Bitter pit: a progress report on the use of calcium nitrate sprays for its control

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Bitter Pit

A Progress Report on the Use of Calcium Nitrate Sprays for Its Control

by

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Freedom from serious pests and diseases such as Black Spot and Codling Moth and relative immunity from storage rots has greatly simplified apple growing in Western Australia. However, what has been gained in this respect is often countered by pre-harvest and post-harvest physiological troubles which are rather common to apple growing in this State.

Over the years the disorder which has remained a problem and in some years caused widespread losses is Bitter Pit. The incidence of pit varies considerably from year to year, from orchard to orchard and from tree to tree but almost invariably it will show up in some degree on Cleopatras and in Granny Smiths and Golden Delicious in light crops and on young trees.

Fruit of these varieties was particularly prone to pit during the past season which was probably comparable with some of the worst years experienced in the past.

Visible losses commence at harvest with rejections for tree pit in the orchard, and continue on the sorting table, but probably the most serious economic loss is when after handling, packing and cool storage charges have been incurred, the fruit is rejected for export. Returns on the local market under such conditions often fail to cover the costs involved. Where susceptible fruit does get away it creates an unfavourable impression overseas.

Although pit rejections for Cleos were high during the 1960 export season it is well to note that the allowable tolerance for pit was no different from previous years. Increased rejections of fruit destined for Scandinavia resulted from the compulsory storage of Cleos for one week before inspection, but by this means fruit which could only have brought bad outturn reports was held back.

Pit Liability

Growing conditions in Western Australia accentuate the pit problem. The summer is normally hot and dry with many sunny days and hot drying winds which combine to produce permanent drought or temporary physiological drought within the trees. That is a situation develops in which the leaves are transpiring water at a greater rate than the roots can absorb it and a water deficit is developed within the tree.

The majority of Cleos are growing without irrigation and this further accentuates the drought effects.

Pit develops as a result of localised water deficits in the maturing fruit resulting in collapse of certain tissue which subsequently discolors and forms the brown depressed areas we know as pit. Apart from surface pits the disorder often extends in the form of small localised areas of brown tissue scattered through the flesh.

The water deficit may occur while the fruit is still on the tree as the result of excessive moisture loss from the foliage producing the tree pit seen at harvest. Some of the necrotic areas may not be readily visible at this time but develop in the early storage period. Water shortage in certain tissue may also occur during ripening due to uneven conversion of starch to sugar. In varieties which are pit liable the loss of starch from the tissue...
occurs very unevenly as the fruit matures. Water is required for the process of changing starch to sugar and as the sugary tissue has a greater attraction for water, areas of acute water shortage will develop in the high starch areas. This condition results in the formation of storage pit, a series of dark brown depressed spots located towards the calyx end of the fruit.

Low humidity in cool store will accentuate pit and under Western Australian conditions low temperatures appear to increase the disorder. By slowing down the rate of ripening, cool storage will increase pit apparently by prolonging the period during which conditions for pit development are present.

Conditions in the orchard which accentuate pit are periods of serious competition between leaves and fruit for moisture. Anything which induces excessive growth such as pruning, heavy nitrogen usage, young trees or ideal summer growing conditions such as occurred last season and particularly if associated with light crops, will render the fruit pit liable. With trees carrying good crops adequate irrigation appeared to greatly reduce pit in the past season.

Storage pit is most likely to occur in fruit with excessive starch, that is fruit picked immature or where for some reason the conversion of starch to sugar is slow. This is the case with light crop fruit and may also have been a factor in the prevalence of pit last season.

The only means available in the past for reducing pit have been to limit excessive tree vigour, pick at the correct stage of maturity and only store fruit from good crops off mature trees. Irrigation appears to have a beneficial effect in reducing pit and thinning out fruit clusters by hand or by the use of chemical thinning sprays has proved worthwhile.

**CALCIUM DEFICIENCY**

Calcium is known to be an important element in cell wall construction and is necessary for normal cell functions. Localised calcium deficiency in the cells of the fruit is thought to be related to the cell collapse responsible for the development of pit. It has been suggested that moisture stress actually produces a localised calcium deficiency in the subsequently disease cell areas.

The effect of calcium nitrate foliage sprays in reducing blossom end rot in tomatoes, a somewhat comparable disorder, resulting from physiological drought conditions in the tomato plant, attracted attention to the use of this material for the control of bitter pit in apples. Field trials were therefore conducted with Cleopatras during the 1959-60 season incorporating suggestions made by Dr. D. Martin of Tasmania who has had considerable success with these sprays.

**CALCIUM NITRATE SPRAY TRIALS**

The south-west was selected as a suitable area for this work and blocks of Cleos were chosen on the properties of W. Della Polina & Son, Bridgetown, and M. C. Fry & Sons, Donnybrook.

