EVALUATION OF SOIL-APPLIED EDDHA-CHELATED IRON FERTILIZER FOR USE IN CORRECTING IRON DEFICIENCY SYMPTOMS IN MATURE PECAN TREES IN THE PECOS BASIN, NEW MEXICO

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ABSTRACT

Soils in the Pecos Basin of New Mexico are characterized by pH 7.5-8.5 and lime content 15-30%. Under these conditions pecan trees are prone to micronutrient deficiencies; pecan trees throughout the basin exhibit interveinal leaf chlorosis symptoms characteristic of iron (Fe) deficiency. In orchards where the Fe chlorosis symptoms occur, affected trees are typically scattered through the orchard in no apparent pattern. Foliar application of ferrous sulfate fertilizer sprays (as well as other micronutrient sprays) has been ineffective in correcting these symptoms and affected trees decline over time. EDDHA-chelated Fe fertilizers are effective in managing Fe nutrition of some annual and perennial crops under alkaline and calcareous soil conditions, but have not been evaluated for use in mature pecan orchards. On 16 July 2009 fifteen trees exhibiting apparent Fe deficiency symptoms and five adjacent asymptomatic, healthy trees were selected in a mature commercial 'Western' pecan orchard located in the Pecos Basin New Mexico. The symptom severity of each tree was quantified through SPAD ("greenness") readings taken on 8 leaflets. Each of the symptomatic trees were given one of three Fe-EDDHA fertilizer treatments (fertilizer was broadcast to the entire area within the dripline of the tree canopy) on 6 August 2009: 1) 200 g Fe-EDDHA per tree, 2) 100 g Fe-EDDHA per tree, or 3) 0 g Fe-EDDHA. On 30 April and 27 May 2010 the same Fe-EDDHA fertilizer treatments were made to each tree, but the fertilizer was applied as a drench in a circle around the dripline of each treated tree. To assess the effects of fertilizer applications in alleviating the apparent Fe deficiency symptoms, SPAD readings were made on each symptomatic and asymptomatic tree 20 September 2009, 7 July 2010 and 21 September 2010. Effects of a single Fe-EDDHA application on severity of apparent Fe-deficiency symptoms were not evident in the first season of the study, but by July and September 2010, after three fertilizer applications, SPAD readings of about half of the treated trees had improved over that of untreated trees of similar 2009 symptom severity. In 2010 there was no clear difference in tree response between the 100 and 200 g tree^{-1} treatment rates and treated trees with improved SPAD readings still had lower SPAD readings than that of asymptomatic trees. The results indicate that soil-applied Fe-EDDHA may be useful for correcting Fe deficiency in mature pecan trees grown on alkaline and calcareous soils. Nevertheless, it remains to be seen whether all of the treated symptomatic trees will eventually respond to Fe-EDDHA or how long it will take for symptoms to completely disappear on responsive trees.

INTRODUCTION

There are about 16,000 ha (40,000 acres) of pecan orchards in New Mexico, with an average statewide annual production value of $94 million (USDA, Ag Census, 2007; USDA NASS, 2010). The southern Pecos River Basin (Eddy and Chaves counties) is a significant pecan production region with 20% of New Mexico's current pecan production (USDA Ag Census, 2007) and is where much of the growth in the state's pecan industry is occurring.

Pecos Basin soils are alkaline and highly calcareous, typically with pH greater than 7.5 and 15-30% lime. Such soils are characterized by very poor availability for root uptake of the metal micronutrients zinc, manganese, iron, copper and nickel (Marschner, H., 1995). As such, Pecos Basin pecan orchards are far more prone to micronutrient deficiencies than orchards in other pecan production regions in New Mexico or the southeastern US. Even when regular foliar micronutrient fertilizer application programs are in place, it is common in the Pecos Basin for several different visible micronutrient deficiency symptoms to be present in a single pecan orchard block. Thus, micronutrient deficiencies due to the highly calcareous soils, represents a major limitation to profitability of pecan orchards in New Mexico's Pecos Basin.

Unlike most pecan production areas, Pecos Basin pecan orchards usually have trees exhibiting the leaf symptoms commonly associated with iron (Fe) deficiency: moderately severe to severe interveinal chlorosis. Severely symptomatic leaves are almost completely white. The symptoms are typically most severe on the leaves nearest the shoot terminal and oftentimes symptom severity varies dramatically from limb to limb within a tree canopy. Over time vegetative growth and nut yield of symptomatic trees decline and eventually branch dieback or even tree death may occur. Trees exhibiting Fe chlorosis symptoms appear to be randomly distributed throughout orchards such that symptomatic trees are often surrounded by all asymptomatic trees.

