The storage of Granny Smith apples

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The Granny Smith, since its introduction into Western Australia about 1914, has had a very decided influence on the apple industry in this State. It has for many years now been the main variety and at present is approaching 50 per cent. of plantings. The general age level is considerably below that for the other important varieties and with its domination of new plantings in recent years production can be expected to increase considerably at the expense of the other varieties, particularly Cleos and Dunns, and some of the red varieties. The annual production has been as high as a million bushels in a heavy year.

The reasons for the popularity of the Granny Smith are not difficult to find. Under Western Australian conditions the trees grow well, crops are heavy and the fruit usually attains good size with little thinning. Harvesting may be spread over a relatively long period and with its dual-purpose nature and long storage qualities it is the popular choice of growers. It is well-liked on the local market and overseas importers pay premium prices.

It is sought after in Singapore, in the United Kingdom and also in Scandinavian countries and by virtue of the absence of black spot and codling moth in Western Australia, fruit of a high quality can be shipped.

The Granny Smith has certain characteristics which make for easy handling. It has a tough skin, a thick waxy coating which resists moisture loss better than most varieties and a slow rate of ripening which permits harvesting over a relatively long period. These features coupled with a capacity for long storage have resulted in some laxity with the result that Granny Smiths are often not handled or stored to the best advantage. No matter for what purpose the fruit is required, better results are obtained if the correct procedure is adopted. For long storage proper handling is essential.

The commercial harvesting of Granny Smiths commences before mid-March for the Singapore trade and concludes by about mid-May, the May pickings being mainly for immediate sale on the local market. The bulk of the fruit is picked in April. Although harvesting may be spread over two months the extremes should be avoided except for specific purposes. Early-harvested fruit is usually immature, more liable to bitter pit and very subject to superficial scald and, therefore, is only suitable for limited storage. On the other hand, Granny Smiths picked late, that is early May, are forward in colour and maturity and par-
particularly after rain, are very subject to bruising. This fruit is ideal for immediate sale on the local market but should not be stored for lengthy periods.

SCALD

The most serious problem associated with the cool storage of Granny Smiths is their susceptibility, under Western Australian conditions to scald. Scald is a physiological disorder which develops in cool store and while not affecting the soundness of the fruit it seriously affects its saleability. There are two main types of scald.

Sunburn scald, as the name implies, develops on the surface of the apple which has been exposed to the direct rays of the sun and usually shows some sun injury as a yellowing or browning of the skin at the time of picking. In cool store the discolouration deepens in colour and may eventually develop a shiny ebony black appearance (see Fig. 1). This occurs quite early during storage and is often prominent by July.

No means has yet been found of controlling this disorder but experiments have shown that there is a tendency for the condition to be less severe in later harvested apples.

SUPERFICIAL SCALD

The second type of scald is known as superficial scald. It is essentially a problem with long stored fruit and appears in increasing amounts in apples stored from September onwards. The first evidence of the disorder may be apparent as early as July but is not a serious problem at that time. The disorder develops rapidly from the end of October onwards. Superficial scald appears as a dull brown skin discolouration, irregular in shape, usually slightly depressed and prominent at the calyx end of the apple. In severe cases it can involve the majority of the skin surface (Fig 2.)

Superficial scald will occur more on fruit growing in the protected parts of the tree or on the shaded side of the apple. At times an apple will develop sunburn scald on the exposed surface and superficial scald on the sheltered side. Fruit produced under good growing conditions is also usually more subject to superficial scald than that grown under harder conditions.

The severity of the disorder varies from year to year according to the weather conditions, hot summers with high light intensity being the worst.

Although scald results from low temperature storage the discolouration may not become prominent until the apples have been out of store for several days. Fruit which comes out of cool store in apparently good condition may be badly scalded before it reaches the consumer. The uncertainty of what may happen to fruit showing evidence of scald in the market, limits the price offered by buyers.

CONTROL OF SUPERFICIAL SCALD

Since 1950 a series of detailed trials have been conducted to obtain information on the factors involved in scald development and find means of control. These experiments have proved highly successful so that it is now possible to make definite recommendations for commercial control.

The earlier results of these trials were published in Vol. 2 (Third Series) 1953, of this Journal and reprinted as Bulletin 2033.

Time of Picking.

The maturity of the fruit at harvest is the basic factor determining its susceptibility to scald. Experiments conducted over a number of years have shown quite conclusively that superficial scald is a disorder of early picked fruit. As the apples mature, so the liability to scald decreases.

This is well illustrated in the following results obtained in 1957 with Granny Smiths stored at 32° F. until November.

