The Effect of Pre-Harvest Applications of Ethrel on Concord Grapes

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Abstract. Ethrel sprays were applied to Concord grape vines on September 4, 11, 19, and 26, 1968 in concentrations varying from 10 to 2000 ppm. At daytime temperatures averaging 69.7°F Ethrel promoted the abscission of berries in six days or less at 250 ppm and higher. Daytime temperatures of 63°F or higher prior to normal harvesting appeared necessary to activate berry abscission in six days or less. Concentrations of 250 ppm and higher induced leaf yellowing and accelerated leaf senescence. Berries removed easier when shaken off at 77°F than at 62°F. Grapes receiving a foliar application of 250 ppm of Ethrel 14 days before harvest removed easier than those receiving 500 ppm Ethrel applied six days before harvest when both were shaken off the same day. Ethrel resulted in no differences in fruit soluble solids, titratable acidity, pH and color determinations. There was no response from dipping only clusters in Ethrel. A minus 11°F on December 30 caused serious bud damage on vines sprayed on September 4 at 2000 ppm, compared to non-sprayed vines.

Fruit growers are in want of compounds that will initiate fruit abscission to facilitate harvesting. Recently, chemicals have been found that promote abscission of apples, pears and cherries (4). This is a report of an ethylene releasing compound (3), Ethrel (Amchem 68-62) (1), which caused interesting responses when applied as a foliar spray to Concord grapes prior to harvest.

Ethrel is composed of 2-chloroethane-phosphonic acid, 2-chloroethene phosphonic anhydride and mono-2-chloroethyl ester. Ethrel is made up with a glycol base, and is water soluble.

Applications were made to Concord vines located in two experimental vineyards at the Irrigated Agriculture Research and Extension Center, Prosser (IAREC). Concentrations used in this study varied from 10 to 2000 ppm. The spreader used in all treatments was X-77 at the rate of 5 ml/gal. Foliar sprays were applied on September 4 and 11, at the rate of 0.83 gal/vine; and on September 19 and 26, at the rate of 0.5 gal/vine. All treatments consisted of three vines each except the September 26 applications which consisted of single vines. All treatments were in duplicate and arranged in increasing concentrations.

In addition to foliar treatments, clusters only were thoroughly wetted by dipping in varying concentrations in 500-ml plastic beakers. Five clusters were treated with each concentration of Ethrel.

Vines receiving 250 ppm concentration of Ethrel on September 11 and a 500 ppm concentration applied on September 19 were hand shaken to determine the ease of berry removal as affected by time of harvest and time of day.

Temperatures reported in this study were recorded on a weekly Foxboro thermograph placed in a U.S. Weather Bureau type shelter located under a 4-foot-wide canopy of grape foliage in an 18-year-old experimental vineyard at the IAREC.

Observations and data were obtained for the effect of Ethrel on berry abscission, berry drop, berry quality analyses, dipped clusters and bud cold-hardiness. Berry abscission was determined by the presence or absence of the brush of vascular tissues retained on the pedicels when the berries were removed. Brush counts were determined by sampling at random five clusters from each treatment. If there were no vascular tissues on the end of the pedicel, abscission was complete, and the berry skin was unbroken; otherwise, the berry skin was ruptured. Analyses for soluble solids, titratable acidity, pH, and color were made on samples of 100 berries obtained from the four tip berries of 25 clusters taken at random (2).

The first observation of the effects of Ethrel applied on September 4 was made on September 10. In six days berry abscission had occurred on vines receiving 1000 and 2000 ppm. Those receiving 250 and 500 ppm could easily be removed by shaking the trellis wire. Concentrations of 500 ppm or more caused a noticeable maturity of foliage, particularly of basal leaves. Severe epinasty of shoot tips and a burning of tendril tips resulted from concentrations of 1000 and 2000 ppm.

To determine the minimum concentration of Ethrel for obtaining berry abscission, foliar sprays of 50, 100, 150, 200 and 250 ppm were applied on September 11. Unlike the earlier sprays no abscission of berries occurred in six days so additional applications of 100, 200, 300, 400, and 500 ppm of Ethrel were made on September 19 for further study. Five days later, on September 24, berries began abscissing from applications made September 11 and 19 of 100 ppm and higher concentrations. With a very limited supply of Ethrel remaining, a wide range of concentrations were applied to single vines on September 26 to evaluate applications prior to harvest at 17% soluble solids. In two days both 1000 and 2000 ppm of Ethrel caused complete berry abscission. After this response, the authors decided to use the absence or presence of the brush^ on the pedicel, when the berry was removed, for evaluating the effectiveness of the treatments. Table 1 shows the results of such evaluations made in October on the effectiveness of the Ethrel sprays applied in September.

