FOLIAR BORON APPLICATION TO DECREASE PFA, INCREASE FRUIT SET AND YIELDS IN WALNUT.

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SUMMARY:

In 1996-7, we reported that foliar B application reduced pistillate flower abortion (PFA) of several walnut cultivars at five sites in California. This year, four walnut field sites were chosen for a more extensive evaluation of the effects of foliar applied B on PFA in walnut. Sites were chosen by UC farm extensionists Steve Sibbett (Visalia), Lonnie Hendricks and Kathy Kelley (Modesto), and Joe Grant (Ripon). Boron was applied at a rate of 3 lbs solubor per 100 gallons of water per acre at either (1) early catkin stage (catkins around 1 inch in length; sprayed mid-March); (2) two weeks after nut set; (3) early catkin and two weeks after nut set. A control was applied by omitting B from the spray solution. Treatments were replicated six times.

Results indicate a foliar application of B to walnut trees had little to no effect on reducing the incidence of PFA in walnut (Table 1). The field experiment at Visalia exhibited no PFA and therefore results from this site are not presented. PFA was most prevalent in Modesto, at the property of W and J Hack, with PFA reported at around 58%. It was also at this site that a foliar application of B sprayed two weeks after nut set reduced PFA by around 8% and increased yield by 20% (P > 0.15). At sites where PFA were not as severe, the application of B had no effect on reducing PFA. The results therefore indicate that the effect of B on PFA is variable and is strongly affected by prevailing weather conditions. Further research is required to verify the role of B in fruit set in Walnut.

BACKGROUND INFORMATION

Pistillate flower abortion (PFA) is a widespread problem facing walnut growers in California. Over the past 20 to 30 years PFA has contributed to reduced walnut yields and while considerable research effort has tried to identify the reasons for this phenomena, to date, scientific evidence is limited to explain why PFA occurs.

Recent evidence by our group supports a role for boron (B) in mitigating PFA. In Almond and Pistachio in California, and Apples and Pears in Oregon and Washington it has been demonstrated that foliar B application can increase fruit set and yields in orchards with apparent B deficiency and in orchards with no apparent B deficiency. The mechanism by which this occurs in unknown but may relate to the occurrence of a short-term B deficiency at the time of flower production or a localized deficiency of B in the rapidly growing fruit. Preliminary results definitively show that Walnut also responds favorably to foliar B application. This will be discussed below.
Many California orchards in the upper Sacramento valley (north of Yolo County to Chico) and eastern regions of the San Joaquin valley (from Modesto to Fresno) occupy soils low in B which may cause incipient B deficiency in sensitive tree crop species and cultivars. Although very little information regarding the B nutritional demand of walnut is available, Shear and Faust (1980) reported leaf critical values in the range of less than 25 ppm to be deficient, 25-200 ppm to be adequate and more than 300 ppm to be excess. The critical values in the adequate range appear to be too wide to be meaningful and tend to be higher than the respective values of 30-85 ppm reported adequate for almonds or 20-60 ppm for apples and pears. These critical values have to be interpreted with caution because they have been determined from visual symptoms and not on yield responses.

In walnuts, gross vegetative B deficiency is characterized by stunted, bushy stature of the trees due to inhibited internode growth, leaves may be small, chlorotic and misshapen. In severe cases, terminal die back may occur. There have been no reports of the specific B requirements of walnut during reproductive growth or yield. However, in other crops, the flowering process have been found to have a higher demand for boron than does the vegetative growth. Boron deficiency in many crops results in premature flower and fruitlet drop and reduced yield, a phenomenon well known in walnuts but whose cause has not yet been established.

Results of 1996-7 Experiments:

In 1996 and 1997 we established small scale test plots to determine the effect of foliar B on Walnut productivity. Both years confirm that B plays a very important role in walnut flowering, PFA, fruit set and yield.

1996 Summary: Statistically significant increase in fruit set and yield where observed. These increases where directly related to increases in tissue B levels.

1997: Trails were established in Modesto, Tehama and Tulare counties. The trial at Modesto was abandoned due to errors in application and assessment.

Tehama County: Details are provided in the Walnut Research Report for 1997. Applications of B to Serr and Chandler were made at four rates at either one inch Catkin (first spray), or 5% pistillate receptivity (second spray), in a well replicated trial. PFA and fruit set were determined in both cultivars.

Results (See details 1997 report): In Serr, PFA was reduced from 40% flower loss (60% retained) to 8% flower loss (92% retained) following application of 2 or 3 lbs Solubor. Either spray time was equally effective, this effect was statistically significant at the P > .01%. Final nut set was increased by the first but not the second B application date. Optimum response was observed at the 2-3 lb solubor rate.
In Chandler, very little PFA was observed in either treatment. There was a trend toward decreased PFA in trees receiving the first B application. Nut set in Chandler was significantly increased by B applications. Increases of 18 and 15%, respectively were obtained in trees receiving 2-3 lbs B at either first or second spray date.

Tulare County: Details are provided in the research report and the attached table. Applications of one rate of B (3 lbs solubor/100 galls) were made at a single date (bud break) to 7 cultivars growing at three sites. This was a non replicated trial with five trees per treatment at each site. PFA and % drop are shown.

Results of 1997 Studies: The effect of B on reducing PFA at all sites and in all cultivars measured was remarkable. PFA was almost completely eliminated in all cultivars. Even with the very small replication, used here, these results were statistically significant. Nut drop in all cultivars except Chandler followed a similar trend with a 5 to 10 fold reduction in nut drop as a result of B application. Again these results are highly statistically significant. Yield analysis was not conducted in Tehema. Yield analysis showed no significant effect of B sprays at the Tulare site. We (Steve Sibbett and myself) found this most surprising and inconsistent with PFA and nut drop data, we suggest that some other biological or human factor may have resulted in significant yield loss between second set (July) and harvest.