Pecos Basin pecan producers report that foliar application of ferrous sulfate fertilizer does not prevent or reverse these chlorosis symptoms. EDDHA-chelated Fe fertilizers have been demonstrated to be effective in managing Fe nutrition of some annual and perennial crops (Bañuls, et al., 2003; Gil-Ortiz and Bautista-Carrascosa, 2005; Hansen, et al., 2006; Rombolá, A.D. and M. Tagliavini, 2006) under alkaline and calcareous soil conditions. However, this has never been evaluated for mature pecan orchards. The objective of our study is to determine the efficacy of soil application of Fe-EDDHA fertilizers in reversing Fe-chlorosis symptoms of mature pecan trees growing in a calcareous Pecos Basin soil.

METHODS

The experimental site is a mature (>25 year old) commercial 'Western' (syn. 'Western Schley') pecan orchard located in the Pecos river basin northwest of Roswell, NM [33°35'N, 104°33'W; elevation 1107 m (3633 ft)] with a history of Fe chlorosis problems. Trees were grafted to seedling rootstocks. Tree rows were planted 18.3 m (60 ft) apart with trees spaced 9.1 m (30 ft) apart within rows. Soils at the site are primarily Reakor sandy loam (Ra) and Reakor loam (ReA). Soil lab analyses indicated that soils at this site had somewhat less extreme pH and lime content than for many other Pecos Basin agricultural soils: average soil pH at the orchard site was 7.4 (range 7.3-7.5) and average soil lime content was 13% (range 4-27%).

The orchard was regularly flood-irrigated from an irrigation well. Adequate macronutrient nutrition was maintained through springtime fertilizer applications broadcast on the orchard floor. Micronutrient fertilizers (including ferrous sulfate) were applied foliarly in the spring. Weed-free strips were maintained with herbicides in the tree rows. Weeds were managed between the tree rows by regular mowing. Populations of pecan aphids and pecan nut casebearer were maintained below economic thresholds using insecticides as needed.

On 9 July 2009, based on visual assessment, we selected 15 trees with Fe chlorosis symptoms and 5 apparently healthy trees for the experiment. Fe chlorosis symptom severity was quantified for each tree by measuring leaf SPAD (a chlorophyll content or "greenness" index) on representative branches with a portable SPAD 502 chlorophyll meter (Minolta Corp., Ramsey, NJ). Leaflet samples were collected and analyzed for total Fe and "active Fe" concentration.

On 6 August 2009 each of the 15 chlorotic trees was subjected to one of three Fe-EDDHA (Disolvine Q40, Akzo Nobel, Herkenbosch, the Netherlands) treatments: 1) 200 g Fe-EDDHA per tree, 2) 100 g Fe-EDDHA per tree, or 3) no Fe-EDDHA applied (untreated control). For both the Fe-EDDHA treatments orchard floor litter was raked away before the fertilizer was broadcast in a 3.7 m (12 ft) radius circle onto the soil bare soil around each tree (approximately corresponding to the area within the trees' driplines). The orchard floor litter was raked back after application. No Fe-EDDHA was applied around the healthy trees. The same Fe-EDDHA fertilizer treatments were repeated for each tree on 30 April 30 2010 and 27 May 27 2010, but the fertilizer was applied as a drench in a circle around the dripline of each treated tree rather than broadcast.

To evaluate the effects of soil Fe-EDDHA applications in alleviating the apparent Fe deficiency symptoms, SPAD readings were made on each tree 20 September 2009, 7 July 2010 and 21 September 2010. On each date for each tree an average SPAD reading of 8 leaves on representative branches was made. On 7 July 2010 leaflets were collected for leaf tissue analysis.

RESULTS AND DISCUSSION

In 2009 and 2010, no differences were evident between the response of Fe chlorotic pecan trees to the 100 g Fe-EDDHA and 200 g Fe-EDDHA treatments. The SPAD data for these two treatments were therefore pooled for regression analyses.

