HortScience 41(1):275–276. 2006.

Fall-applied Foliar Zinc for Pecans

J.L. Walworth,[1] A.P. Pond, and G.J. Sower

Department of Soil, Water, and Environmental Science, University of Arizona, 429 Shantz Building, #38, Tucson, AZ 85721

M.W. Kilby

Department of Plant Science, University of Arizona, 303 Forbes Building, Tucson, AZ 85721

Additional index words. *Carya illinoinensis,* 'Western Schley', Zinc Sulfate, Arizona

Adequate Zn nutrition is critical for commercial pecan production. Providing sufficient Zn through soil application is particularly problematic in high pH desert soils, due to the low solubility of Zn in alkaline conditions, and also the complexation of soil Zn by carbonate minerals (Lindsay, 1979). Foliar Zn applications are more effective than soil applications and can provide adequate Zn for maximum growth and production (Malstrom et al., 1984). The most commonly used materials for this purpose are $ZnSO_4$, $Zn(NO_3)_2$, and NZn.

A typical Zn fertilization program in Arizona consists of spraying $ZnSO_4$ directly on the pecan foliage beginning at budbreak, and continuing until vegetative growth has subsided (Kilby, 1985). In total, three to five applications of 2.2 to 3.4 kg·ha^{-1} Zn are required at about 2-week intervals. Total season application is usually about 10 kg·ha^{-1} Zn. Foliar Zn fertilization programs are effective for avoiding Zn deficiency problems in southwestern pecans, however, they are expensive and time-consuming.

Received for publication 3 Aug. 2005. Accepted for publication 7 Sept. 2005.

[1]Corresponding author; e-mail walworth@ag.arizona.edu.

We investigated an alternative foliar Zn fertilization program that includes a late-season Zn application to replace some, or all, of the applications made in a typical Zn foliar fertilization program. Preliminary demonstration trials indicated that this may be an effective treatment strategy (M. Kilby, personal communication), presumably because high rates of Zn applied foliarly just as the leaves begin to senesce can be translocated into the phloem or into bud tissue and be reused the following season (Marschner, 1986). A late season Zn treatment might replace some or all of the in-season foliar sprays now employed in typical production systems.

A field study was established in an existing production orchard near Picacho, Ariz., on 25 year-old 'Western Schley' trees. The experiment was laid out as a randomized complete block with five treatments (control, fall = 5 kg·ha^{-1}, fall = 10 kg·ha^{-1}, spring = 5 kg·ha^{-1}, spring = 10 kg·ha^{-1}) and four replications. Each plot consisted of seven trees in a row, with the five middle trees being sampled and the two end trees serving as a buffer. Individual rows were about 45 m apart and trees were 9 m apart within rows. In mid-September 2002 and 2003 the single applications of either 5 kg·ha^{-1} (14 kg·ha^{-1} $Zn(SO_4)_2$) or 10 kg·ha^{-1} (28 kg·ha^{-1} $Zn(SO_4)_2$) of Zn. The following springs, the same rates of $ZnSO_4$ were applied in a five application split. Spring sprays began on 15 Apr. 2003 and 8 Apr. 2004 and were repeated every 14 d. All Zn sprays were applied in 468 L·ha^{-1} H_2O, and contained 1.75 L·ha^{-1} UAN as an adjuvant.

In February 2003 and 2004, samples of the previous season's growth were collected by removing the end 15 cm from four branches per tree. The branches were then washed in a mild detergent, rinsed three times in deionized water followed by a rinsing in ultra pure water, and dried. The buds were then removed from the wood and each was ground separately. Leaf samples, consisting of 30 middle leaflets from middle leaves on lower fruiting branches, were collected every 2 weeks beginning in early May 2003 and 2004. Samples were immediately refrigerated, washed in the same manner as the branch samples, dried and ground. All tissue samples were dry-ashed, dissolved in 2 M HCl, and analyzed for Zn content on a Spectro Modula M120 ICP. Leaf area was measured on the samples taken at the end of July of both years using the digital imaging analysis method of O'Neal et al. (2002).

Analyses of bud and twig samples indicate that fall applications did elevate Zn in those tissues (Table 1). However leaf samples collected during the growing season did not follow this pattern (Table 2). In all cases, the trees receiving Spring Zn applications contained significantly more Zn than those receiving Zn the previous fall. Zinc concentrations in trees receiving fall applied Zn were similar to the control. Even though fall Zn applications did increase Zn in bud and twig tissues, there did not appear to be an effect on leaf Zn concentrations the next growing season. Surprisingly, Zn concentrations in all leaf samples increased rapidly after the 25 June 2003 sampling date. This was unexpected, and has not happened in other pecan trees we have monitored through the growing season. The reason for this is unknown.

