TO FACILITATE mechanical harvesting of olives by trunk or limb shakers, and increase fruit removal, research has continued toward reducing the fruit-stem attachment force. Previous studies in California have shown that ascorbic or iodoacetic acid are effective in reducing the attachment force of olive fruit, but only when applied under conditions of very high air moisture. Attempts at artificially increasing the humidity surrounding the trees during or following spray application have been unsuccessful. The addition of surfactants or penetrants has not enabled use of ascorbic or iodoacetic acid to effectively loosen olive fruits under the low humidity conditions which prevail during the table olive harvest season in California.

In screening tests with other organic acids during November and December, 1966, in California, salicylic acid was found to be quite effective in inducing abscission of olive fruits. This material, applied under cool, rainy weather conditions, at 0.5% to Manzanillo olives reduced the fruit attachment force after 13 days from an average of 552 grams on unsprayed control branches to 54 grams on sprayed branches. Some pitting of the fruit developed, however. Higher concentrations (up to 1.5 per cent) gave similar abscission promotion, but caused considerable fruit pitting and leaf damage. Lower concentrations (0.25 and 0.125 per cent) resulted in less abscission promotion, averaging 366 and 330 grams removal force, respectively.

Following completion of olive harvest in California, these studies were continued from March to July, 1967, in Victoria, Australia, during harvest there in the orchards of Oliveholme, Pty. Ltd., Robinvale. Further tests were made with salicylic acid and with a growth regulator developed by Amchem Products, Inc. and released for testing under the code number 66-329 (2-chloroethanephosphonic acid equivalent, as a mixture of free acid, anhydride, and mono 2-chloroethyl ester).

Sprays of Amchem 66-329 plus a wetting agent were applied June 27, 1967, in Australia, at 1000, 2000, and 4000 ppm and fruit removal force was determined (table 2). All concentrations caused pronounced fruit abscission and, at the conclusion of the trial, leaf dropping had commenced. It was obvious from this preliminary test that concentrations lower than 1000 ppm would be more suitable.

In September, 1967, these studies were conducted again in California at the onset of the olive harvest season. Sprays of salicylic acid and its sodium, potassium, and ammonium salts of salicylic acid plus a wetting agent were applied May 17, 1967, to Verdale and Correggiolo olives (table 1). The force to remove the fruits was first measured five days after spraying, then at two-day intervals for five further samplings. In every case the sprays caused significant, but not pronounced, reductions in removal force in comparison with unsprayed branches. Previous studies in California indicated that with a fruit removal force of about 250 grams or less, a high percentage of olive fruits will be removed by commercially available, inertia-type tree shakers. However, residue determinations on sprayed fruits showed about 37 ppm salicylic acid, which, in Australia, is unacceptable in food products.

Sprays of Amchem 66-329 plus a wetting agent were applied June 27, 1967, in Australia, at 1000, 2000, and 4000 ppm and fruit removal force was determined (table 2). All concentrations caused pronounced fruit abscission and, at the conclusion of the trial, leaf dropping had commenced. It was obvious from this preliminary test that concentrations lower than 1000 ppm would be more suitable.
TABLE 1. FORCE REQUIRED TO REMOVE OLIVE FRUITS. FOLIAR SPRAYS APPLIED MAY 17, 1967, ROBINVALE, VICTORIA, AUSTRALIA.

<table>
<thead>
<tr>
<th>Sampling date</th>
<th>Control</th>
<th>Sodium salicylate 0.5%</th>
<th>Potassium salicylate 0.5%</th>
<th>Ammonium salicylate 0.5%</th>
<th>L.S.D. Removal force* in grams</th>
<th>5% level</th>
<th>1% level</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 22</td>
<td>401</td>
<td>375</td>
<td>365</td>
<td>384</td>
<td>24</td>
<td>26</td>
<td>35</td>
</tr>
<tr>
<td>May 24</td>
<td>410</td>
<td>384</td>
<td>408</td>
<td>36</td>
<td>19</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>May 26</td>
<td>415</td>
<td>371</td>
<td>365</td>
<td>376</td>
<td>23</td>
<td>36</td>
<td>35</td>
</tr>
<tr>
<td>May 29</td>
<td>381</td>
<td>325</td>
<td>329</td>
<td>345</td>
<td>20</td>
<td>36</td>
<td>40</td>
</tr>
<tr>
<td>May 31</td>
<td>372</td>
<td>327</td>
<td>329</td>
<td>345</td>
<td>20</td>
<td>36</td>
<td>40</td>
</tr>
<tr>
<td>June 2</td>
<td>346</td>
<td>300</td>
<td>329</td>
<td>309</td>
<td>27</td>
<td>36</td>
<td>35</td>
</tr>
</tbody>
</table>

* Average of 40 fruits per sampling.

TABLE 2. FORCE REQUIRED TO REMOVE OLIVE FRUITS. AMCHEM 66-329 FOLIAR SPRAYS APPLIED JUNE 27, 1967, ROBINVALE, VICTORIA, AUSTRALIA.

<table>
<thead>
<tr>
<th>Sampling date</th>
<th>Control</th>
<th>1000 ppm</th>
<th>2000 ppm</th>
<th>4000 ppm</th>
<th>Removal force* in grams</th>
<th>5% level</th>
<th>1% level</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 30</td>
<td>521</td>
<td>465</td>
<td>505</td>
<td>427</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>July 5</td>
<td>467</td>
<td>451</td>
<td>332</td>
<td>162</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>July 10</td>
<td>403</td>
<td>111</td>
<td>192</td>
<td>72</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>July 13</td>
<td>378</td>
<td>105</td>
<td>74</td>
<td>43</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Average of 10 fruits per sampling.