Figure 1 shows the relationship between leaf SPAD readings taken 16 July 2009, prior to any Fe-EDDHA fertilizer applications, and leaf SPAD readings taken on the same trees 20 September, 2009, forty five days after a single soil application of Fe-EDDHA fertilizer. If the fertilizer application had effectively lessened the severity of Fe chlorosis over this relatively short time period, the September SPAD readings of treated trees would be greater than that predicted by the regression relationship between July 2009 leaf SPAD and September 2009 leaf SPAD for untreated trees. However, the linear regression relationship between leaf SPAD readings in July 2009 and September 2009 were similar for treated and untreated trees. Thus, in 2009 the Fe chlorosis symptom severity of pecan trees treated with Fe-EDDHA fertilizer in mid-season had not improved over that of untreated trees.

Figure 2 shows the relationship between the initial SPAD readings from July 2009 and SPAD readings from the same trees in July 2010, after a total of three Fe-EDDHA fertilizer applications. By 6 July 2010, SPAD readings of about half of the treated trees had clearly improved over that predicted for untreated trees of similar 2009 symptom severity. Of those trees showing improvement, SPAD readings had increased by 5.2-14.4 over that predicted for untreated trees. The highest July 2010 leaf SPAD readings for treated trees were 35-40, still well below that of healthy trees (the average SPAD reading for healthy trees in July 2010 was 47.6). Leaf SPAD readings were higher for most of the trees (regardless of Fe-EDDHA treatment) on September 2010 than July 2010, but the general patterns were similar (data not presented).

There was no obvious relationship of soil Fe-EDDHA application (or chlorosis severity) to July leaflet tissue Fe concentration (data not presented). Nevertheless, since application of this Fe-containing fertilizer alleviated the chlorosis symptoms, the results from the current study seem to confirm that this particular chlorosis symptom in Pecos Basin pecan orchards is (at least sometimes) due to Fe deficiency. These data indicate that soil-applied Fe-EDDHA may be useful for correcting Fe chlorosis in mature pecan trees grown on alkaline and calcareous soils. In the second year of the experiment, it remains to be seen whether all of the treated chlorotic trees will eventually respond to Fe-EDDHA or how long it will take for symptoms to completely disappear on responsive trees.

SUMMARY

Fe chlorosis symptoms of mature Pecos Basin pecan trees were not affected by soil application of EDDHA-chelated Fe fertilizer in the first season of the study. However, by July 2010, after three fertilizer applications, chlorosis symptom severity of about half of the treated trees had diminished to some degree. The results indicate that soil-applied Fe-EDDHA may be useful for correcting Fe deficiency in mature pecan trees grown on alkaline and calcareous soils

REFERENCES

Bañuls, J., A. Quiñones, B. Martín, E. Primo-Millo, and F. Legaz. 2003. Effects of the frequency of iron chelate supply by fertigation on iron chlorosis in citrus. J. Pl. Nutr. 26: 1985-1996.

Gil-Ortiz, R. and I. Bautista-Carrascosa. 2005. Response of leaf parameters to soil applications of iron-EDDHA chelates in a peach orchard affected by iron chlorosis. Comm. Soil Sci. and Plant Anal.36: 1839-1849.

Hansen, N.C., B.G. Hopkins, J.W. Ellsworth, and V.D. Jolley. 2006. Iron nutrition in field crops. *In* L.L.Barton and J. Abadía (eds.) Iron nutrition in plants and rhizospheric microorganisms. Springer, Dordrecht, The Netherlands.

Marschner, H. 1995. Mineral nutrition of higher plants. Academic Press, San Diego.

Rombolá, A.D. and M. Tagliavini. 2006. Iron nutrition of fruit tree crops. *In* L.L.Barton and J. Abadía (eds.) Iron nutrition in plants and rhizospheric microorganisms. Springer, Dordrecht, the Netherlands.

USDA Ag Census. 2007. 2007 Census Report. Available at http://www.agcensus.usda.gov/Publications/2007/Full_Report/index.asp. USDA National Agricultural Statistics Service, Washington, DC.

USDA NASS. 2010. Non-citrus fruits and nuts: 2009 summary. Available at http://usda.mannlib.cornell.edu/usda/current/NoncFruiNu/ NoncFruiNu-07-07-2010.pdf. USDA National Agricultural Statistics Service, Washington, DC.

