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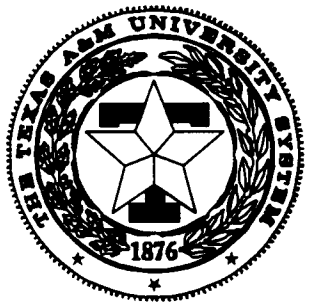

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EFFECT OF BORON FERTILIZATION AND pH ON YIELD OF ALFALFA

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Background. Soil fertility and fertilizer requirements for alfalfa are being developed through research on acid soils at Overton. We studied the growth response of 'Alfagraze' alfalfa to residual and applied levels of boron at varying soil pH on a Darco loamy fine sand. Alfalfa was overseeded into the sod of 'Coastal' bermudagrass at a 27-in.-row spacing. Specific plots were limed three times with zero, one, and two tons of ECCE (effective calcium carbonate equivalent) 62 or 100 calcitic limestone per acre during the four years before planting alfalfa. The limestone contained 4% magnesium. Boron rates applied annually to specified plots during this time were zero, one, and two lb/acre. Because yield of alfalfa was lower than expected for the seedling year, we increased the B rate to two and four lb/acre for the second and third years of the alfalfa study. Phosphorus was applied to all plots at a rate of 125 lb P_2O_5 per acre in 1992 and 1993 and 80 lb per acre in 1994. Potash application was maintained above 300 lb K_2O per acre each year. Sulfur and magnesium were applied annually at rates of 60 and 30 lb per acre, respectively. Because nitrogen applied for the bermudagrass production decreased soil pH, samples of the surface soil were collected from the 0- to 2-in. and 2- to 6-in. depth. Soils were analyzed for hot-water-soluble B, 1:2 soil:water pH, and DTPA levels of Mn.

Research Findings. As indicated by the R^2 term, 76% of the variability in alfalfa yield was attributed to soil pH, soil B, applied B, and soil Mn. Alfalfa response data for increasing rates of applied B at variable soil pH were generated using the following regression equation:

$$\text{Yield} = -24.25 + 0.92 \times B - 0.12 \times B^2 - 16.53 \times 0.5 + 26.45 \times 0.5^2 + 6.55 \times pH - 0.37 \times pH^2 + 0.14 \times 7.5$$

B = Boron applied at rates between 0 and 4 lb/acre, increasing at one lb increments
Soil pH set to vary from 5.7 to 7.7
The soil boron level was set at 0.5 ppm and soil manganese was held at 7.5 ppm

Estimated yields increased as soil pH and applied B levels were raised (Table 1). Alfalfa yield was maximized at boron rates between three and four pounds per acre under the conditions set for this regression equation. At a soil pH of 7.2, yield was increased from 3.1 to 4.8 tons per acre at the three-pound-per acre rate of applied boron. To determine the optimum rate of applied boron for alfalfa under conditions for this study, we recalculated yield using the same equation but with applied boron rates increasing at quarter-pound increments. Results in Table 2 show that the marginal rate of return for alfalfa yield occurred at 3.75 pounds of applied boron per acre.

Application. Acid soils of the Coastal Plain usually need to be limed for economic production of alfalfa. When low organic matter, acid soils are limed, residual, plant-available B is adsorbed by hydroxyaluminum 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. Results from this study show that alfalfa responds to applied rates of boron approaching four pounds per acre. The value of the increased alfalfa yield when the rate of boron was raised from 3.50 to 3.75 lb per acre exceeded the cost of 0.25 lb of boron. Rates of boron above 3.75 lb/acre provided no additional increase in alfalfa yield.

Table 1. Estimated response of alfalfa to soil pH_w in the 2- to 6-inch depth and to boron applied to a Darco loamy fine sand.†

Soil pH	Applied B, lb/acre				
	0	1	2	3	4
	DM, tons/acre				
5.7	0.46	1.26	1.82	2.14	2.22
6.2	1.53	2.33	2.89	3.21	3.29
6.7	2.42	3.22	3.78	4.10	4.18
7.2	3.13	3.93	4.49	4.81	4.89
7.7	3.65	4.45	5.01	5.33	5.41

†Hot-water-soluble soil boron held at 0.5 ppm with DTPA extractable Mn at 7.5 ppm.

Table 2. Estimated response of alfalfa to incremental increases in applied boron at a soil pH of 7.20.†

Applied B	DM Yield	Yield Increase†		Applied B	DM Yield	Yield Increase†	
lb/ac	t/ac	t/ac	$‡	lb/ac	t/ac	t/ac	$
0.00	3.13			2.25	4.59	0.10	11.20
0.25	3.35	0.22	24.64	2.50	4.68	0.09	10.08
0.50	3.56	0.21	23.52	2.75	4.75	0.07	7.84
0.75	3.75	0.19	21.28	3.00	4.81	0.06	6.72
1.00	3.93	0.18	20.16	3.25	4.85	0.04	4.48
1.25	4.09	0.16	17.92	3.50	4.88	0.03	3.36
1.50	4.24	0.15	16.80	3.75	4.89	0.01	1.12
1.75	4.37	0.13	14.56	4.00	4.89	0.00	0
2.00	4.49	0.12	13.44				

†Hot-water-soluble soil boron held at 0.5 ppm with DTPA extractable Mn at 7.5 ppm.
‡Alfalfa valued at $100.00 per ton of 12% moisture hay. One pound of boron valued at $2.87.