TABLE 3. FORCE REQUIRED TO REMOVE MANZANILLO OLIVE FRUITS. FOLIAR SPRAYS APPLIED OCTOBER 2, 1967, DAVIS, CALIFORNIA, SUR-TEN (0.1%) ADDED AS A WETTING AGENT.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Amchem 66-329</td>
<td>100</td>
<td>581</td>
<td>542</td>
<td>548</td>
<td>None</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>100</td>
<td>500</td>
<td>503</td>
<td>459</td>
<td>424</td>
<td>Slight</td>
<td>0.6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1000</td>
<td>500</td>
<td>503</td>
<td>459</td>
<td>424</td>
<td>Slight</td>
<td>0.6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1500</td>
<td>500</td>
<td>503</td>
<td>459</td>
<td>424</td>
<td>Slight</td>
<td>0.6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Abscisic acid</td>
<td>250</td>
<td>654</td>
<td>509</td>
<td>500</td>
<td>None</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>500</td>
<td>553</td>
<td>575</td>
<td>550</td>
<td>550</td>
<td>None</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1000</td>
<td>500</td>
<td>553</td>
<td>575</td>
<td>550</td>
<td>None</td>
<td>0.6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2000</td>
<td>500</td>
<td>553</td>
<td>575</td>
<td>550</td>
<td>None</td>
<td>0.6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Control</td>
<td>537</td>
<td>537</td>
<td>550</td>
<td>494</td>
<td>None</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

* Average of 10 fruits each on 3 replicate branches.

On October 2, foliar sprays of abscisic acid and Amchem 66-329 were applied to olive trees at the concentrations shown in table 3. A rain shower (0.13 inches) which fell during the evening after spray application may have influenced the results obtained. Abscisic acid at 1,000 and 2,000 ppm caused complete leaf abscission after 16 days but had no effect on fruit abscission. Neither leaves nor fruit abscissed at the two lower concentrations. Amchem 66-329 at the two higher concentrations caused heavy leaf and fruit drop but had little influence at the two lower concentrations.

On October 27, Manzanillo olive trees were sprayed with Amchem 66-329 at 200, 300, 400, and 500 ppm, with and without urea (1.35 per cent). The addition of urea accentuated the loosening effect (table 4). In fact, only when 66-329 was used at 500 ppm, plus urea, was adequate fruit loosenings obtained. However, this was accompanied by severe defoliation. In addition, the lenticles on the fruit became somewhat darkened.

There seems to be a varietal difference in olives in their response to Amchem 66-329. In trees sprayed on November 21 with this material at 425 ppm + urea, the fruit removal force 13 days later for Manzanillo averaged 28 grams (control 548 grams)—while in comparison, Mission averaged 291 grams, Barouni 475 grams and Ascolano 336 grams. Leaf drop was heavy for Manzanillo but only moderate for the other varieties.

Any appreciable leaf drop from olive trees in the fall cannot be tolerated since defoliation at this time interferes with subsequent flower formation. In an effort to separate leaf and fruit abscission, several treatments were tried. A water spray drench on the tree 24 hours after spray application (66-329, 425 ppm + urea, 1.35 per cent) increased the average fruit removal force—after 13 days—from 28 grams to 353 grams but leaf drop was still heavy. The same water drench treatment—but 6 days after spraying—resulted in 329 grams fruit removal force but with a moderate leaf drop. A very light spray application of 66-329—barely wetting the leaves—in contrast to spraying to runoff, was not effective, giving an average fruit removal force of 539 grams (unsprayed control, 548 grams), with no leaf drop. However, adding naphthaleneacetic acid at 150 ppm to the 66-329 + urea combination completely blocked the abscission-inducing effect of the 66-329, giving (after 13 days) an average fruit removal force of 607 grams (control, 548 grams), with no leaf drop.

Since it appeared that naphthaleneacetic acid influenced the abscission-inducing activity of 66-329, a series of spray treatments using 66-329 with various concentrations of NAA, plus a wetting agent, was made to young non-fruiting Manzanillo olive trees grown in containers in the greenhouse. Sprays were applied December 13, 1967, and leaf abscission counts were subsequently made at 2-, 4-, 6-, and 8-week intervals. These results are shown in the graph. Low concentrations of NAA added to 66-329 gave a rapid and pronounced promotion of leaf abscission; at high concentrations (150 ppm) a lesser and delayed stimulation occurred. At intermediate levels, especially 50 ppm, a reduction in the leaf-abscission effect of...
66-329 occurred. However, when further similar tests were conducted with this same series of spray combinations, both with and without added urea (1.35 per cent), but with another variety—Asco-lano—different results were obtained. Leaf abscission at all concentrations was not only much less than obtained with Manzanillo, reaching a maximum of 40 per cent 6 weeks after spraying (control, no leaf drop), but the addition of NAA at 5 to 150 ppm did not appreciably influence the abscission-inducing effect of 66-329 on the leaves. Apparently, as noted earlier, the abscission-inducing influence of 66-329 is not the same for all varieties of olives.

It is known that, in some cases at least, the physiological action of 66-329 follows that of ethylene. In view of this, gas chromatography was used for determinations of the ethylene production of leaves sprayed with 66-329-containing materials (ascorbic acid, salicylic acid, and abscisic acid) known to have caused abscission of olive fruits or leaves was also determined (table 5). Since only the leaves sprayed with 66-329-containing materials showed a production of ethylene, it is considered likely that the abscission of such leaves resulted from the presence of ethylene.

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For research by Food Science & Technology .................. 6,190.00
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To further research on evaluation of freestone peach varieties ..................................... 539.25
Northern California Turfgrass Council .............. 300.00
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Oki Nursery, Inc. ......................................................... Plants, containers, labor
To establish a root development study by Environmental Horticulture