Five trees were included in each treatment and randomised.

Treatments were as follows:

1. Borax at 1 lb. per 100 gallons of water applied at full blossom.
2. Calcium nitrate at 16 lbs. per 100 gallons of water applied at—
   b. Donnybrook on 15th November, 1st December, 1st January.
   c. Bridgetown on 1st January, 11th January, 25th January—Triton at the rate of 4 fl. ozs. per 100 gallons of water was added.
3. Borax 1 lb., Calcium nitrate 16 lb. per 100 gallons of water applied as in 2 (a) and 2 (b).
4. Control—unsprayed.

Boron was included as this element is known to be associated with the development of corkiness an allied condition.

Trees at Della Polina's were old trees, poor to fair vigour and carrying a heavy crop. Trees at M. C. Fry & Sons were large and vigorous and carrying a very light crop. In both instances past experience had shown pit to be severe in most years. At Fry's it has not been unusual for a high proportion of the fruit to be lost during the harvest, handling and early storage period.
SPRAYING

A satisfactory solution of the calcium nitrate was only obtained by dissolving the salt in very hot water and then adding to the spray vat. At Bridgetown two-thirds to one gallon of spray was applied per tree by means of a power spray. At Donnybrook a knapsack was used.

Some leaf scorching occurred on weak foliage sprayed with calcium nitrate in late January. Fruit injury consisting of a greenish grey tear stain mark was also noted on fruit from one tree. It is felt that this could have resulted from inadequate mixing in the spray vat.

HARVESTING AND STORAGE

A sample of 200 fruits was harvested from each tree at Bridgetown on February 24th and at Donnybrook on February 29th. The apples were sorted and a record made of tree pit. The remaining sound fruit was stored in experimental chambers at Robbs Jetty Cool Stores at 32° F. until May by which time storage pit was well developed. Assessment of pit was made after a period of one week out of cool store.

RESULTS

Unfortunately as the result of an abnormally mild winter the trial trees at Donnybrook were very late blossoming, fruit set was erratic and very light and the resultant fruit was very off type. Pit was very severe and although some improvement resulted from the sprays no commercial control was obtained. It should be noted that the last spray was January 1st. Sprays later in January may have been more effective.

The trial at Bridgetown was however, very successful. Borax gave no improvement but calcium nitrate sprays reduced total pit that is tree pit plus storage pit to almost one fifth. Fruit from unsprayed trees developed 24 per cent. pit as against 5 per cent. for the calcium nitrate treatment. The effect was, however, more spectacular than these figures indicate because of the much greater severity of pitting in individual apples in the unsprayed control. Prior to harvest sprayed trees could easily be picked out in the orchard because of the very pronounced reduction in tree pit.

Details of the variation in pit according to treatment are shown in the following table. Slight pit would include fruit showing some pitting but insufficient to prevent its sale. Severe pit would seriously reduce the commercial value of the fruit. It will be noted that practically no severe pitting occurred where calcium nitrate sprays were used.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Tree Pit at Harvest</th>
<th>Slight</th>
<th>Severe</th>
<th>Total Fruit Pitted per 200 Fruit Sample</th>
<th>Average per cent. Pit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Borax Spray</td>
<td>1</td>
<td>8</td>
<td>18</td>
<td>40</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>12</td>
<td>21</td>
<td>55</td>
<td>48</td>
</tr>
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<td>3</td>
<td>22</td>
<td>12</td>
<td>56</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>24</td>
<td>35</td>
<td>81</td>
<td>55</td>
</tr>
<tr>
<td>2. Calcium Nitrate Sprays, 15th Nov., 1st Jan., 11th Jan.</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>2</td>
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<td>8</td>
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<td>3</td>
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<td>3</td>
<td>6</td>
<td>5</td>
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<td>3. Calcium Nitrate Sprays, 1st Jan., 11th Jan., 25th Jan.</td>
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<td>1</td>
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<td>5</td>
<td>5</td>
<td>2</td>
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<td>5</td>
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<td>4. Unsprayed</td>
<td>1</td>
<td>5</td>
<td>21</td>
<td>17</td>
<td>43</td>
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<td></td>
<td>2</td>
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While no firm recommendation can be made at this stage it is felt that calcium nitrate sprays are worth trying on an experimental basis by anyone who has trouble with Bitter Pit in Cleos. From all information available it would appear that at least three sprays are required and the best time would be during December and January. A suggested programme would be mid December, early and mid-late January. In view of the slight injury to leaves and fruit on odd trees it is not advisable to exceed 10 lb. of calcium nitrate per 100 gallons of water. Calcium nitrate was not available in commercial form last season but it is anticipated that supplies will be obtainable later this year.

This is the first promising lead for the control of pit and further work is planned for the coming season.
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—but they won't hatch
why?

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