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Ineffectiveness of Foliar Application and Pressure Trunk Injection of Mg-N Formulation for Correction of Mg Deficiency of Pecan[1]

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Abstract. **An Mg-N formulation (RES-20482) used as a 0.25 or 0.50% spray solution or when trunk injected at 5 ml/2.54 cm of trunk circumference did not significantly increase leaf Mg of pecan (*Carya illinoensis* (Wang.) K. Koch).**

A previous study showed that Mg deficiency in pecan was difficult to correct rapidly; foliar sprays were ineffective at the rates used (8). Recently a formulation of zinc and nitrogen has greatly increased uptake of zinc by pecan leaves (5) and resulted in the marketing of a material called NZN, a nitrogen-zinc nitrate solution (2). A nitrogen-magnesium nitrate solution (16-0-0-4 Mg) RES-20482[3], utilizing a similar formulation is the subject of this paper.

The first objective was to determine concentrations of RES-20482 that could be safely sprayed or injected. This was accomplished for sprays by dipping intact pecan leaves on small branches in solutions of decreasing concentrations of RES-20482 beginning with full strength solutions. Solutions of 2% or stronger burned the leaf tissue when applied on April 16. No ncecrosis was observed when a 1% solution was used. The main area of necrosis was along the leaflet margins where the solution had drained and dried. Leaflet distortion was observed when 8 liters of 12.5% (by volume) solution per tree was injected into the tree trunk. Concentrations selected for field tests then were lower than the above.

Concentrations of 0.25 and 0.50% RES-20482 were applied to runoff at Tifton and Blackshear on May 13 and May 17, respectively, utilizing an air blast sprayer. Two additional treatments included a second application 2 weeks later. These treatments were compared with an application of a $MgSO_4$ spray supplying the same rate of Mg as the 0.50% RES-20482 solution. The injection treatment was 5 ml of RES-20482/2.54 cm of trunk circumference (breast height) diluted in 8 liters of water/tree as described previously (9). The trees were injected on the same dates as the first spray application. All treatments were compared with an unsprayed control. The design was randomized complete block with 4 replications at each location.

Pretreatment leaflet samples were collected on the same date as the first spray application to be used later as a covariate in an analysis of covariance. Leaflet samples were collected on July 28 (Tifton) and July 30 (Blackshear) by collecting about 50 leaflets/tree from middle leaves of terminal shoots around the periphery of the canopy, as instructed by the guidelines for collecting pecan leaves used by the University of Georgia Soil Testing and Plant Analysis Laboratory. Leaflets were washed sequentially in detergent solution (Alconox), tapwater, 1% HCl, and 3 separate distilled H_2O baths, then drained and dried overnight at 70°C. They were ground to pass a 20 mesh sieve and duplicate samples were dry ashed at 450°C and analyzed for Mg by atomic absorption Spectroscopy. The correlation coefficient between duplicate samples was 0.986. A duplicate sample was analyzed by emission spectroscopy (3). Correlation coefficients between the 2 kinds of analysis was 0.91. The data presented is the atomic absorption analysis. Trees were rated for vigor and color at Blackshear on September 8. Data were analyzed by SAS analysis of variance and general linear models procedures (1) and by Duncan's multiple range test.

Trees were recovering from a severe Mg deficient condition; therefore, most of them were low in Mg. The control in the Tifton study was low in leaf Mg compared with most of the other treatments, but none of the treatments caused a significant increase in leaflet Mg concentration over the control (Table 1), and none of the treatments brought the mean leaflet Mg concentration up to the accepted optimum range of 0.30-0.60% (7). Pecan trees naturally vary greatly in leaflet concentration from tree to tree; therefore, data were adjusted to the same pretreatment level by use of covariance but the conclusions remained the same. Data from the atomic absorption analysis, the emission spectrograph analysis and an analysis from a commercial laboratory all gave similar conclusions. No changes in the conclusion were attained when results from the 2 locations were combined to give 8 replications or when testing the control vs. sprays. No differences between treatments were detected for tree vigor, color, or Mg deficiency symptoms.

In this study and in the previous study (8), there was little or no response to foliar applied Mg under the conditions used. Leaves were almost full grown in mid-May when the treatments were applied, and younger leaves might have been more efficient. The RES-20482 was also applied at low rates in order to prevent leaf burn. If concentrations of the spray residue at the leaflet margins could be avoided, then more concentrated solutions could be

Table 1. Effect of foliar sprays and pressure trunk injection of Mg on leaf Mg of pecan trees.

Treatment	No. applications	Leaf Mg^z Tifton	Leaf Mg^z Blackshear
1. Control	–	0.16^y	0.19
2. RES-20482 0.25%	1	0.20	0.14
3. RES-20482 0.50%	1	0.25	0.19
4. Magnesium sulfate Equivalent Mg as 3 above	1	0.23	0.15
5. RES-20482 0.25%	2	0.17	0.18
6. RES-20482 0.59%	2	0.22	0.12
7. Magnesium sulfate Equivalent Mg as 3 above	2	0.14	0.11
8. Trunk injection 5 ml RES-20482 per 2.54 cm trunk circumference	1	0.24	0.11

^{z}Treatment differences were not significant at 5% level of Duncan's Multiple Range Test.
^{y}Any values <0.30% are considered commercially unacceptable.