<table>
<thead>
<tr>
<th>Date of Harvest</th>
<th>Percentage of Fruit Developing Scald</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4/57</td>
<td>91.0</td>
</tr>
<tr>
<td>15/4/57</td>
<td>51.1</td>
</tr>
<tr>
<td>24/4/57</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Granny Smiths harvested at the beginning of April are very susceptible and almost 100 per cent. of the apples picked at this time may eventually scald if stored at a temperature in the vicinity of 32° F. As the fruit matures there is a gradual
Fig. 2.—Severe superficial scald—dull brown irregular skin discoloration slightly depressed and prominent at the calyx end

decline in scald, although the disorder may still develop quite seriously in apples picked after mid-April. During the latter part of April the fruit appears to undergo some functional change which vitally affects the physiological process responsible for the development of scald during storage. This change which normally appears to occur between April 21 and April 25, marks the end of the danger period for scald. It is influenced by seasonal effects on maturation. All Granny Smiths picked before about April 25 can be regarded as scald liable and should be treated accordingly.

As a general guide it is recommended that Granny Smiths for long storage should be picked between April 10 and 25, the season, the district and condition of the trees being taken into account in determining actual harvest dates. Fruit picked earlier will have poorer dessert quality and runs a distinct risk of scalding. If it must be harvested and cannot be disposed of immediately, storage should be terminated by the end of August.

Handling.

It has been common practice in the past to hold Granny Smiths loose in picking boxes in the shed for a period of a week or more before packing as a measure for controlling scald. While experiments have shown that under certain circumstances some benefit can accrue in this direction, generally the practice has nothing to recommend it. The effect on different lots of fruit is rather unpredictable and where the shed storage is of short duration—say one week or less—there may be an increase rather than a decrease in scald. A longer period appears to be more effective but the adverse effect on the storage life and quality of the apples which results, more than offsets any benefit from reduced scald which can be better controlled by other means. The best procedure is to cool store the fruit as soon as possible after picking.

Oil Wraps.

Oil wraps are used in Western Australia for all Granny Smiths packed either for export or storage. While for highly susceptible fruit, oil wraps alone do not give satisfactory control of superficial scald, in conjunction with new methods of storage which will be discussed later they are very useful. A high oil content is necessary for maximum effect.

Under certain limited conditions Granny Smiths have been stored successfully unwrapped. This is discussed later after the question of storage temperatures has been considered.

Storage Temperatures.

Trials were commenced in 1950, to investigate the role of storage temperature in the scald problem. As the result of this work a practical means of controlling superficial scald has been developed. The results have shown quite conclusively that superficial scald is a low temperature disorder and susceptible fruit stored continuously at 32° F. is certain to scald. Over 90 per cent. of apples picked at the beginning of April have consistently scalded by October in each year. Fruit harvested later has produced less scald but invariably has been worse at 32° F. than where modified temperature storage involving higher temperatures was used.
Early in these trials it was found that a very significant reduction in scald was obtained by storing the apples initially at a higher temperature. Holding the apples wrapped in oil wraps at 40°F. until the end of May before dropping the temperature to 32°F. gave good results and promoted a more detailed investigation of the times and temperatures in this initial period which would give the best control. Temperatures of 36°F., 38°F. and 40°F. were used and periods varied from two to nine weeks. As the outcome of these investigations it has been established that a temperature of 40°F. will give the greatest control of scald. The period required at this temperature varies with the time of picking but generally extends to about the end of May. In some years 38°F. is adequate for the initial temperature extending over the same period. Temperatures lower than 38°F. do not give sufficient control to be commercially useful. At 40°F. the effect on colour is greatest and for this reason 38°F. may be preferred. However, the difference is not very great.

In some years, scald is much easier to control than others but as these years are very hard to predict with certainty, uniform recommendations have been made based on the requirements over a number of years.

Most of the experimental work was conducted with apples harvested at the beginning of April to ensure having fruit of high scald susceptibility. Apples harvested at the recommended stage for long storage would be less liable to scald.

It is recommended that for Granny Smiths picked within the scald-susceptible period and required for other than very short storage, Modified Temperature Storage be used. This entails storing the apples directly after picking in a chamber with temperature variations maintained within the 38°F.- 40°F. range. At the end of May the temperature is dropped to 32°F. and maintained at this level for the remainder of the storage period.

As an alternative procedure where it suits cool store practice the initial temperature of 40°F. may be dropped to 40°F. after four to five weeks and to 32°F. at the end of May. This method gives very good control of scald.

