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RESPONSE OF ALFALFA TO ZINC, COPPER, AND MOLYBDENUM

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Background. In addition to sunlight, plants need carbon and oxygen from carbon dioxide, hydrogen and oxygen from water, and require at least 13 other essential nutrients that they obtain mainly from the soil. Nitrogen, phosphorus, and potassium are used in relatively large quantities by plants and are considered the primary or macronutrients along with the secondary nutrients calcium, magnesium, and sulfur. Nutrients used in small amounts in plants are called micronutrients. These are zinc, iron, copper, manganese, chlorine, boron, and molybdenum. Some of these nutrients are amply available in the soil for plant uptake. Those that are deficient may be supplied as fertilizers, as soil amendments such as limestone or gypsum, and as manure. In acid soils such as exist in the East Texas Timberlands, all of the micronutrients become less available in limed acid soils except for molybdenum which increases in plant availability as acidity decreases. For all but boron, there is a deficiency of information available regarding forage response to the micronutrients in limed acid soils. A study was established to evaluate alfalfa response to zinc, copper, and molybdenum on a Darco loamy fine sand limed to a pH of approximately 7.0. Plots that measured 10 by 20 feet were treated with increasing rates of zinc, copper, or molybdenum at rates required in a central-composite rotatable design experiment. Copper rates were zero, 1.45, 3.57, 5.69, and 7.4 lbs. per acre. Zn was applied at rates of zero, 2.89, 7.14, 11.38, and 14.28 lbs. per acre. Molybdenum, which is used by plants in very small amounts, was applied at rates of zero, 36.18, 89.23, 142.28, and 178.46 g per acre. In a central-composite rotatable experimental design, only a selected few of the possible rate combinations are used. Alfalfa was seeded on this experimental site in the fall of 1995 at 20 pounds of seed per acre. Five harvests were collected in 1996, four in 1997, three in 1998, and four in 1999. For a couple of those years, alfalfa yields were reduced due to drought. Total dry matter yields for the four years of this study are shown in Tables 1 and 2.

Research Findings. The Darco loamy fine sand was limed to raise soil pH to 7.0. Over four years, increasing molybdenum rates tended to increase dry matter production at low copper rates and decrease yield at the high rates of copper (Table 1). Increasing rates of copper tended to decrease dry matter production at the higher rates of molybdenum. Similar effects from copper were apparent at the high rates of zinc (Table 2). These yield trends were not statistically significant.

Application. The lack of significant alfalfa yield differences in response to zinc, copper, and molybdenum on this Darco soil may not be applicable to other limed acid soils in East Texas.

However, results from this study indicate that alfalfa, a deep rooting legume, was able to obtain sufficient amounts of these micronutrients from one of the more sandy soils in East Texas even after the surface depth was limed to increase pH to 7.0. Either adequate amounts of these plant nutrients were still available in the limed surface soil, or the alfalfa obtained sufficient amounts from the unlimed subsoils, or both.

Table 1. Alfalfa response to copper and molybdenum fertilization on a Darco soil.

	Copper fertilizer rate, kilograms/hectare[†]				
Molybdenum	0	2	4	6	8
oz/acre	----------Four-year total dry matter produced, tons/acre----------				
0	12.6	12.4	12.4	12.6	12.9
0.71	12.9	12.7	12.6	12.6	12.8
1.43	13.1	12.8	12.6	12.5	12.6
2.14	13.2	12.8	12.5	12.3	12.3
2.85	13.3	12.7	12.3	12.1	11.9

[†] One kilogram/hectare equals 0.89 pounds/acre. Copper rates equal 0, 1.78, 3.57, 5.35, and 7.14 pounds/acre.

Table 2. Alfalfa response to zinc and copper fertilization on a Darco soil.

	Zinc fertilizer rate, kilograms/hectare[†]				
Copper rate	0	4	8	12	16
kg/ha[†]	----------Four-year total dry matter produced, tons/acre----------				
0	12.0	12.7	13.1	13.1	12.8
2	11.8	12.5	12.8	12.7	12.3
4	11.8	12.3	12.6	12.5	12.0
6	11.8	12.3	12.5	12.4	11.8
8	12.0	12.5	12.6	12.4	11.8

[†] One kilogram/hectare equals 0.89 pounds/acre. Zinc rates are 0, 3.6, 7.1, 10.7, and 14.3 pounds/acre. Copper rates equal 0, 1.78, 3.57, 5.35, and 7.14 pounds/acre.