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[3] Specifications for RES-20482 supplied by Allied Chemical Co., are: Nitrate N(7.4%), ammoniacal N(2.8%), Organic N, Urea (5.8%), and Mg (0.4%). The trade name is NMg. Financial support and the RES-20482 were supplied by Allied Chemical Co. Supported by State and Hatch funds allocated to the Georgia Agricultural Experiment Stations.

used without burn. When spray must be blown through low canopy foliage to reach upper canopy foliage, however, the low canopy foliage often receives excessive amounts of the spray ingredients. It also appears that it might be difficult to apply macronutrients in sufficient quantities to cause significant increases in leaf concentration by trunk injection without causing leaf damage. More work is required to find suitable combinations of anions and cations at suitable concentrations for rapid correction of Mg deficiency by trunk injection. The latter method of application of micronutrients and pesticides has been successful (6, 7) and is now being used commercially on 250,000 pear trees in California (4) for control of pear decline.

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Tree Implanted Zinc-bentonite Paste as a Source of Slow-release Zinc for 'Delmas' Pecan[1]

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Abstract. **Zinc was supplied to trees of 'Delmas' pecan (*Carya illinoensis* (Wang. K. Koch) by means of Zn saturated bentonite paste implanted into the limbs. Five treatments, 0, 56, 107, 133 and 213 mg Zn per limb in the form of Zn-bentonite paste were applied to 5 years-old trees in a commercial plantation at the beginning of the growing season. Almost all the Zn was released during growth into the transpiration stream and increased the Zn-leaf concentration. No visual damage in treated limbs was caused by implantation *per se,* although the highest rate of Zn reduced leaf growth somewhat. The optimal dose of Zn was 107 mg/limb equivalent to only about 2-3% of the Zn usually supplied by commercial spraying.**

Extreme Zn deficiency in pecan causes the symptomatic "rosette" development of twigs and reduces nut yield. Therefore, the addition of Zn is an essential part of the economical pecan growing process in many areas (3, 4, 11, 12). However, in plantations grown in calcareous soils, zinc deficiencies are quite difficult to correct. The customary method in Israel is to apply 3 to 5 foliar sprays early in the spring growth season (April-May), generally using a mixture of 0.5% $ZnSO_4$ and 0.5% urea. Use of other forms of Zn, such as chelates (6), is very limited for economic reasons. Spray application to fully developed pecan trees is time consuming and expensive. Moreover, zinc uptake from foliar spray is sometimes erratic and considerable differences in Zn-leaf concentration between treated trees, are found (10).

Trunk injection has been attempted as a means to supply nutrient elements to various trees. Phosphorus has been injected into pecans (5), iron into avocado (8) and zinc into apple (7) and pecan (13). In all these cases, aqueous solutions of the element(s) were pressure-injected into the trunk or limb(s) of trees. Advantages of an effective direct injection system of nutrients to trees are numerous (13) and include biological, technical and economic benefits: a) Movement of added elements in the tree is rapid and deficiencies are quickly corrected, b) quantities used are small compared with foliar or soil applications, thus reducing cost and minimizing air, soil and crop pollution hazards and c) equipment operation costs are relatively low. However, there are some disadvantages to the solution injection method, mainly due to a rapid rise in the concentration of the element injected in the leaves. Localized and temporarily high concentrations of the injected element may cause tissue damage due to either osmotic effects or specificity effects or both. Use of low solution concentration necessitates either long injection periods or frequent injections.

An ideal micronutrient supply system would be a concentrate of the nutrient element maintained at a "slowly available" state, placed in the trunk or limb and slowly released into the transpiration stream of the tree. A novel, recently developed fertilizer carrier for micronutrients, metal-bentonite (1), might be such a source of slow release micronutrients. Previous experiments with metal-bentonite (2, 9) showed that in soil applications to annual plants, was more effective than salts and slightly less effective than chelates in supplying Zn to tomato and bean plants. The present study reports some preliminary but promising results on the use of slow release bentonite-adsorbed zinc for limb and trunk implantation into young pecan trees.

Young (5-years-old) 'Delmas' pecan trees in a commercial plantation, Kibbutz Shoval, Beersheva region, Israel, were used for this study. The soil is aeolian in origin and of loamy to silty loam texture containing 16 to 22% $CaCO_3$; and the pH of the saturated soil paste is 7.2 to 7.9.

Zinc-bentonite paste used as Zn-carrier was prepared by the "quantitative ion exchange method" (1), the clay concentration in the paste was 39.5% and it contained 8.4 mg Zn/g paste, of which 5.5% and 93.8% were in soluble and exchangeable forms, respectively. Ten trees were used for the experiment. Each treatment was applied to 2 similar (15-20 cm in circumference) limbs in each of 2 trees, giving 4 replications. In the base of each treated limb, 2 to 5 holes, with diameters of 1.2 or 1.9 cm were drilled, containing either 3 or 6 cm^3 of paste,

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