Zinc and Sulfur Content in Pecan Leaflets as Affected by Application of Sulfur and Zinc to Calcareous Soils1

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Abstract. Five rates of ZnSO₄ and 3 rates of S were applied in March 1966 in a single application to pecan trees (Carya illinoensis (Wang) K. Koch) in a factorial experiment. A rate of ZnSO₄ in excess of about 20 kg/tree was required to reach June 1966 leaflet Zn concentration in excess of 60 ppm. No 1966 treatment resulted in leaflet Zn concentration in excess of 60 ppm in June 1967 or 1968. Significant Zn and S interaction was detected in September 1966 and 1967 leaflet Zn concentrations. There was a direct relationship between application rates of ZnSO₄ and S on leaflet Zn concentration in September 1966 and 1967.

Six-year-old ‘Western’ trees (no visual Zn deficiency symptoms) growing in a deep Tivoli sand (mixed thermic, Typic ustipsamments) in Dawson County, Texas (south plains) were used. Pecan growers have observed that ‘Western’ pecan trees do not display Zn deficiency rosette symptoms as readily as other cultivars, even though leaflet Zn concentration is less than 60 ppm. Single treatments (0, 1.4, 6.4, 12.7, and 31.8 kg/tree ZnSO₄ and 0, 4.5, 11.4 kg/tree S) were applied in a complete factorial arrangement in a completely randomized design with 4 trees per treatment (1 tree experimental unit). The single soil application treatments were broadcast in March 1966 to the soil in the outer one-third of the limb spread and incorporated to a depth of 15 cm. The soil moisture was maintained near field capacity by flood irrigation in which large basins around each tree were filled with water. The treated area was within this basin.

Leaflets were collected in June and September 1966 and 1967 and in June 1968. The leaflets were prepared and analyzed by atomic absorption spectroscopy according to the method of Smith and Storey (6, 7). All data were analyzed utilizing multiple regression computer program. Graphs shown in Figs. 1 and 2 were generated from results of the statistical analysis. Those graphs having 3 lines indicate significant interaction between Zn and S while those graphs with single lines indicate no significant S effect or Zn-S interaction.

Sulfur had no effect on leaflet Zn concentration of the June leaflets (Fig. 1). Leaflet Zn concentration was more than 60 ppm in June 1966 when ZnSO₄ was applied at the rate of 31.8 kg/tree (Fig. 1). Zinc sulfate applied at the rate of 21 kg/tree might also have increased leaflet Zn concentration of 60 or more ppm in June 1966. Although increasing the rate of ZnSO₄

Literature Cited


Zinc deficiency of pecan trees is characterized by small leaves or rosettes at the shoot terminals (1). Soil applications of Zn salts are complexed and unavailable to cotton roots (4). The ZnSO₄ reacts with CaCO₃, CO₃ ions, and other anions prevalent in high pH soils to form water-insoluble Zn salts, or some other unknown complex form of Zn(CO₃)₂ (3, 4, 5). Sulfur forms H₂SO₄ in the soil, which reduces pH and increases the availability of the soil Zn by changing the form of the competing ions present (2). Because soil Zn is unavailable to plants growing in calcareous soils, pecan growers must resort to Zn sprays for Zn-deficiency prevention (1). High winds and low humidity in the western pecan-growing areas make foliar Zn applications more difficult and less effective. If soil applied Zn could be made available to pecan roots, application of Zn would be a simple and economical system for growers.

The objectives of this experiment were to determine: 1) if soil-applied ZnSO₄ would increase the Zn content of the entire tree as indexed by measuring the leaflet Zn concentration; 2) if soil-applied S would increase the availability of soil-applied Zn as indexed by measuring the leaflet Zn concentration; 3) if combinations of soil-applied ZnSO₄ and S would result in increased leaflet Zn concentration.

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increased leaflet Zn concentration, no 
ZnSO₄ treatment resulted in leaflet 
Zn concentration of 60 or more ppm in 
June 1967 and 1968 (Fig. 1).

Addition of S increased leaflet Zn 
concentration in September 1966 leaf­
lets if more than 7 kg/tree was applied. 
However, about 20 kg/tree ZnSO₄ 
was required for leaflet Zn concen­
tration to reach 60 ppm. The amount of 
ZnSO₄ required to reach 60 ppm was 
reduced to 16.2 and 18.8 kg/tree when 
June 1967 and 1968 (Fig. 1).

Foliar application of ZnS0₄ was applied in March 1966 at 
rates greater than 4.8 kg/tree (Fig. 2). 
However, S and ZnSO₄ treatments 
were inversely related to leaflet Zn 
concentration. At any given rate (above 
1.4 kg/tree) of ZnSO₄, leaflet Zn 
concentration was reduced due to the 
addition of S (Fig. 2). 

The difference in the September 
1966 and 1967 leaflet Zn concen­
tration as influenced by S might be explained 
by an initial positive influence of S on 
Zn availability that was exhausted 
before September of the second year 
after application. 

This study indicates leaflet Zn of 
pecan trees in calcareous soils can be 
increased by soil applications of ZnSO₄, 
but a larger increase occurred when S 
was applied in conjunction with ZnSO₄. 
Foliar application of Zn is the best 
method of increasing and maintaining 
pecan leaflet Zn concentration (8). 

**Literature Cited**


**Nitrogen Fertilization Increases Yield without Enhancing Blossom Receptivity in Almond¹**

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**Abstract.** Ground application of urea increased yields of 'Nonpareil' almond (Prunus amygdalus Batsch) by increasing the number of flowers per tree rather than by increasing blossom receptivity and percentage fruit-set. Hand pollination of flowers on caged limbs indicated that blossom receptivity declined between 3 and 6 days after anthesis.

All commercial almond cultivars are self-sterile and require (insect-mediated) cross-pollination to produce a crop. Fertilization of the egg is essential because the edible part of the almond is the seed. Because the almond blooms during February and early March, weather is often unfavorable during anthesis, interfering with pollination and/or fertilization. At temperatures below 13°C honeybees are inactive and low temperatures slow the growth of pollen tubes (6). Ovules remain viable for only short periods after anthesis. Even if stigmas are receptive at pollination, fertilization is not assured, as 4 to 5 days are typically required for the pollen tube to traverse the style under field conditions (2). Fertilization and fruit-set cannot occur if the ovule senesces before the pollen tube arrives.

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