REFINING ETHOPEHON USE IN WALNUTS

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ABSTRACT

To eliminate the use of pruning towers or cumbersome poles recommended for uniform packing tissue brown (PTB) sampling, a study was initiated during the 1998 season in two mature Serr orchards to determine where in the walnut canopy PTB occurs last. A dense, 30' x 30' well irrigated orchard with a completely shaded floor was compared to another equally well managed but spaced 40' x 40' with abundant light exposure to all sides of the trees. Results indicate PTB develops more uniformly within canopies without light limitations. Complete PTB occurred last in the bottom third of the canopy in both orchards. An additional ten days elapsed in the shaded orchard before 95% percent PTB was attained in the bottom canopy. PTB is first completed in the uppermost portion of the canopy.

After two years, a harvest timing study conducted in a 40' tall, dense Serr orchard treated with ethephon at PTB indicates small but significant improvements in removal and hullability compared to untreated trees in a randomized complete block experimental design. Harvest data collected 14, 17, 20 and 23 days after treatment (DAT) indicates acceptable harvest 17 DAT. Nut removal between treated and untreated trees was no different after 23 DAT; percent sticktights remained significantly less in the treated trees. Even though application was performed at night with a turbo-charged, engine driven sprayer (FMC 757) at 1.75 mph and 200 gpa, coverage is still suspect for the limited ethephon response in this trial because of the tree height and canopy density.

BACKGROUND

Walnuts are mature and of optimum quality once the packing tissue surrounding the kernel turns completely brown. However, harvest often does not commence for 30 or more days after packing tissue brown (PTB) because of insufficient nut removal and difficulty in separating the fleshy green hull from the shell. Growers initiate harvest when 80% nut removal and 90% hullability is estimated. Delaying harvest further for improved removal and hullability can, depending upon the year, significantly reduce walnut quality and income due to insect damage and darker kernel color.

Significant economic losses still frequently occur in walnut from dark kernels and navel orangeworm (NOW) insect damage due to excessive delays in harvest timing. Reasons for delayed harvest include equipment availability, grower uncertainty about crop maturity and their lack of awareness about the quality losses. To mitigate the impact, some growers use organophosphate insecticides 14 to 21 days prior to harvest to reduce potential insect damage. Reducing organophosphate use in walnuts is a major concern to the industry since many orchards now border urban areas and the large speed sprayers used for application create the potential for off-site drift onto surface waters.
Ethephon, an ethylene-generating plant growth regulator, has been demonstrated over numerous projects and years as an effective tool for advancing harvestability and hullability when properly applied at packing tissue brown or ten days before normal harvest timing. However, most of this research has been performed as single-tree experiments using handgun applications. Larger scale, speed sprayer studies have been conducted but on older varieties such as Hartley, Franquette, Gustine and Marchetti. Literature review has not yet revealed extensive study of ethephon on Serr, California’s third most important cultivar, using commercial application methods.

Serr is the most important early cultivar in the southern San Joaquin Valley because it is typically harvested first; hence, its quality influences the seasonal attitude of growers and walnut marketers. Although high in edible yield, Serr’s overall quality is easily affected by rapid loss in kernel color from excessive heat and harvest delays. It is also susceptible to insect damage since its maturity date coincides with peak egg laying of the third generation of NOW. Advancing Serr harvest minimizes many of these quality issues and allows for greater processor efficiency by initiating dehydrating and delivery earlier in the season. For these reasons, the industry is interested in using ethephon to harvest Serr as promptly as possible to optimize early season quality.

Growers report difficulty in duplicating the ethephon research results in Serr orchards. It is believed this is due partly to the large, dense canopies found in many mature orchards which present a coverage challenge. Shaking the Serr walnut from the tree is also harder than other cultivars such as Hartley, presumably because of a longer or thicker fruit stem which resists transmission of force to the base of the nut. Growers are also uncertain how long to wait after application to obtain commercially acceptable removal and hullability. Lastly, growers and consultants find it logistically difficult to follow current University recommendations regarding sampling from the top, middle and bottom of mature orchards for PTB completion. This requires a pruning tower or cumbersome pole which few people use. Hence, knowing where PTB occurs last in the canopy would aid in accurate PTB monitoring and proper ethephon timing.