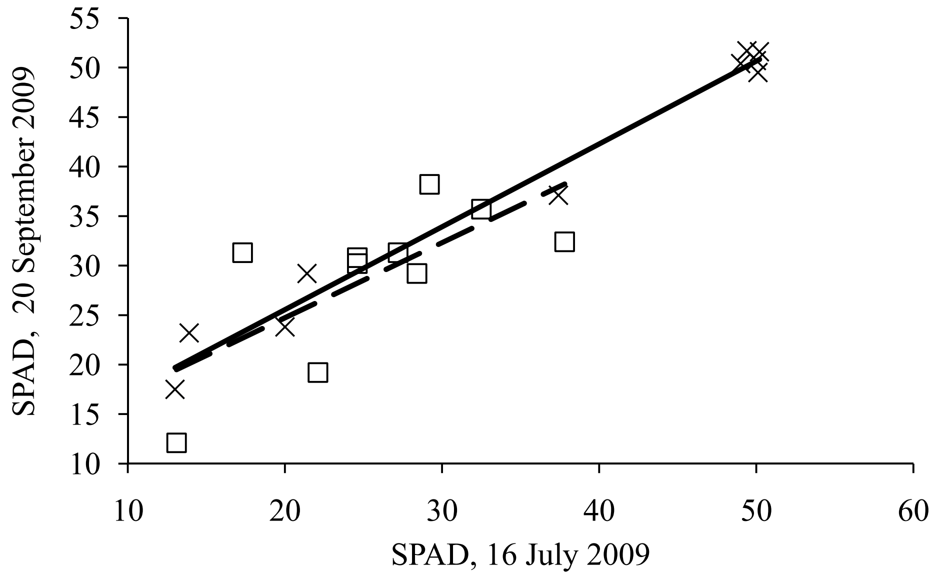

Fig. 1. Relationship between leaf SPAD readings taken July 16, 2009, prior to any Fe EDDHA fertilizer applications, and leaf SPAD readings taken on the same trees 20 September, 2009, forty five days after a single soil application of Fe-EDDHA fertilizer. Data are shown for Fe EDDHA- treated trees (open boxes and dashed trendline, $r^2 = 0.4917$) and untreated trees (X's and solid trendline, $r^2 = 0.9795$).

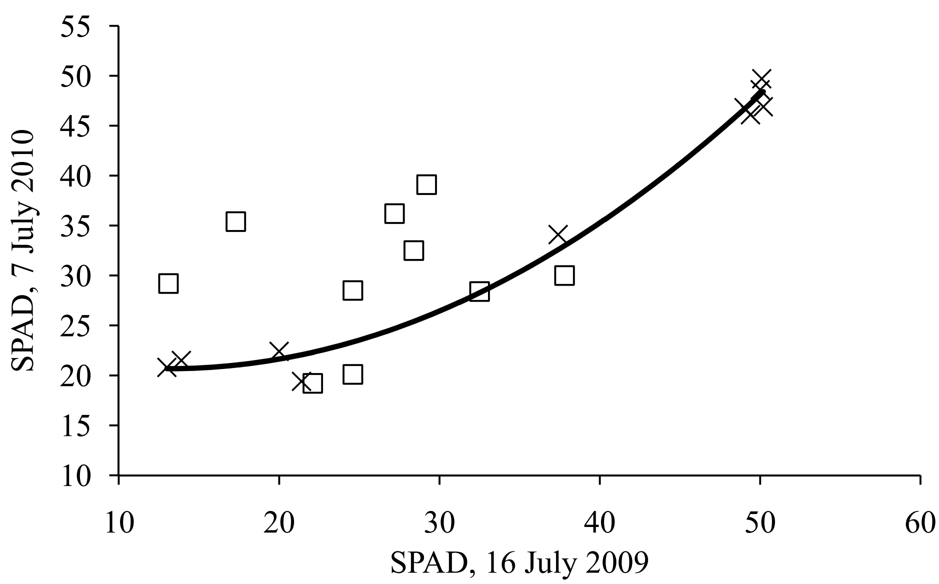

Fig. 2. Relationship between leaf SPAD readings taken July 16, 2009, prior to any Fe EDDHA fertilizer applications, and leaf SPAD readings taken on the same trees 7 July 2010, after a three soil applications of Fe-EDDHA fertilizer. Data are shown for Fe EDDHA- treated trees (open boxes) and untreated trees (X's and solid trendline, $r^2 = 0.9896$).

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