OBSERVATIONS ON THE HARVESTING AND STORING OF
APPLES FROM HOOD RIVER VALLEY

by

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The problem of harvesting, handling and storing of apples under Hood River conditions is peculiar in many respects. The weather conditions at harvest time, the varieties grown, the prevalence of fungous troubles and the spray residue problem, all tend to complicate the situation. Precautions that can be overlooked entirely in other districts are of paramount importance under these conditions.

Much has been learned regarding the handling of apples during recent years. No other fruit, in fact, has received more attention than has the apple. Handling practices, however, have not always kept pace with findings of research in this field, and doubtless many of the losses sustained could be avoided if the knowledge now available was put to use.

An Apple is a Living Thing

An apple, whether attached to the tree or whether in storage or in transit, is a living organism. It carries on life activities and its ultimate quality and length of life are dependent upon both external and internal factors. Consequently, it must be treated as a living thing and not as a mere mass of dead or inert material.

Life Activities Affected by Temperature

Of the several factors affecting the life activities of apples, none is of more importance than temperature. The rate at which life activities are carried on, in fact, is in direct proportion to the temperature at which the fruit is kept. Studies relating to ripening activities in apples show that, within certain limits, the rate of ripening is increased by two and three times with each increase of 18° Fahrenheit. This means that at 70° F., apples, on the average, ripen ten times as rapidly as they do at 32°F. Varieties such as Delicious and Jonathan often ripen fifteen times as rapidly at 70°F. as they do at 32°F.
The significance of those figures is at once apparent. Apples left under the trees or in packing sheds deteriorate as much in one day as they do in ten to fifteen days in cold storage. The idea that apples are safe so long as they are picked and in boxes is doubtless responsible for much of the spoilage that occurs in the handling of apples.

Apples ripen faster after picking than they do before picking at the same temperatures. This means that apples left in boxes in the orchard ripen at a more rapid rate than those attached to the tree. Apples held in cold storage, however, ripen much slower than either those left on the trees or those left in boxes outside.

**Too Many Overripe Apples**

There is but little doubt that the apple has lost in popularity in recent years because the markets have been filled with overripe apples. The consuming public soon tires of fruit that has lost its flavor and juiciness. The Hood River district has spent large sums of money in the construction of cold storage plants. No other district, in fact, has better storage facilities. The value of this investment is lost, however, if because of delays in handling, the fruit is allowed to live its natural storage life before refrigeration is applied.

**Climatic Conditions**

The climate of the Hood River Valley during the harvesting season is not ideal for the handling of apples. Cool nights are rare, the day temperatures are frequently high, and the air is usually humid. These conditions bring on quick ripening and foster the development of decay organisms. Deleterious effects from such conditions can only be overcome by prompt and efficient handling.

**Storage Temperatures**

The rate of ripening in apples can be reduced to a minimum by cold temperatures. It is impossible, however, to stop completely the ripening process without injury to the fruit. It is generally recognized that 30° to 32° F. are desirable temperatures for the long keeping of apples. Recent studies have shown, however, that storage rooms held at 30° F. are from 16 to 20 per cent more efficient than those held at 32° F.

**Storage Humidities**

Apples in storage lose weight excessively unless they are kept at fairly high humidities. Losses in weight ranging from six to twelve per cent may occur during the storage period unless the humidity factor receives attention. This is especially true of such varieties as Spitzenburg, Golden Delicious, and Jonathan.
Relative humidities varying between 80 and 85 per cent are usually sufficient to prevent excessive loss of weight.

**Time of Picking**

Casual observations as well as experimental evidence have emphasized the fact that the degree of maturity attained at picking time exerts a pronounced influence upon the dessert and keeping quality of apples. When picked prematurely, apples are often undersized, and may wilt considerably in storage. They lack in flavor and may be tough in texture. Frequently they are susceptible to storage scald. When picked too late, on the other hand, apples are usually short lived. They become dry and mealy very quickly and are especially susceptible to decay and to certain physiological troubles.

**Color in Relation to Maturity**

Apparently the red or over-color in apples is not definitely related to maturity. Apples that are comparatively immature may display considerable color while others of the same variety may be matured and yet be poorly colored. The high color requirements for Spitzenburg, Jonathan, and Delicious are undoubtedly responsible for the fact that the fruit of these varieties is often allowed to hang on the trees too long. This is especially true since red color usually develops quickly during cool weather, but develops very slowly during hot spells when the fruit is ripening rapidly. Lack of color with resulting delays in picking is undoubtedly being aggravated by the changes in cultural practices employed in recent years. Increased nitrogen fertility doubtless retards the development of red color.

**Jonathan Breakdown**

In recent years the trouble known as "Jonathan breakdown" has been a factor, especially in Jonathan and to a less extent in Spitzenburg and other varieties. Jonathan breakdown is characterized by softening and darkening of the tissue early in the storage period. The trouble is especially severe in the large sizes, particularly when the fruit comes from lightly loaded trees. The small and symmetrical specimens coming from heavily loaded trees are far less susceptible to the trouble.

