Response of Lemon to Micronutrient Fertilization

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Abstract

A study was initiated in the spring of 2003 to evaluate the response of lemons to soil and foliar applied micronutrients for two growing season (2003-2005). Soil applied Fe, Zn, Mn, and Cu was applied in sulfate form and B as Solubor in shallow holes around the skirt of each tree. Foliar applied micronutrients were all applied as "Metalosate" products. Lemon leaf tissue analyses show marginal levels of Zn, Mn, and Cu throughout the study. In 2003-2004, soil fertilization sometimes increased leaf nutrient composition but there was no effect to foliar fertilization. In 2004-2005, ,leaf B and Zn increased to soil fertilization and leaf Mn and Cu increased to foliar fertilization Overall, there were no significant differences in yield or quality to micronutrient fertilization in either growing season.

Introduction

Abundant information exists showing plants produced on high pH soils or soils with free lime are predisposed to micronutrient deficiencies. Because soils used for citrus production in Arizona typically have pH values ranging from 7.5 to 8.5 and free calcium carbonate, it is presumed that responses to Fe, Zn, and Mn are likely. However, we are not aware of any recent experiments in Arizona showing positive responses of citrus to micronutrient fertilization. Transitory deficiencies of Zn are seemingly periodically observed, particularly during the winter and early spring. Nevertheless, we have no data documenting tree growth reduction; yield reduction, or fruit quality losses to these transitory deficiencies. The objective of this experiment was to evaluate the response of lemons to foliar or soil applied micronutrients. Studies aimed at rates, sources, and combinations of micronutrient fertilization might follow in subsequent years depending on the results of this first study. The long-term objective is to assess to economic viability of micronutrient fertilization of desert lemons.

Materials and Methods

This field study was conducted at the Yuma Mesa Farm of the Yuma Agricultural Center on 11-year old Lisbon Lemons. This preliminary study evaluated response to single micronutrients either soil or foliar applied. The treatment design is as follows:

1. Soil Applied Fe (20 kg/ha)
2. Soil Applied Zn (20 kg/ha)
3. Soil Applied Mn (15 kg/ha)
4. Soil Applied Cu (5 kg/ha)
5. Soil Applied B (2 kg/ha)
6. Foliar Applied Fe
7. Foliar Applied Zn
8. Foliar Applied Mn
9. Foliar Applied Cu
10. Foliar Applied B

Soil applied Fe, Zn, Mn, and Cu was applied in sulfate form and B as Solubor in shallow holes around the skirt of each tree. All soil fertilization of micronutrients occurred March 17 in 2003 and March 31 in 2004. Foliar applied micronutrients were applied as Metalosate products provided by Albion Advanced Nutrition. The rates applied each application were 40, 40, 40, 20, and 10 mL per tree for Zinc Metalosate, Manganese Metalosate, Iron Metalosate, Boron Metalosate, and Copper Metalosate, respectively. These were applied with a sprayer especially designed for research work at 4 total gallons water per tree. Foliar micronutrients were applied March 18 and April 4 in 2003 and April 1 and May 3 in 2004. The experimental design was randomized complete block with four replications.

Leaf samples were collected in April, June, August, October, December, and February in the 2003-2004 season. For the 2004-2005 season leaf samples were only collected on August 11. All leaf samples will be dried, ground and digested for analysis of N, P, K, Ca, Mg, Na, Fe, Zn, Mn, Cu, and B. Fruit yield and fruit quality was measured on all plots.

Results and Discussion

2003-2004 Season

The micronutrient status of citrus leaves as affected by treatment and sampling time are shown in Figures 1 through 5. There is a lot of variation and many of the observed differences are not statistically significant. Leaf Fe levels were typically within range of levels considered adequate. There were no significant changes in leaf Fe concentration to soil or foliar applied Fe. Leaf B concentrations for most sample dates increased to soil B applications but there was no similar increase to foliar B applications. Nevertheless, all leaf B levels exceeded the critical concentration of 30 ppm and we would not anticipate a response to B fertilization.

Optimum leaf concentrations of Zn should range from 25 to 100 ppm. There was an increase in leaf Zn in June but this was temporary. We did not successfully increase leaf Zn with foliar fertilization and leaf Zn concentrations were marginal throughout the study period. Leaf Mn concentrations for some sample dates was significantly increased by soil applied Mn fertilizer but there were no significant affects to foliar Mn. Leaf Mn concentrations were near the critical level of 25 ppm for most sample dates. Leaf Cu levels were often erratic and this variation may be associated with contamination. However, Cu concentrations were generally below the critical concentration of 5 ppm and we they were not significantly increased to soil or foliar fertilization.

Overall, there were no significant differences in yield (Table 1) or quality (data not shown) to micronutrient fertilization.