To attempt to explain differences in berry abscission for different dates and concentrations of applications Table 2 was prepared. Except for the September 11 applications, 250 ppm and higher concentrations caused abscission in six days or less, regardless of date applied. With lesser concentrations, and later applications, more time was required for berry abscission.

The partial effect of temperature upon abscission when the number of days that the daylight temperature was 63°F or higher is shown in Table 3. The selection of 63°F as a minimum activating temperature was based on berry abscissions obtained from Ethrel applications made on September 11 and September 26. The average daytime temperature from September 4 application to September 10 was the highest (69.7°F) and that from September 19 to 26 was the lowest (61.4°F). For concentrations

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2 Berry vascular tissues attached to pedicel.
Table 1. The effect of foliar-applied Ethrel concentrations on abscission of Concord berries from clusters.

<table>
<thead>
<tr>
<th>Ethrel conc. ppm</th>
<th>Sprayed 9/4 sampledb</th>
<th>PER CENT BERRIES WITHOUT BRUSHb</th>
<th>Sprayed 9/11 sampled</th>
<th>Sprayed 9/19 sampled</th>
<th>Sprayed 9/26 sampled</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10/3</td>
<td>10/29</td>
<td>10/7</td>
<td>10/29</td>
<td>10/1</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>0</td>
<td>97</td>
<td>100</td>
<td>100</td>
<td>99</td>
<td>100</td>
</tr>
<tr>
<td>10</td>
<td>93</td>
<td>54</td>
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<td>50</td>
<td>52</td>
<td>17</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>100</td>
<td>12</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>150</td>
<td>c</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>200</td>
<td>–</td>
<td>–</td>
<td>1</td>
<td>58</td>
<td>18</td>
</tr>
<tr>
<td>250</td>
<td>6</td>
<td>4</td>
<td>e</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>300</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
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<td>–</td>
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<td>–</td>
<td>4</td>
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</tr>
<tr>
<td>500</td>
<td>0</td>
<td>d</td>
<td>–</td>
<td>e</td>
<td>e</td>
</tr>
<tr>
<td>1000</td>
<td>d</td>
<td>d</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>2000</td>
<td>d</td>
<td>d</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

aBerry vascular tissues (brush) retained on pedicel of cluster.
b5 Clusters sampled at random.
c Treatment not applied.
d All berries on the ground.
e Harvested 9/25.

Abscission between time of treatment on September 16 and October 1. This result emphasizes the importance of applying sprays to the foliage rather than to the berries. The berries apparently did not absorb sufficient Ethrel to be effective.

To obtain information concerning the effect of temperature on berry removal and quality at two concentrations of Ethrel, duplicate 3-vine treatments, each receiving 250 and 500 ppm, were hand shaken by their trellis wires. They are expressed as follows:

200 ppm Ethrel treatment - September 11

AM (Sept. 25)-19% berries removed by medium hard shaking
51% berries removed by hard shaking
65% berries removed when shaken gently
67% berries removed by hard shaking
30% berries were hand picked as clusters
17% berries shaken off were not split

PM (Sept. 25)-15% berries removed by easy shaking
18% berries were hand picked as clusters
27% berries shaken off were not split

500 ppm Ethrel treatment - September 19

AM (Sept. 25)-19% berries removed by medium hard shaking
17% berries removed by hand shaking
30% berries were hand picked as clusters
17% berries shaken off were not split

PM (Sept. 25)-15% berries removed by easy shaking
67% berries removed by hard shaking
18% berries were hand picked as clusters
27% berries shaken off were not split

There were two responses here that are worth noting: a) the berries removed easier in the afternoon than in the morning, possible because of a 15°F difference in temperature; b) the berries receiving 250 ppm, applied 14 days of 200 ppm or higher, a 63°F level or higher, seems adequate for abscission. For lesser concentrations to be effective in the same length of time higher temperatures may be required. At 100 ppm or less later applications caused berry abscission at lower temperature, but more time was required. Natural senescence of the fruit at this time of the year, which was advanced by Ethrel, could account for the lower temperature requirement. However, there was little evidence up to the end of this study that berries on untreated vines were abscissing normally.

Berry quality determinations were made on samples obtained September 19 and October 7 and 29 from all treatments. Neither time nor varying concentrations of Ethrel had any effect on the titratable acid, pH, color, and soluble solids.

Dipping clusters in 250 to 500 ppm of Ethrel did not promote berry abscission. A total of 35 clusters were treated without any significant abscission between time of treatment on September 16 and October 1. This result emphasizes the importance of applying sprays to the foliage rather than to the berries. The berries apparently did not absorb sufficient Ethrel to be effective.

Table 2. The number of days following foliar applications of Ethrel to approximately 50% berry abscission.

