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EFFECT OF SOIL BORON AND APPLIED BORON ON YIELD OF ALFALFA

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Background. Boron is an essential plant nutrient. We have determined that liming acid soils for clover and alfalfa production stresses the soil's ability to supply boron to these forages. The inability of these limed soils to supply this nutrient for leguminous crops may be due to a low boron supply in the soil that is unable to supply the needs of a fast growing legume. Additionally, published research indicates that soil boron is fixed into forms unavailable to plants as liming raises soil pH to a level favorable for legume production. Legume crops are more sensitive to low levels of soil boron than are grasses. The research on which this report is based resulted from a need to determine the boron requirements for successful alfalfa production on a Darco soil limed to achieve varying pH levels. Zero, one, and two tons of calcitic limestone were applied to specific plots on this Darco soil three times from 1989 through 1992. Limestone that contained 4% magnesium was applied as ECCE 62 and 100% material at each application rate each time limestone was applied. Limestone was left on the soil surface until the final treatment in 1992. At that time, the soil was lightly disked to a depth approximating two inches. Boron was applied annually to specific plots at rates of zero, one, and two lb/acre for clover production the first four years. The same boron rate was used for alfalfa the first year. Because of lower than expected yields, we raised the boron application rate to two and four lb/acre the second and third years. 'Alfagraze' alfalfa at 6.7 lb of seed per acre was overseeded into the Darco soil established to Coastal bermudagrass. The alfalfa row spacing was 27 inches to allow the bermudagrass to grow between the rows. The experimental site was fertilized with phosphorus, potassium, magnesium, sulfur, zinc, and copper at levels adequate for alfalfa. Yield data from 1994 were used to generate results for this report.

Research Findings. Estimated alfalfa dry matter yields in Table 1 result from the interaction of soil pH and boron levels in the 2- to 6-inch depth, and to soil manganese, and applied boron. The equation that represents the response to treatment and soil variables follows:

$$Y = -24.25 + 0.923 \times FB - 0.12 \times FB^2 - 16.53 \times SB + 26.45 \times SB^2 + 6.55 \times 7.0 - 0.37 \times 7.0^2 + 0.138 \times 7.5$$

Where: FB = rates of boron applied in pounds per acre, ranging from zero to 4.0.

SB = hot-water soluble soil boron ranging from 0.3 to 0.7 in the 2- to 6-inch soil depth

Data in Table 1 result from allowing applied rates of boron and soil levels of boron to vary while maintaining soil pH at 7.0 and soil manganese at 7.5 ppm. Estimates predicted by this equation indicate that alfalfa yields in response to applied boron were increased as the boron rate was increased. Yield increases were greater as boron application rates were increased at the lower level of applied boron. As applied boron rates approached 4.0 lb/acre, regardless of the soil boron content, yield was maximized for the conditions in this soil. At any rate of boron applied, increasing boron levels in the soil produced an increased yield of alfalfa. Estimated yield was relatively unchanged by increasing soil levels of boron from 0.30 to 0.35 ppm. At soluble boron levels above 0.35 ppm, yield rapidly increased. The higher the level of soil boron, the greater is the increase in estimated alfalfa yield. Alfalfa yield is predicted to increase approximately 1.8 tons/acre when the soil boron level in the 2- to 6-inch depth is increased from 0.6 to 0.7 ppm.

Application. Results from this study show the importance of maintaining an adequate level of boron in acid, sandy soils limed for alfalfa production. The majority of soils from East Texas contain soluble levels of soil boron below 0.35 ppm before application of limestone. Since soil boron is rendered less available by raising the pH of an acid soil above 6.0, it becomes increasingly important to apply boron for leguminous crops such as alfalfa. The level of boron in the soil is also important. This research indicates that alfalfa yields are rapidly increased as the soil boron level increases to 0.7 ppm. Since soil levels of soluble boron did not exceed 0.7 ppm and yield of alfalfa was still increasing exponentially, the optimum level of soil boron could not be determined from this research. Additional research is needed to determine the level of soil boron needed to maximize alfalfa production on this soil.

Table 1. Predicted response of alfalfa to rates of applied boron and to increasing levels of boron in the 2- to 6-inch depth of a Darco loamy fine sand near Overton in 1994.

Applied boron	Soil boron (ppm)						
	0.3	0.35	0.4	0.45	0.5	0.6	0.7
lb/ac	-----Dry matter yield, tons/acre-----						
0	1.93	1.96	2.12	2.42	2.85	4.11	5.89
0.5	2.36	2.39	2.56	2.85	3.28	4.54	6.33
1.0	2.73	2.76	2.93	3.23	3.66	4.91	6.70
1.5	3.04	3.07	3.24	3.54	3.97	5.22	7.01
2.0	3.29	3.33	3.49	3.79	4.22	5.47	7.26
2.5	3.48	3.52	3.68	3.98	4.41	5.67	7.45
3.0	3.62	3.65	3.81	4.11	4.54	5.80	7.58
3.5	3.69	3.72	3.89	4.18	4.61	5.87	7.66
4.0	3.70	3.73	3.90	4.19	4.62	5.88	7.67