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ZINC NUTRITION OF AVOCADO

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Project Objectives: To evaluate fertilizer application methods and materials for correction of zinc deficiency in Hass avocado.

Zinc and other trace metal deficiencies are common in many southern California avocado orchards and are suspected to be an important limiting factor in fruit production. Several methods have been developed to correct the problem such as foliar applications of zinc sulfate and zinc chelates, trunk injections, or soil applications of sulfur to lower soil pH and thereby increase zinc availability. However, currently there is no consensus as to which methods are the most efficient and cost effective. There has also been confusion when treatments recommended for acid soils of San Diego County are used for treatment of calcareous soils in Ventura County. As a result, growers are now employing a wide variety of methods and many orchards have been subjected to random combinations of zinc treatments. Based on this historical problem, the objective of this research is to experimentally evaluate several commonly used zinc materials and application methods so that specific recommendations can be made for correcting trace metal deficiencies on problem soils.

During the first year of this project, our primary task has been to install a field experiment that will examine methods for correction of zinc deficiency in avocado. Initial design criteria suggested by the Avocado Research Board were that the experiment be located in Ventura County in an orchard planted with the Hass variety. From our observations of this area, zinc deficiency symptoms occur in highly localized patterns within affected orchards, suggesting that there may be specific soil or irrigation factors associated with zinc deficiency. All of the affected areas contained highly calcareous soils, which is consistent with low zinc availability and which would also lower the availability of iron and manganese. Because of a problem in locating one contiguous site uniformly affected by zinc deficiency, the field experiments were located on three separate sites. All three sites are under commercial management by ProAg Inc. The largest site, Field 1 (Winchester), is located on a hillside overlooking the Las Posas and Santa Rosa Valleys and contains 132 trees within an area where more than half of the trees are visibly affected by zinc deficiency symptoms. Field 2 (Wildgoose) and Field 3 (Warwar) contain 50 and 46 affected trees, respectively and are located within a few miles of Field 1.

At this time, all of the trees have been permanently marked and mapped and baseline nutrient analysis data have been obtained using 10 leaf samples from each tree. The initial baseline nutrient analyses data were conducted by Albion Laboratories. The first set of leaf analyses for all trees following zinc fertilization is now being conducted at UCR in January 1993. Results of the first baseline analyses prior to fertilization showed that there was considerable variability in the zinc, iron, and manganese contents of the foliage (Table 1). The normal sufficiency range for these elements in avocado are: zinc (30-150 ppm), iron (50-200 ppm), and manganese (30 -500 ppm). In comparison to these normal values, the mean foliar zinc contents in Fields 1, 2, and 3 were 45, 33, and 43 ppm respectively, which fall in the low to moderately sufficient ranges for zinc. Many trees were below the sufficient range with some trees having values for zinc as low as 21, 15, and 11 ppm, indicating severe deficiencies (less than 20 ppm). Preliminary nutrient analyses suggested that iron and manganese were also deficient in many of the trees. To eliminate problems with iron and manganese deficiencies that could confound results of the zinc treatments, chelated iron and manganese (Libfer, Allied Colloids Inc. and manganese-EDTA) were applied to all of the treatment trees in Fields 1 and 2. Field 3 was reserved for a companion experiment that is examining iron, zinc, and manganese interactions and the effect of multiple deficiencies on fruit yield and tree vigor.

After the baseline leaf samples were obtained, 10 experimental treatments were imposed in November 1992 as outlined in Table 2 using a completely randomized block design for Fields 1 and 2. During the remainder of this five year experiment, we will continue to maintain the treatments and collect and analyze samples from all of the experimental trees. Given the variability among trees within treatments, all tree responses to the application methods and materials will be based on individual tree data (foliar nutrient content and yield) using correlation and regression analyses to determine treatment efficacy. Treatments examining trunk injections and soil applications will be repeated only as necessary to maintain adequate foliar zinc levels. Cost analyses will examine material and time costs for each of the treatment methods. The first year's fruit yield responses will be examined for individual trees after the harvest in the Fall and Winter 1993.

In conjunction with these activities, we will continue to examine soil factors which may be related to development of trace metal deficiency problems. Initially we are looking for cluster patterns within the experimental sites using Krieging, a statistical method that generates a topographic plot of tree foliar nutrient contents. An example of this analysis is shown for iron in Figure 1. Similar analyses will be conducted for zinc and manganese. Although soil nutrient analysis data are generally not well correlated with trace metal deficiency problems, it may be possible to better determine whether these cluster deficiency patterns are associated with certain soil physical factors such as bulk density, organic matter content, percent calcium carbonate, or irrigation problems. Preliminary recommendations for correcting zinc deficiency based on the treatments in Table 2 will be available at the end of year two in 1994

Table 1. Baseline analyses of avocado leaves from Zinc nutrition experimental sites in Ventura County, California.

Field Location	Statistics	Fe	Mn	Zn
Field 1	Mean	116	181	45
	Std Dev.	37	95	11
	Minimum	57	42	21
	Maximum	262	863	73
Field 2	Mean	152	113	33
	Std Dev.	35	43	9
	Minimum	101	48	15
	Maximum	235	204	60
Field 3	Mean	122	169	43
	Std Dev.	29	91	12
	Minimum	61	69	11
	Maximum	195	502	86

Table 2. Schedule of application methods, zinc materials, and timing for each combination.

Application Method	Zinc Material	Application Timing
Control		
Foliar	Zinc sulfate	Once per year
	Zinc metallosate	
	Zinctrac 8	
Trunk Injection	Zinc nitrate	One time initially and repeated as necessary
Simulated Irrigation	Zinc sulfate	Four times per year
	Zinc chelate	
Soil Banding	Zinc sulfate	Once per year or as necessary

Figure 1. Krieging statistical analyses of iron concentrations in avocado trees revealing cluster patterns for tree nutrient contents and possible relationship to soil physical factors. Representative plot data for trees located in middle section of Field 1.