2004-2005 Season

As in the first season leaf Zn, Mn, and Cu levels were marginal (Table 2). During this season leaf Mn and Cu levels increased to foliar fertilization with the respective nutrient. Leaf B and Zn concentrations similarly increased to soil fertilization. There were no significant differences in yield (Table 3) or quality (data not shown) to micronutrient fertilization.

Table 1. Results of Yields of 'Lisbon' lemons sampled in 2003.

Treatment	First Yield (lbs/tree)	Second Yield (lbs/tree)	Total Yield (lbs/tree)
Soil Fe	113.75	100.00	213.75
Soil Zn	83.75	108.75	192.50
Soil Mn	92.50	143.75	236.25
Soil Cu	75.00	113.75	188.75
Soil B	102.50	131.25	233.75
Foliar Fe	88.75	103.75	192.50
Foliar Zn	87.50	100.00	187.50
Foliar Mn	98.75	135.00	233.75
Foliar Cu	93.75	117.50	211.25
Foliar B	77.50	138.75	216.25
Stat.	NS	NS	NS

NS = not significant at the 5% level.

Table 3. Results of Yields of 'Lisbon' lemons sampled in 2004.

Treatment	First Yield (lbs/tree)	Second Yield (lbs/tree)	Total Yield (lbs/tree_
Soil Applied Fe	158.8	41.5	200.3
Soil Applied Zn	145.0	35.8	180.8
Soil Applied Mn	177.5	44.5	222.0
Soil Applied Cu	137.5	29.5	167.0
Soil Applied B	132.5	43.5	176.0
Foliar Applied Fe	140.0	39.3	179.3
Foliar Applied Zn	151.3	35.8	187.0
Foliar Applied Mn	171.3	36.0	207.3
Foliar Applied Cu	131.3	36.8	168.0
Foliar Applied B	176.3	28.3	204.5
	NS	NS	NS

Table 4. Micronutrient content of lemon leaves to micronutrient fertilization in 2004.

Treatment	Fe (ppm)	B (ppm)	Zn (ppm)	Mn (ppm)	Cu (ppm)
Soil Applied Fe	77	103	14	20	4.8
Soil Applied Zn	73	100	22	20	4.8
Soil Applied Mn	77	111	17	42	5.3
Soil Applied Cu	76	107	14	18	5.5
Soil Applied B	48	133	16	15	5.3
Foliar Applied Fe	74	107	14	16	4.8
Foliar Applied Zn	90	98	15	27	4.5
Foliar Applied Mn	53	67	18	16	5.8
Foliar Applied Cu	69	101	15	19	7
Foliar Applied B	73	108	15	18	4.8
LSD	28.5	51.5	4.5	9.9	1.4

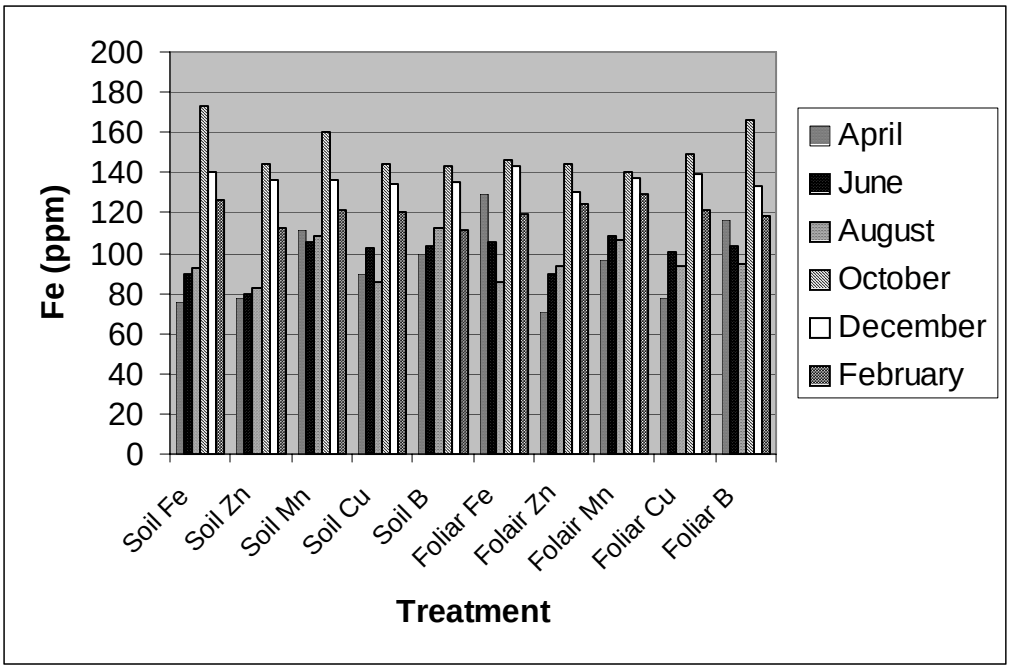

Figure 1. Iron (Fe) content (ppm) of lemons leaves to soil and foliar micronutrient fertilization.

