1995 California Avocado Research Symposium pages 47-49
California Avocado Society and University of California, Riverside

ZINC FERTILIZATION OF AVOCADO TREES

David E. Crowley. Woody Smith, and Ben Faber*
Dept. of Soil and Environmental Sciences,
University of California, Riverside, CA 92521,
and *University of California, Cooperative
Extension, 669 County Sq. Dr.,
Ventura, CA 93003

Zinc deficiencies are common in many subtropical areas where avocados *(Persea americana* Mill) are grown, and are suspected to be an important limiting factor in fruit production and tree health. Deficiencies of Zn are typically associated with calcareous soils in which availability of the metal is limited by its extremely low solubility at alkaline soil pH. Under these circumstances, applications of inorganic fertilizers such as Zn sulfate result in temporarily increased availability until the metal precipitates out of solution as the poorly soluble oxide. Zinc deficiencies have also been reported to occur in acid, sandy soils that have low total Zn contents, and in warm, semiarid regions that typically have low soil organic matter. In these cases, the Zn is relatively soluble, but is leached out of the surface soil occupied by the feeder roots. Thus the strategies that should be used for correction of Zn deficiency depend largely on the soil pH, and perhaps also on the amount of organic matter available to form metal complexes. Other factors that influence Zn deficiency are high levels of nitrogen and phosphorus fertilizers and seasonal fluctuations in leaf micronutrient content that may be related to irrigation and climatic factors affecting root growth and nutrient uptake.

In this research methods for Zn fertilization of 'Hass' avocado trees were evaluated in a two year field experiment on a commercial orchard located on a calcareous soil (pH ca. 7.8) in Ventura County, California. The Zn fertilization methods included soil or irrigation-applied Zn sulfate, irrigation applied Zn chelate (Zn-EDTA), trunk injection of Zn nitrate, and foliar applications of Zn sulfate, Zn oxide, or Zn metalosate. Efficacy of the individual treatments was determined by leaf tissue analyses on 114 trees using a completely randomized design for the soil and irrigation-applied materials, and a block design for the foliar treatments. Other experiments evaluated leaf washing techniques and the relative importance of surfactants in the absorption of Zn from the foliar-applied materials. At the start of the field experiment, the average Zn concentration in dry leaf material for all trees was ca. 45 *µg/g,* and many individual trees in the orchard were both Zn and iron deficient (Zn concentration < 30 *µg/g).*

Soil Treatments. Among the three soil and irrigation treatments, the least effective and most expensive was Zn chelate applied at the relatively low rate of 43 g Zn-EDTA/tree recommended by the manufacturer. Trees fertilized with this material were no different than unfertilized control trees. In comparison, Zn sulfate applied at an annual rate of 3.2 kg $ZnSO_4$ per tree, either quarterly as a simulated irrigation or annually as a single soil application, increased foliar Zn concentrations to 75 and 87 *µ*g/g, respectively.

One concern was whether the most zinc-deficient trees would respond similarly to those that had normal levels of zinc, or were impaired in their ability to acquire Zn as a result of local soil site factors. However, the response proved to be similar for trees in both the low and normal Zn status categories, which had Zn concentrations ranging from 71 to 109 *µglg* after the first fertilizer application. A second application of fertilizer in 1993 resulted in no significant increase in Zn concentrations. Trees that had high levels of Zn greater than 50 *µglg* at the start of the experiment generally showed no significant response to fertilizer additions, with the exception of those receiving Zn sulfate by soil banding, which increase to 103 *µglg* in 1993 and decreased the following year to 61 u*g/g.*

Foliar treatments. Foliar application of Zn sulfate (5.4 g/liter), Zn oxide (0.8 g/liter) and Zn metalosate (0.9 g/liter) all resulted in an increase in foliar Zn concentration (Figure 1) to levels that would ameliorate any deficiency, providing that the Zn is actually absorbed by the leaves and translocated to other Zn-deficient tissues in the tree. In this regard, Zn oxide, which had the lowest application rate was at first shown to be the most effective, but was suspected and later shown to have poor penetration into the leaf tissue. When applied with a methylated seed oil adjuvant, Sun-It II, the mean leaf Zn concentrations in 1993 were 75, 100, and 125 *µglg* for Zn metalosate, Zn sulfate and Zn oxide, respectively. In 1994, a different surfactant, Kinetic with better dispersion properties was used, but resulted in similar Zn contents to those measured the previous year, except for Zn sulfate which increased leaf Zn concentrations to ca 220 *µglg.* On a per unit Zn basis, Zn metalosate appeared to be best in terms of penetrating the leaf tissue, but less expensive Zn sulfate was also taken up by the leaf tissue when applied at recommended concentrations.

General conclusions. Almost all of the Zn fertilization methods we tested resulted in increased foliar Zn concentrations, with the exception of irrigation-applied Zn-EDTA and trunk injection of Zn nitrate. The trunk injection treatment was tested only one time in the Fall of 1992 and gave a short term response in which foliar Zn concentrations transiently increased from 40 to 65 *µglg* in the spring, but dropped to control levels by the following August. The 6 mm holes that were drilled into each of the major scaffold limbs healed very slowly and continued to exude sap for several months. This was judged to be a potentially dangerous treatment that could allow introduction of *Phytophthora citricola* into the wounds, which is opportunistically associated with trunk wounding and de-suckering. The treatment was therefore discontinued.

Even though foliar application is presently one of the most common zinc-fertilization methods, and appears to be as effective as either soil-or irrigation-applied Zn materials based simply on foliar analysis, there is not yet any rigorous evidence that this method is effective for correcting Zn deficiency in avocado. If foliar-applied Zn is not translocated in avocado, deficiencies may still persist in the newly developing fruit, inner leaf canopy, and the feeder roots, even though the outer canopy has been treated. Given the present uncertainty as to whether foliar-applied Zn fertilizers are taken up in quantities that would be significant for satisfying the Zn requirement of the entire tree, our results suggest that soil application of Zn may be the most reliable method for correcting Zn deficiency in avocado. This may be accomplished using Zn sulfate in a band applied under the irrigated, sprinkler zone of the canopies of the deficient trees, or simply by addition of solubilized Zn sulfate in the irrigation line.