SOIL ZINC APPLICATION FOR SOUTHWESTERN PECAN

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ABSTRACT

Pecan trees grown in the alkaline soils of the southwestern United States are prone to zinc deficiency unless supplemental zinc is regularly applied. Standard treatment involves multiple foliar zinc applications. Soil zinc application would provide several advantages. A field study was initiated in 2005 with three soil zinc treatments: no zinc (control), $ZnSO_4$ (74 $kg \cdot ha^{-1}$ Zn), or ZnEDTA (19 $kg \cdot ha^{-1}$ Zn) were applied one time in March, 2005 in bands 18 cm deep and 1.2 m on both sides of the tree row. 2005 mid-season zinc concentrations in leaves from upper branches, but not those from lower branches, were increased by soil application of ZnEDTA. In 2005 and 2006 zinc in leaves from ZnEDTA treated trees was higher than those from untreated trees on six out of fourteen sampling dates. In both 2005 and 2006 specific leaf area was unaffected by zinc treatment. Nut yield was also not affected by soil zinc applications.

OBJECTIVES

Zinc deficiency has long been recognized as a problem common in pecans grown on high pH soils (Alben and Hammer, 1944; Walworth and Pond, 2006). Because Zn is sparingly available in alkaline soils, soil Zn application is also difficult in orchards with high pH soils, and foliar zinc fertilization is standard. In Arizona, the standard method of treatment is foliar application of an inorganic salt, usually $ZnSO_4$, with a urea ammonium nitrate adjuvant. Three to five applications of approximately 2 to 3 $kg \cdot ha^{-1}$ of zinc each are typically applied beginning at bud-break and continuing until vegetative growth has subsided. Complete tree coverage and zinc distribution within the tree are problematic. These limitations could be overcome if adequate zinc could be soil-applied.

We evaluated soil application of two zinc fertilizer formulations, $ZnSO_4$ and ZnEDTA, for their effect on leaf zinc concentrations, leaf area, and nut yield.

METHODS

$ZnSO_4$ was applied to 7-year old 'Wichita' pecan trees at a rate of 74 $kg \cdot ha^{-1}$ zinc and ZnEDTA at 19 $kg \cdot ha^{-1}$ zinc on March 23, 2005, during the dormant season. Fertilizer was banded approximately 1.2 m on both sides of the tree and 18 cm deep. Trees are spaced 6m x 6m. Plots consisted of one row of 18 trees, and were separated by buffer rows. Treatments were replicated four times in a randomized complete block design.

Leaves were collected six times in 2005 and eight times in 2006 throughout the growing season and analyzed for zinc content. Specific leaf area was measured on August 5, 2005 and on July 27, 2006. Entire plot rows were harvested mechanically. A sub-sample of nuts from each plot was shelled, and kernel percentage recorded. Only partial nut harvest data are available for 2006.