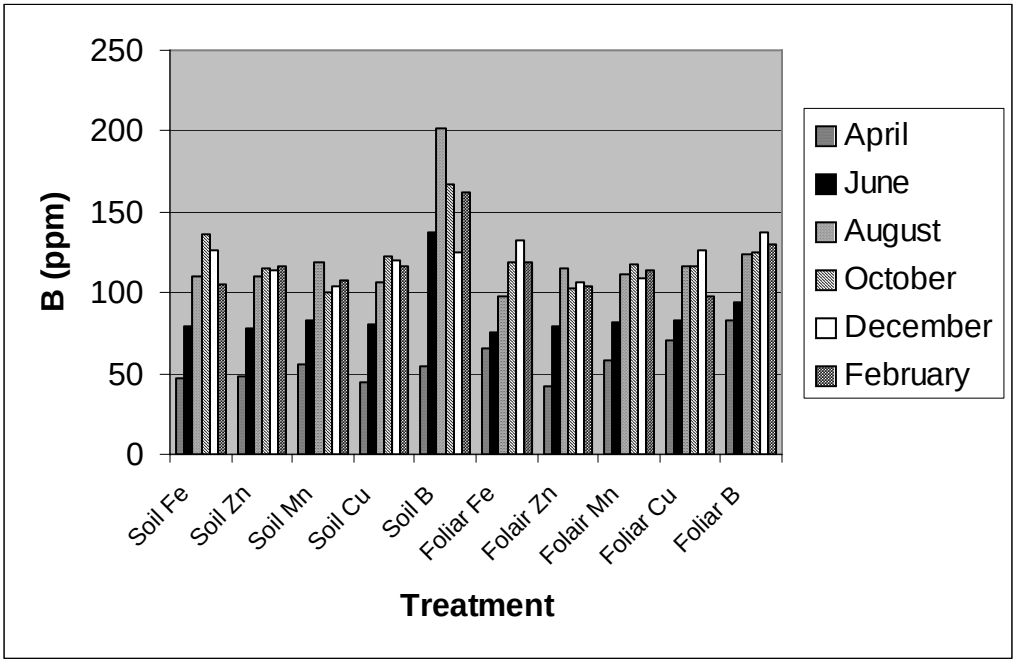

Figure 2. Boron (B) content (ppm) of lemons leaves to soil and foliar micronutrient fertilization.

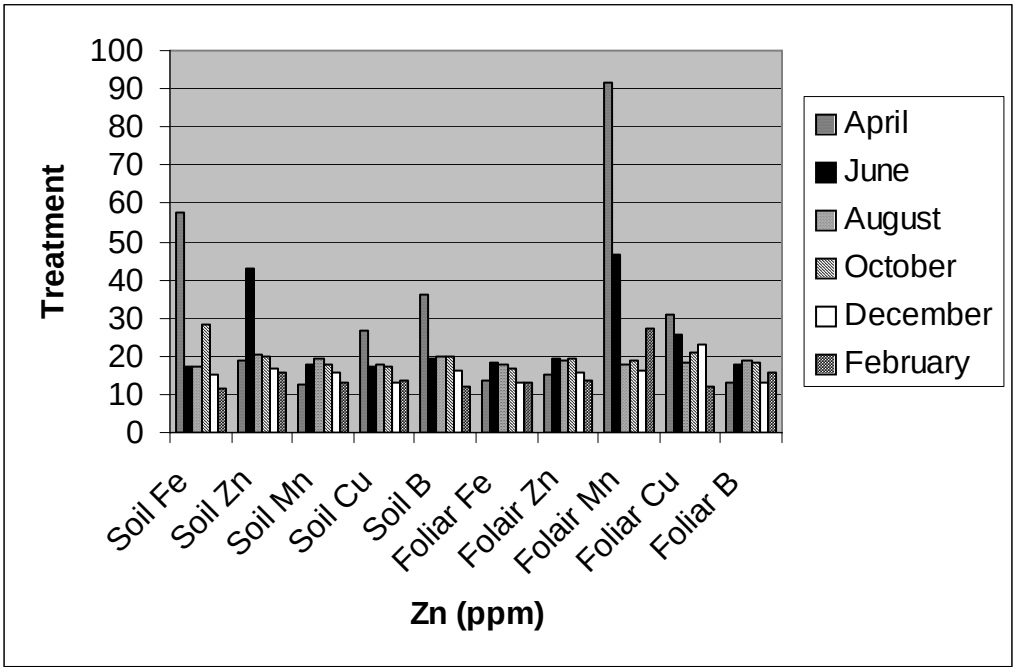

Figure 3. Zinc (Zn) content (ppm) of lemons leaves to soil and foliar micronutrient fertilization.