OBJECTIVES

1. Determine the effect of harvesting 14, 17, 20, and 23 days following commercial ethephon treatment at PTB on percent removal and hullability in the Serr walnut cultivar.

2. Determine where PTB occurs last in the walnut canopy in order to improve sampling efficiency and avoid premature ethephon application which reduces dry nut weight.

PROCEDURES

Objective 1. A randomized complete block experiment was established in 1996 in a dense, 30’ x 30’, north - south planted Serr orchard with excellent cultural practices. Sixteen rows, each 22 trees long were selected in the most uniform portion of the orchard. Treatment timings were randomly assigned across the first four rows. Five blocks were established over the row length with buffer trees between each block. This procedure was repeated in rows 7 - 10 and 13 - 16. Two buffer rows were established on either side of the untreated middle block to guard against drift. This resulted in ten treated blocks and five untreated. Ethephon application was made August 17, 1996.
and August 30, 1998 at 95% PTB using a turbo-charged, engine driven speed sprayer (FMC 757) traveling 1.75 mph at 200 gpa and 4 pints Ethrel®. Night application ensured the proper spray temperature.

Individual tree harvests began 14 DAT and were repeated every three days until 23 DAT. After the first harvest of the 23 DAT treatment, 14 days elapsed before all treatments were re-harvested over two days. In addition to yield data, each plot was individually sampled, weighed and commercially hulled and dried. No airleg was employed during hulling to avoid biasing the treatment effects. Following weighing of the dried, 30 pound samples, those from the first harvest were evaluated for sticktightness by count. A sticktight was defined as adhering hull one - eighth or more of the shell surface. A six pound sample was then submitted to Diamond Walnut Growers in Stockton, California, for quality analysis. Percent removal, hulls removed, and sticktightness were calculated. Prior to statistical analysis using harvest date as a split plot on treated and untreated, the two ethephon plots on either side of its respective control were averaged to provide equal replication numbers. The same procedure was applied to the quality data.

Objective 2. Ten single trees were randomly selected in the same Serr walnut orchard used for the ethephon trial. Beginning August 11, 1998, ten nuts from the bottom, middle and top third of the canopy were randomly collected every 3 - 4 days. Because of wet orchard floor conditions, the first two sampling dates were done with a 20 foot fiberglass pole and 14 foot ladder from the berm. The 30 samples were then evaluated for completion of PTB in the laboratory.

On August 17, 1998, a second Serr orchard spaced 40' x 40' was included in the study to determine if the degree of orchard shading affected PTB development in the lower canopy. The second orchard was equally well managed as the first but had light falling on all sides of the tree.

RESULTS

Objective 1. Table 1 shows ethephon application provided a slight but significant improvement in nut removal over the two years studied. Treating with ethephon reduced hull retention by 5% or 100 pounds per ton. Sticktightness were reduced about 8%.

Sequential harvesting at three day intervals from 14 to 23 days after treatment showed the expected increase in removal with time. Only 69% removal with 37% sticktightness was recorded 14 DAT. Waiting three days significantly reduced the sticktightness to 24.8% with 75% nut removal. Percent sticktightness continued to decrease with longer harvest delays. By 23 DAT, nut removal was the same for treated and untreated trees; sticktightness were 8.3% for the ethephon treatments and 14.5% for the untreated. The lack of a significant interaction between the treatments and time of harvest indicates ethephon did not significantly accelerate the rate of nut removal or reduce sticktightness relative to the harvest delay effect.

Nut removal, hull dehiscence and hullability were all significantly better during 1996 than 1998. The lack of significant interaction between treatment and year suggests the season played a bigger role. During 1996, removal for the ethephon treated trees averaged 81.8% compared to 77.3% for the untreated. In 1998, no differences were observed between treated and untreated trees, averaging
72.9% and 71.4%, respectively. Sticktights were significantly greater in 1996 than 1998. Review of the data associated with the highly significant interactions between treatment and harvest timing by year for sticktights suggests ethephon had greater influence on improving hullability in 1996 than 1998.