RESULTS AND DISCUSSION

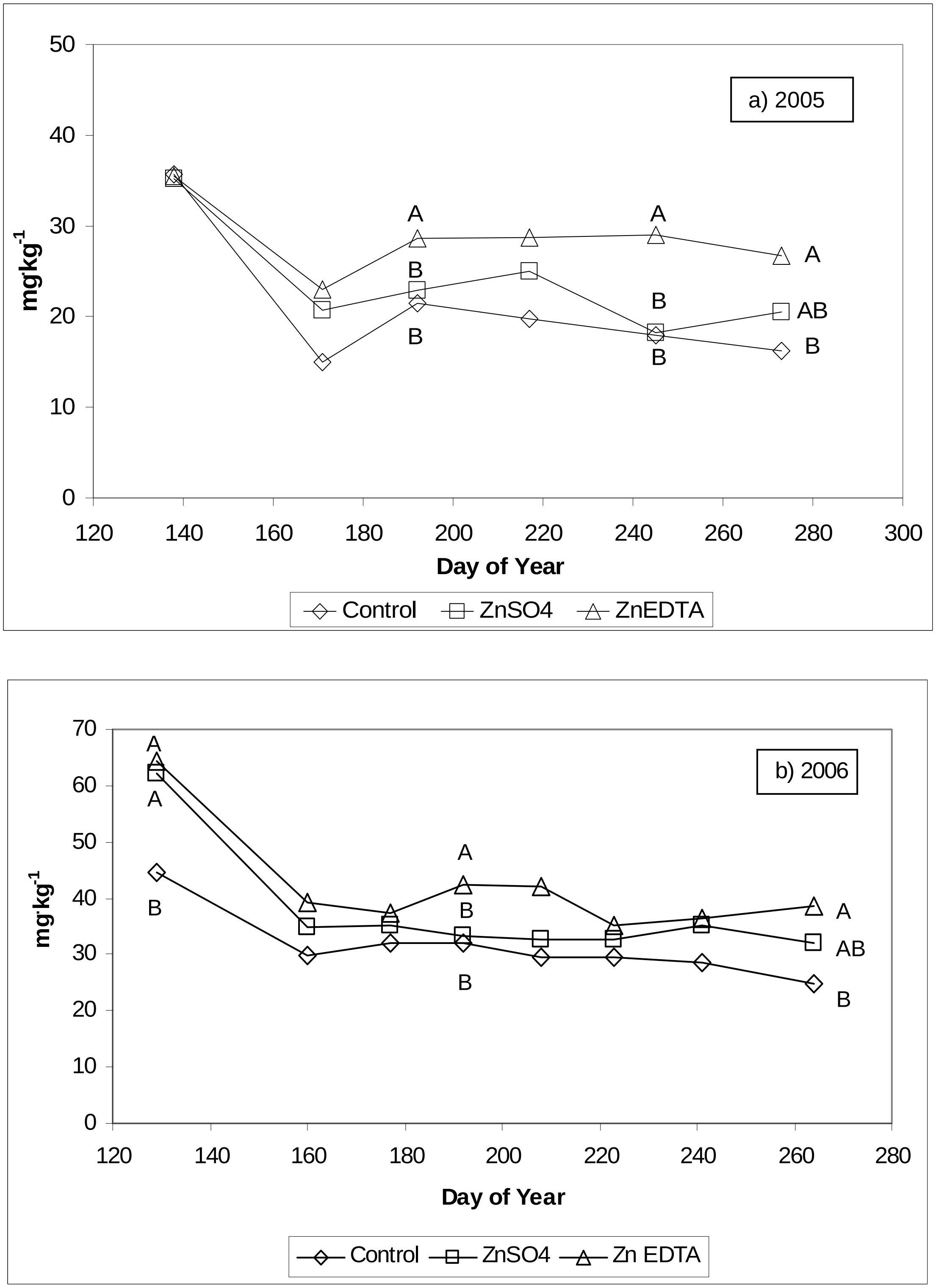
Leaf tissue zinc levels were higher in ZnEDTA treated trees than in untreated trees on three out of six sampling dates in 2005 and on three out of eight sampling dates in 2006 (Figure 1). On August 5, 2005 (day 217) leaves were collected separately from the top and bottom half of the trees. In leaves from the top half of the tree zinc concentrations were 29.5, 32.8, and 42.1 $mg \cdot kg^{-1}$ from control, $ZnSO_4$, and ZnEDTA treated trees respectively. The level in the ZnEDTA treatment was significantly higher than in the other two treatments. Differences in corresponding levels in lower leaves (19.7, 25.0, and 28.7 $mg \cdot kg^{-1}$, respectively) were not significant. Overall, leaves from trees treated with ZnEDTA were marginally higher than those from $ZnSO_4$ treated trees (significantly higher on three of fourteen sampling dates over two years). However, zinc levels in foliar tissue from ZnEDTA treated trees were highest and those in untreated trees lowest on every sampling date, even when statistical significance was lacking.

The "critical level" of Zn for pecan leaves is generally considered to be 40 to 60 $mg \cdot kg^{-1}$ in samples collected during mid-season (Worley et al., 1972; Sparks, 1993; Storey et al., 1971), although lower figures also have been proposed (Lane et al., 1965). Sparks (1994) noted that deficiency symptoms were eliminated, and vegetative growth and nut yield were maximized, with leaf Zn greater than 50 ppm. Sparks and Payne (1982) recommended a sufficiency range of 50 to 100 ppm. Second season leaf zinc levels are thus approaching critical levels in ZnEDTA treated trees, but are still marginal. Untreated trees or those treated with $ZnSO_4$ generally had leaf zinc levels below 40 $mg \cdot kg^{-1}$.

There are indications that soil-applied zinc can be effective in alkaline soils provided application rates are high enough. For example, Storey et al. (1971) found that 126 kg per tree of $ZnSO_4$ provided adequate Zn to pecan trees in a calcareous Texas soil. Effective rates may be lower when zinc is banded rather than broadcast. A broadcast application of 45 $kg \cdot ha^{-1}$ of $ZnSO_4$ was required to maintain foliar zinc levels of 50 $mg \cdot kg^{-1}$ five years after treatment in a Georgia soil with pH ranging from 4.8 to 5.2, whereas 22 $kg \cdot ha^{-1}$ was needed in banded treatments (Payne and Sparks, 1982). Several years may be needed for maximum treatment response. Payne and Sparks (1982) observed that zinc levels in leaves from trees receiving a single application of $ZnSO_4$ increased every year for five years following treatment. Thus it is hoped that tree zinc levels will continue to rise in the current study.

Zinc deficient trees may produce smaller leaves than well-fertilized trees (Walworth et al., 2006). However, average area of leaves collected from trees in 2005 and 2006 were not significantly affected by zinc treatment (data not shown). Additionally, neither nut yield nor quality parameters were affected by soil-applied zinc in 2005. Yield data from the 2006 season have not been completed.

Figure 1. Zinc concentrations in leaves collected in a) 2005 and b) 2006 from pecan trees treated with no zinc, $ZnSO_4$ (74 kg·ha^{-1} zinc) or ZnEDTA (19 kg·ha^{-1} zinc) in March 2005. Different letters accompanying points on each date signify statistical significant (95% confidence level); on dates with no letters differences were not significant.



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