Overall Conclusions and Justification: Foliar B application dramatically increased fruit set and retention, and eliminated PFA. These results are statistically significant and occur to varying degrees in all six cultivars tested, in both years and at five separate sites.

Based on 1996/7 results the following objectives were proposed for 1998:

LONG-TERM OBJECTIVES

To establish the B requirement of walnuts and determine the relative benefits of foliar B application.

SHORT-TERM OBJECTIVES

1. To investigate the effect of foliar B application on tissue B concentration, fruit set and yield.
2. To determine sampling protocol for boron diagnostic surveys in walnuts.

EXPERIMENTAL PROCEDURES

The experiments were conducted at four field sites (Visalia, Ripon and two sites near Modesto) and designed on a randomized complete block design with B applied at a rate of 3 lbs solubor per 100 gallons of water per acre at either (1) early catkin stage (catkins around 1 inch in length; sprayed mid-March); (2) two weeks after nut set; (3) early catkin and two weeks after nut set. A control was applied by omitting B from the spray solution. Treatments were replicated six times.
Prior to foliar B application when walnut flowers were just visible, 20 nut doublets (40 nuts in total) were selected on each tree, and tagged with 'jewelers' tags for ease of identification. These 20 nut doublets were counted mid-March and June for the incidence of PFA.

RESULTS

Foliar application of B had minimal effect on the incidence of PFA or on nut set at the four walnut trial sites (Table 1). At Visalia, no PFA was observed at the first sampling date, mid-May. PFA was observed at all other field sites with its incidence greatest at the property of W & J Hack, Modesto. At this same site, a foliar application of B two weeks after nut set reduced PFA by around 8 % and improved nut set by 20% (P > 0.15). PFA at other sites was not reduced by the application of B.

Table 1. The Effect of Foliar Boron (B) Fertilization on Nut Set in Field Grown Walnut.

<table>
<thead>
<tr>
<th>Foliar B Tmt</th>
<th>Experiment Location</th>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Modesto (Hack)</td>
<td>Modesto (Jackson)</td>
<td>Ripon</td>
<td></td>
</tr>
<tr>
<td>Nut Set (%)</td>
<td>PFA (%)</td>
<td>Nut Set (%)</td>
<td>PFA (%)</td>
<td>Nut Set (%)</td>
</tr>
<tr>
<td>Control (No B Spray)</td>
<td>42 ± 3</td>
<td>58 ± 3</td>
<td>74 ± 3</td>
<td>26 ± 4</td>
</tr>
<tr>
<td>Early Catkinx</td>
<td>42 ± 4</td>
<td>58 ± 4</td>
<td>62 ± 3</td>
<td>38 ± 3</td>
</tr>
<tr>
<td>2 Weeks After Nut Setx</td>
<td>51 ± 5</td>
<td>50 ± 5</td>
<td>72 ± 3</td>
<td>28 ± 3</td>
</tr>
<tr>
<td>Early Catkin + 2 Weeks After Nut Setx</td>
<td>-</td>
<td>-</td>
<td>71 ± 3</td>
<td>29 ± 3</td>
</tr>
</tbody>
</table>

x Foliar B treatment: 3 lb Solubor acre¹

DISCUSSION

In contrast to results observed in 1996 and 1997 there was no clear positive response to B applications at three sites and only a modest response at one site in 1998. It is unclear why this occurred however in many regards it reflects the nature of B responses seen in other species. Possible reasons for the lack of response in 1998 are:

- B Primarily affects PFA and there was little or no PFA in 1998.
- The unusual weather conditions of 1998 (El Ninó) prevented the occurrence of B. deficiency by providing conditions that ensured optimal B movement to the developing flowers.
- B deficiency was not present in any orchard examined in 1998.
We suspect that either of the first two factors may have played a critical role in the observed lack of response. It is also apparent from extensive research by us with other crops and those reported in the literature, that B deficiency is highly dependent on the environment and that it does not occur to equal degrees in all years. Recent laboratory based fundamental research conducted by our group suggests that reproductive B deficiency occurs when B demand by the flowers exceeds B supply from storage or new uptake. Both the supply and the demand for B are determined by the temperature and environmental conditions prevalent at flowering.

The principle aim of this years field evaluation was to determine the effect of foliar B application on the incidence of PFA in walnut. This work would corroborate, or otherwise, previous field evaluation where the application of B was shown to reduce the incidence of PFA in walnut at Visalia. Clearly from the results presented in Table 1, foliar application of B had a minimal effect on reducing PFA and had a slight effect at Modesto. The small reduction in PFA at one of the Modesto field sites with the application of B, does indicate that B deficiency will increase the incidence of PFA as reported in 1996 and 1997.

In summary, the effect of B on PFA and Nut Set is still unclear. B certainly affected PFA in 1996 and 1997 but had very little effect in 1998. The reasons for this are unknown. Regardless, of the role of B in the PFA and nut set process it remains true that we do not know enough about the flowering process in walnut to explain the tremendous seasonal variability in yield that occurs. Flowering and nut set are the most important factors in determining yield, results in 1996 and 1997 suggest that B deficiency can be an important contributing factor. Boron, however, is not effective in every year at every site. Clearly a better analysis of the factors that determine nut set is of primary importance to nut crop production.