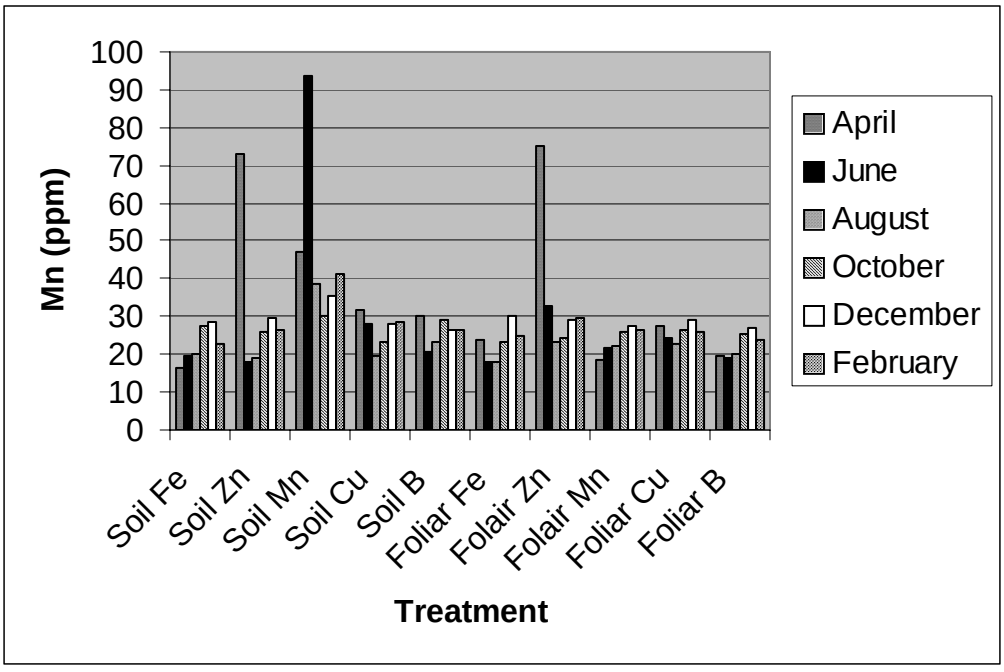

Figure 4. Manganese (Mn) content of lemons leaves to soil and foliar micronutrient fertilization.

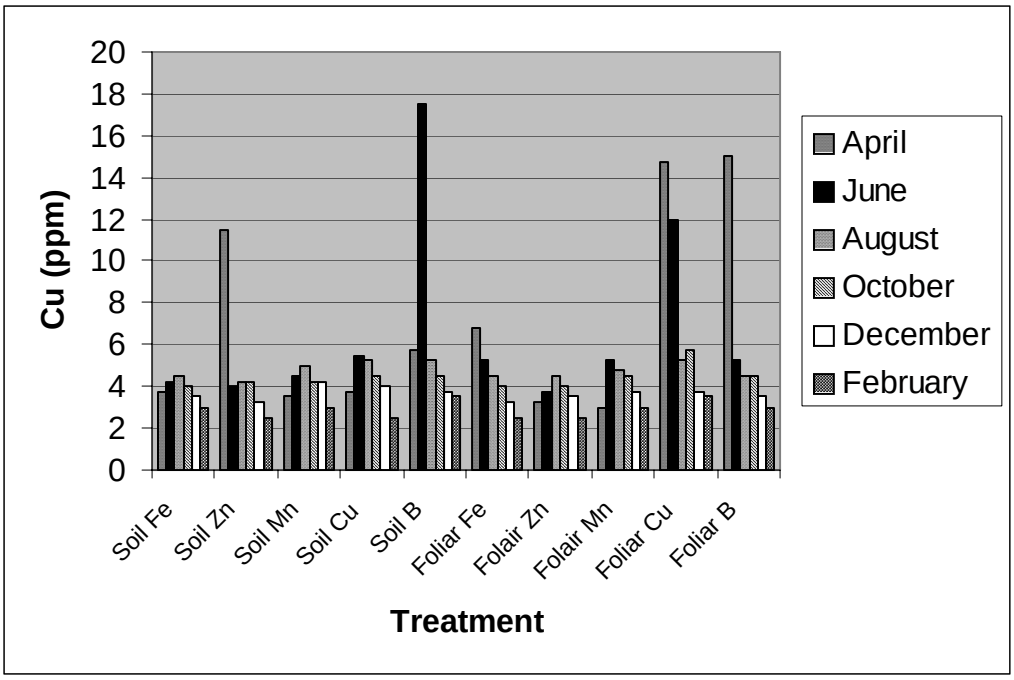

Figure 5. Copper (Cu) content of lemons leaves to soil and foliar micronutrient fertilization.