Recent observations have shown that Jonathan breakdown is associated with time of picking to a large extent, the trouble usually being confined to the late picked fruit. The following table shows the relation of time of picking to this trouble in Jonathan apples:
The Relation of Time of Picking to Breakdown in Jonathan Apples

<table>
<thead>
<tr>
<th>Date of Picking</th>
<th>Date of Examination</th>
<th>% Breakdown</th>
</tr>
</thead>
<tbody>
<tr>
<td>9/17</td>
<td>1/17</td>
<td>5.0</td>
</tr>
<tr>
<td>9/26</td>
<td>1/17</td>
<td>8.8</td>
</tr>
<tr>
<td>10/2</td>
<td>1/17</td>
<td>25.0</td>
</tr>
<tr>
<td>10/8</td>
<td>1/17</td>
<td>24.0</td>
</tr>
<tr>
<td>10/13</td>
<td>1/17</td>
<td>45.9</td>
</tr>
<tr>
<td>10/20</td>
<td>1/17</td>
<td>79.2</td>
</tr>
</tbody>
</table>

Jonathan breakdown can be retarded materially by prompt and efficient cold storage.

Decay

Under Hood River conditions decay in apples usually results from three types of fungi as follows:

Blue mold. Blue mold is one of the so-called saprophytic fungi in that it gains entrance only through dead or damaged tissue. Apples which are free from skin injuries do not decay from blue mold. Stem punctures, worm holes, open cores, growth cracks, pulled stems, and bruises are the common places of entrance for this fungus. Apples that are firm and in good condition resist attack from it much better than those that are soft and overripe.

To reduce blue mold infection, decayed fruit should not only be kept out of washing and packing equipment but should be destroyed. One apple rotted by blue mold can produce sufficient spores to infest several carloads of fruit. Careful handling so as to avoid skin injuries does much to prevent losses from blue mold. Cold storage materially retards blue mold development but does not prevent it entirely.

Anthracnose and Perennial Canker. Although anthracnose and perennial canker are distinct organisms, they can be considered together from the standpoint of decay on the fruit. The characteristic "bulls eye" rot is produced by either anthracnose or perennial canker. Like blue mold, these troubles gain entrance largely through wounds of one kind or another. Pulled stems, arsenic injury, worm holes, stings, broken lenticels and growth cracks afford entrance to anthracnose and perennial canker. Observations of the past several years show that at least 50 per cent of the cases of pulled stems in Hood River apples become infected with these troubles during the storage period.

Apparently a large percentage of the spores that cause anthracnose and perennial canker decay are disseminated during and following rainy periods. This probably accounts for the fact that these troubles become especially prevalent in the
fruit picked late in the season following exposure to wet weather. In 1926, experimental lots of Spitzenburg picked prior to the fall rains showed less than three per cent decay, while those picked late in the season after considerable rain had fallen developed over 80 per cent decay. Aside from the matter of spore dissemination late picked fruit is doubtless more susceptible to attacks of anthracnose and perennial canker. Broken lenticels and growth cracks are more common in this fruit and the tissue itself, due to advanced maturity, offers a more congenial field for the germination and growth of fungi.

Decay from anthracnose and perennial canker is not prevented by cold storage. These organisms, apparently, thrive in cool moist situations. Under the conditions existing last season decay from anthracnose and perennial canker was reduced by prompt and efficient washing, some of the spores apparently being removed by the washing process. To be effective in this connection, however, washing must be done immediately after picking. According to experimental evidence, an application of bordeaux mixture prior to the fall rains aids considerably in reducing perennial canker and anthracnose decay.

**Arsenic Injury**

Arsenic injury apparently is a factor of considerable importance in the handling of Hood River apples. This trouble, when visible from the outside, usually appears in the calyx in the form of a darkened area involving the calyx lobes and surrounding tissue. At times the injury is confined to the calyx tube and is not apparent from the outside. Arsenic injury may occur whenever apples sprayed with arsenicals become wet, either before or after picking. The unusual amount of this trouble during the past two seasons is apparently associated with the extended rainy weather that prevailed during and following harvest.

Arsenic injury is especially serious because in many cases it is followed by decay from anthracnose or perennial canker. Occasionally it is followed by blue mold. The so-called "calyx end rot" which takes a heavy toll in Hood River apples each year, is doubtless a combination of arsenic injury and decay.

The results of the past season show that arsenic injury after picking was prevented to a large extent by prompt and efficient washing. Wiping did not accomplish this result. To be effective in the prevention of arsenic injury, however, washing must be done immediately after picking. Even apples that are stored in a dry place are not safe so long as the spray is left upon them. Changes in temperature, such as occur from night to day may cause the fruit to "sweat" and the moisture collected in this way is sufficient to cause arsenic injury.

It is hoped that experiments now under way will reveal a method for the prevention of arsenic injury prior to the time of picking. The use of lime and other materials along with arsenate of lead offers promise at this time, although more work is necessary before final conclusions can be announced.