wheat. BC

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production. Liming these soils to raise pH to 6.5 or higher is often recommended. Based on results from this research, pH 6.5 is not sufficiently high for maximum alfalfa yield on a Coastal Plain Darco soil. The additional cost of limestone needed to raise soil pH to 7.0 is rapidly offset by the estimated additional 0.78 tons of dry matter (0.87 tons of 12 percent moisture hay) produced. When low organic matter, acid soils are limed, residual, plant-available B is adsorbed by hydroxy aluminum compounds in the pH range of 6 to 9. Adsorption decreases the availability of B to plants, creating the need to apply B to B-deficient soils for crops such as alfalfa that have an elevated need for this nutrient.

Alfalfa response to increased levels of hot-water-soluble soil B appears to be greater than its response to rates of applied B over a varying soil pH range. This indicates the importance of maintaining adequate levels of hot-water-soluble soil B to optimize yield as long as pH is in a favorable range. The higher the pH, the greater is the adsorption and retention of plant-available soil B against leaching with water. In this study, the critical level of hot-water-soluble soil B for alfalfa approximated 0.4 ppm. Alfalfa yield increased only 0.2 tons/A between 0.3 and 0.4 ppm B, but the estimated yield increase was 0.73 tons/A as soil B increased from 0.4 to 0.5 ppm. The hot-water-soluble soil B level considered adequate for alfalfa production on limed acid soils could not be determined in this research because estimated yield was still increasing at the highest level of soil B attained. Additional research is needed at even higher variable levels of soil B and pH to determine the maximum yield response on Coastal Plain soils. BC

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