Leaf areas, measured in late July, reflect the Zn status of the leaves collected at that time (Table 3). Leaf area was related to leaf Zn concentration by the following equation: area (cm^2) = 0.0321 × Zn (µg·g^{-1}) + 19.712 (r^2 = 0.662). Trees receiving the Spring 10 treatment had larger leaves than the control and fall treat-

Table 1. Zinc concentrations (µg·g^{-1}) in pecan bud and twig tissue from trees treated with different rates and timings of foliar Zn application.

Application	Zn rate	2003		2004	
time	(kg·ha^{-1})	Bud Zn	Twig Zn	Bud Zn	Twig Zn
None	0	64 c[z]	22 c	92 c	30 d
Fall	14	128 b	37 b	173 b	75 b
Fall	28	150 a	53 a	275 a	117 a
Spring	14	63 c	21 c	150 bc	52 c
Spring	28	64 c	21 c	205 b	67 bc

[z]Means in each column followed by the same letters are not significantly different at the 5% level.

Table 2. Zinc concentrations (µg·g^{-1}) in pecan leaf tissue from trees treated with different rates and timings of foliar Zn application.

Application time	Zn rate kg·ha^{-1}	Date						
2003		15 May	29 May	12 June	25 June	9 July	24 July	6 Aug.
None	0	31 c[z]	25 c	22 c	21 c	94 c	84 c	66 c
Fall	14	37 c	31 c	24 c	27 c	96 c	87 c	71 c
Fall	28	32 c	26 c	23 c	24 c	87 c	94 c	71 c
Spring	14	62 b	63 b	76 b	83 b	149 b	185 b	173 c
Spring	28	105 a	91 a	107 a	145 a	286 a	328 a	297 a
2004		6 May	23 May	4 June	18 June	2 July	20 July	30 July
None	0	17 b	12 cd	12 b	29 c	38 c	35 c	34 c
Fall	5	22 b	31 cb	19 b	27 c	50 c	53 c	40 c
Fall	10	21 b	10 d	10 b	31 c	37 c	49 c	34 C
Spring	5	52 a	50 ab	80 a	88 b	104 b	128 b	112 b
Spring	10	71 a	68 a	85 a	133 a	137 a	165 a	177 a

[z]Means in each column for a given year followed by the same letters are not significantly different at the 5% level.

Table 3. Area of leaves collected in July from pecan trees treated with different rates and timings of foliar Zn application.

Application time	Zn rate ($kg\cdot ha^{-1}$)	Leaf area (cm^2/leaf)	
		2003	2004
None	0	24.7 bc[z]	20.1 a
Fall	14	22.8 c	20.5 a
Fall	28	24.4 bc	19.1 a
Spring	14	27.8 ab	21.8 a
Spring	28	28.1 a	23.5 a

[z]Means in each column followed by the same letters are not significantly different at the 5% level.

ments in 2003 but were not different from the spring 5 $kg\cdot ha^{-1}$ treatment. In 2004, there were no significant differences in leaf area.

The fall applied Zn applications tested in this study were ineffective. Although Zn applied at the end of the season did affect Zn concentrations in dormant season tissues, it had no effect on subsequent leaf Zn concentrations. Spring Zn applications increased both leaf tissue Zn concentrations and leaf area. The currently used commercial application level (about 28 $kg\cdot ha^{-1}$ $ZnSO_4$) provided only marginal improvement over a lower rate of Zn. However, the higher rate of Zn application is not detrimental to pecan trees, and considering the relatively low cost of $ZnSO_4$, 28 $kg\cdot ha^{-1}$ is a prudent and reasonable application rate. Fall applications of Zn or rates below 28 $kg\cdot ha^{-1}$ are not recommended based on this research.

Literature Cited

Kilby, M.W. 1985. Zinc nutrition of pecan trees in Arizona, p. 9–19. Proceedings of the Western Pecan Conference, March 1985, Las Cruces, N.M.

Lindsay, W.L. 1979. Chemical equilibria in soils. The Blackburn Press, Caldwell, N.J.

Malstrom, H.L., L.B. Fenn, and T.R. Riley. 1984. Methods of zinc fertilization. Pecan South 11(3):16–19.

Marschner, H. 1986. Long-distance transport in the xylem and phloem and its regulation p. 71-102. In: Mineral nutrition in higher plants. Academic Press, New York.

O'Neal, M. E., D.A. Landis, and R. Isaacs. 2002. An inexpensive, accurate method for measuring leaf area and defoliation through digital image analysis. J. Econ. Entomol. 95:1190–1194.