In years of high scald susceptibility such as 1958, complete control may not be obtained by temperature means alone. To obviate undue losses from scald the fruit should be examined at regular intervals from September onwards. Where signs of superficial scald are found it will pay to remove a small sample and keep it at room temperature for several days for further examination. Relying on instore inspection alone is dangerous as scald can develop very quickly out of store particularly late in the year so that apples taken out in apparently satisfactory condition can be badly scalded by the time they are offered for retail sale.

One characteristic of Granny Smiths stored by one of the Modified Temperature methods is the extreme waxiness developed by the fruit. Dessert quality is also superior to that of apples stored at 32°F. This is particularly noticeable in the case of early picked fruit.

Ex cool store there is no great difference in colour between apples stored by Modified Temperature methods and at 32°F. continuously. After a week out of store the difference is more marked but is insufficient to affect commercial values.

D.P.A. WRAPS

As a result of investigations carried out by Professor R. M. Smock in the United States of America, a new chemical has been found which is extremely effective in controlling superficial scald. Experiments conducted in this State have confirmed that wraps impregnated with the chemical Diphenylamine (DPA) will provide good control although some scald may develop in early picked fruit. During the 1958 season in which scald was particularly severe, apples picked at the beginning of April did develop some scald in DPA wraps when stored at 32°F. although very much less than similar fruit in oil wraps. Where DPA wraps were used in conjunction with Modified Temperature Storage complete control was achieved. At the present time diphenylamine has not been released for commercial use but is being subjected to toxicological tests.
Wrapping in oiled wraps is essential for the main crop of Granny Smiths. Oil wraps must be used for export fruit and are necessary for long storage. However, Granny Smiths harvested late in the season, i.e., after about April 25, have been successfully stored loose without wrapping for a reasonable period.

Trials conducted over two years have shown that the fruit may be stored unwrapped with negligible loss from scald until the beginning of September provided it is held at 38°-40° until the end of May before reducing the temperatures to 32°. With continuous storage at 32° although the scald will be very much less than for earlier harvested fruit it can be greater than commercially desirable.

The loose storage of Granny Smiths may be useful in enabling the last of the crop to be harvested within reasonable time while the fruit is still in a satisfactory condition for storage. It can also obviate the delay in cool storing these apples due to the inability of the packing shed to handle the fruit within a reasonable time and further more spread packing over a longer period thus easing the peak load on the shed.

It must be emphasised, however, that the indiscriminate storing of unwrapped Granny Smiths without proper safeguards will lead to serious losses from scald.

**SUNBURN SCALD**

In some ways sunburn scald is more serious than superficial scald in that it develops earlier, it can affect export and so far no means has been found of overcoming the problem except by rigidly excluding all apples showing evidence of sun injury when packing. There is some evidence that later-picked fruit is less subject to sunburn scald but this does not provide a practical means of control. Apples showing little visible sign of sun injury may develop quite severe sunburn scald so that careful grading is required if sunburn scald is to be eliminated.

**SENESENT BLOTCH**

When the Granny Smith is nearing the end of its storage life it will often develop a blotchiness of the skin. This olive green to brown discoloration usually on yellowish green background is known as Senescent Blotch and is an indication that the fruit has been stored too long. A browning just below the skin at the stem end also points to overstorage. The apples should be watched carefully late in the storage season and marketed while the fruit is still in good condition. The normal storage life of Granny Smiths is usually over by the end of November. Under some circumstances the fruit will retain its appearance longer but the dessert quality will be impaired.

**RECOMMENDATIONS FOR STORAGE OF GRANNY SMITHS**

1. Store only sound fruit of good quality.
2. Harvest at the right stage of maturity for the purpose required. Where long storage is involved pick between April 10 and 25.
3. Cool store with a minimum of delay.
4. Rigidly exclude sunburn from fruit required for export or for storage after July.
5. Use oil wraps for all stored fruit except that harvested late and required for limited storage.
6. Modified Temperature Storage should be used for all apples required for extended storage except that fruit picked after April 25 and wrapped in oil wraps may if desired be stored at 32°.
7. **Don't Overstore.**—Keep a close check on the fruit in store and remove at the first sign of senescence. Samples removed from time to time will indicate the scald position.

**ACKNOWLEDGMENT**

Acknowledgment is made of the very helpful assistance given by a number of growers in enabling fruit to be obtained from their properties, to Departmental officers who assisted with the preparation and examination of the fruit and the various cool stores who made storage facilities available. In the latter stages of the trials special experimental chambers provided by the W.A. Meat Exports at Robbs Jetty free of charge made the detailed work on temperatures possible.
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