Objective 2. Figure 1 shows the results from sampling PTB development for two Serr orchards with distinctly different light regimes. Data from one season suggests PTB development correlates with sun exposure. Thus, its completion occurs first in the top of the canopy and last in the bottom. The differential between upper and lower canopy development rate appears to be related to how shaded the lower canopy is. In the dense and strongly shaded orchard, PTB development in the bottom third was ten days behind the upper canopy. Unfortunately, irrigation after final harvest preparation prevented continued sampling in the open canopy orchard. However, there was a 13% difference in PTB completion on August 24 in the open canopy orchard compared to 20% in the dense orchard. This could possibly be a light response but no firm conclusions can be drawn without canopy comparison within the same orchard.

CONCLUSIONS

Results from the ethephon timing trial have been disappointing. Although significant increases in percent removal, hull dehiscence and reduced sticktights have been recorded, their magnitude has not been sufficient to warrant ethephon use based only on this criteria. Handgun studies performed in this same Serr orchard in 1990 clearly showed ethephon efficacy on this cultivar when copious amounts of water were used per treated tree. Hence, even though the speed sprayer size, speed of travel, gallonage, time of application and material rate were well within recommended guidelines, the size and density of the trees may prevent adequate coverage for proper response. Based on funding approval, the final year would employ the use of a volute, larger sprayer or aerial helicopter application to exclude the coverage factor as best as possible.

Sampling for PTB completion in the upper, middle and lower third of the canopy reveals its development occurs last in the bottom. The middle portion is similar to the top. Thus, growers and crop consultants can accurately time PTB ethephon applications by monitoring the bottom of the canopy knowing that the nuts in the upper portions of the tree will be ahead.
Table 1. Effect of ethephon application at packing tissue brown and harvest timings of 14, 17, 20 and 23 days after treatment on Serr walnut removal, hull retention and sticktights in 1996 and 1998.1

<table>
<thead>
<tr>
<th>Harvest Data</th>
<th>Removal2 (%)</th>
<th>Hulls3 (%)</th>
<th>Sticktights4 (%)</th>
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<tr>
<td>A. Treatment:</td>
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<tr>
<td>1. Treated</td>
<td>77.3a</td>
<td>35.0a</td>
<td>17.9a</td>
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<td>2. Untreated</td>
<td>74.3b</td>
<td>40.0b</td>
<td>26.0b</td>
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<td>B. Days after treatment: (DAT)</td>
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<td></td>
<td></td>
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<tr>
<td>1. 14</td>
<td>69.0b</td>
<td>47.9a</td>
<td>37.2a</td>
</tr>
<tr>
<td>2. 17</td>
<td>75.0b</td>
<td>42.6b</td>
<td>24.8b</td>
</tr>
<tr>
<td>3. 20</td>
<td>74.3b</td>
<td>30.2c</td>
<td>14.4c</td>
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<td>4. 23</td>
<td>84.8a</td>
<td>28.5c</td>
<td>11.4c</td>
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<td>C. Year:</td>
<td></td>
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<td></td>
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<tr>
<td>1. 1996</td>
<td>79.6a</td>
<td>36.7a</td>
<td>28.6a</td>
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<tr>
<td>2. 1998</td>
<td>72.1b</td>
<td>37.9b</td>
<td>15.4b</td>
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<td>Treatment x DAT</td>
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<td>N.S.</td>
<td>N.S.</td>
</tr>
<tr>
<td>Treatment x year</td>
<td>N.S.</td>
<td>N.S.</td>
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</tr>
<tr>
<td>DAT x year</td>
<td>N.S.</td>
<td>**</td>
<td>**</td>
</tr>
</tbody>
</table>

1. Ethephon applied 8/17/96 and 8/30/98 using engine-driven FMC 757 speed sprayer at 1.75 mph, 200 gpa and 4 pts. Ethrel® per acre.

2. Based on two harvests per plot, the second 14 days after the 23 DAT treatment.

3. Based on weighing sample bag from each plot before and after commercial hulling.

4. Based on counting nuts with ≥ one-eighth of shell surface with adhering hull.

5. N.S. = not significant at P=0.05. ** = highly significant at P=0.01.
Effect of Canopy Density and Location Within the Canopy on Development of Packing Tissue Brown in Walnuts, Serr Cultivar

Percentage of Packing Tissue Brown

Sampling Date


- - - Top (Dense)
- - - Middle (Dense)
- - - Bottom (Dense)
- - - Top (Open)
- - - Middle (Open)
- - - Bottom (Open)
- - - Open Canopy
- - - Dense Canopy