<table>
<thead>
<tr>
<th>Date of application</th>
<th>Ethrel sprays (ppm)</th>
<th>0</th>
<th>10</th>
<th>50</th>
<th>100</th>
<th>200</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
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<td></td>
<td>&gt;55</td>
<td>55</td>
<td>29</td>
<td>20</td>
<td>–</td>
<td>6</td>
<td>&lt;6</td>
<td>&lt;6</td>
<td>&lt;6</td>
</tr>
<tr>
<td>9/11/68</td>
<td></td>
<td>&gt;48</td>
<td>–a</td>
<td>36</td>
<td>20</td>
<td>13</td>
<td>13</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>9/19/68</td>
<td></td>
<td>&gt;40</td>
<td>–</td>
<td>–</td>
<td>40</td>
<td>18</td>
<td>–</td>
<td>6</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>9/26/68</td>
<td></td>
<td>&gt;33</td>
<td>–</td>
<td>–</td>
<td>&gt;33</td>
<td>–</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

aNo application.
Table 3. The number of days after foliar application to approximately 50% berry abscission when the mean daylight temperature was 63°F or higher.

<table>
<thead>
<tr>
<th>Date of application</th>
<th>10</th>
<th>50</th>
<th>100</th>
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<tr>
<td>9/4/68</td>
<td>20</td>
<td>19</td>
<td>13</td>
<td>–</td>
<td>6</td>
<td>&lt; 6</td>
<td>&lt; 6</td>
<td>&lt; 6</td>
</tr>
<tr>
<td>9/11/68</td>
<td>–</td>
<td>13</td>
<td>13</td>
<td>6</td>
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<td>6</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>9/19/68</td>
<td>–</td>
<td>–</td>
<td>7</td>
<td>7</td>
<td>–</td>
<td>3</td>
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<td>5</td>
<td>–</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>63.8</td>
</tr>
</tbody>
</table>

a No application.
b From 9/26 application to 10/1.

before harvest, removed easier than those receiving 500 ppm, applied 6 days before being harvested. As shown in Tables 2 and 3, there may be a cumulative time and temperature effect. However, the average day temperature was only 0.4°F higher for the sprayed period of the 250 ppm treatment than that for the 500 ppm treatment.

The use of Ethrel may offer some promising uses to facilitate mechanical harvesting, especially where it is still necessary to wash the fruit and the processing of grape products that require the elimination of all stem parts.

Ethrel at 1000 and 2000 ppm applied on September 4 caused primary bud damage, 20 and 64%, respectively, following a -11°F freeze on December 30, 1968. Unsprayed vines showed only a nominal bud damage of 12% to primaries.

Literature Cited

Influence of Ethrel Upon Highbush Blueberry Fruit Ripening

Paul Eck
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Abstract. Ethrel (2-chloroethylphosphonic acid) applied as a foliar spray to blueberry two weeks before first harvest resulted in a significant increase in the percentage of the total yield of ripe fruit harvested in the first picking. The increase in fruit ripe at first picking occurred at a concentration of Ethrel as low as 240 ppm on the Weymouth variety, but for the BlueRay variety 1920 ppm were needed to produce the same effect. Ethrel-treated berries were smaller and were less acid than control berries.

The ability of Ethrel to stimulate fruit ripening was first reported by Russo et al. (6) in studies that compared banana ripening of ethylene-treated fruit with that of Ethrel-treated fruit. Edgerton and Blanpied (3) reported that 'Clapp Favorite' pears and 'McIntosh' apples treated with Ethrel reached their climacteric peak two weeks before control fruits. Garrison (4) reported the stimulation of tomato ripening when Ethrel was injected into the fruit, and Robinson et al. (5) showed that field sprays of Ethrel applied two weeks before harvest increased the proportion of ripe fruit. Anderson (1) has shown that Ethrel treatment increased the rate of ripening of 'Montmorency' cherry. In cranberry an increase in anthocyanin development was associated with Ethrel treatment (2).

The harvest period for individual blueberry varieties ranges from three to six weeks. This prolonged harvest period for any given variety presents a problem to the mechanical harvesting of these varieties. New Jersey blueberry growers have experienced difficulty in adapting the large and expensive commercial blueberry harvesters to more than a single harvest per variety. The machines inevitably leave insufficient ripe fruit so as to pose a quality problem in subsequent harvests. If the blueberry could be made to ripen most of its fruit for a single harvest, an increase in the effectiveness of the mechanical harvester may be realized. In this study, Ethrel as a preharvest fruit spray was tested for its possible influence on highbush blueberry ripening.

Ethrel at 0, 240, 480, 960, 1920, and 3840 ppm was applied to the fruit and foliage of the 'Weymouth' and 'BlueRay' varieties of highbush blueberry two weeks before anticipated fruit harvest. Aqueous sprays containing 0.5% 'Tween 20' were applied by hand sprayer at the rate of 500 ml per bush which was adequate to produce drip. The six treatments were replicated three times in a randomized block design. Fruit was weighed at each picking and yield is reported as the percentage of total fruit ripe at a given picking. Cup counts were