

EFFECT OF MATURITY AND TREE AGE ON THE BEHAVIOUR OF QUEENSLAND GROWN DELICIOUS APPLES STORED AT 34-36°F.

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SUMMARY.

Investigations were conducted over a period of four years to determine the effect of maturity and tree age on the cool storage behaviour of Queensland grown apples of the Delicious variety.

The main disorder encountered was superficial scald, which was extremely severe in fruit picked in February. Later picking dates resulted in almost complete absence of the disorder. As a general rule, fruit from young trees was more susceptible to storage disorders than that from old trees.

Of the picking dates studied, those in the first week in March resulted in long storage with fewer disorders than the earlier picking dates.

In order to avoid severe losses due to withering in the store, the fruit should be removed from storage before the end of September.

I. INTRODUCTION.

In view of a large increase in planting in the post-war period, it has become most important to the Queensland apple industry that the marketing life of apples be spread over as long a period as possible to absorb the increased production.

A series of experiments was initiated in 1953 to study the effect of time of picking and tree age on the storage behaviour of the Delicious variety grown on the Granite Belt and held under refrigerated conditions. The investigations were continued each year until 1956. Progress has been briefly reported in the Annual Reports of the Queensland Department of Agriculture and Stock for the years 1953-54 to 1956-57. More extended reports have appeared in *Queensland Fruit and Vegetable News*, a weekly newspaper published for fruit growers by the Queensland Committee of Direction of Fruit Marketing. In addition, the 1955 investigations were fully reported by Stevenson (1957) as part of a report on apple cool storage investigations for that year.

II. EXPERIMENTAL DETAILS.

The experimental fruit for each year was obtained from the same six orchards on the Granite Belt surrounding Stanthorpe. These orchards were selected as representative of the different growing environments within the

area. Blocks of old and young trees were selected in each orchard and all fruit used in these investigations was harvested from these trees. The ages of the young trees varied between 6 years and 13 years and those of the old trees between 19 years and 30 years. In 1953, two picking dates were studied but in the three subsequent years three picking dates were used. The dates were as shown in Table 1.

Table 1.
PICKING DATES.

Pick.	1953.	1954.	1955.	1956.
First .. ..	..	Feb. 17	Feb. 14	Feb. 16
Second	Feb. 24	Feb. 25	Feb. 23	Feb. 23
Third	Mar. 5	Mar. 9	Mar. 7	Mar. 6

Three half-bushel cases from each picking date were taken from each of the blocks of old and young trees in each of the six orchards—i.e. 12 half-bushel cases from each orchard in the 1953 experiment and 18 half-bushel cases from each orchard in the subsequent experiments.

After picking, the fruit was wrapped in oiled paper wraps and stored at 34–36 deg. F. Removals of fruit from store were made on three occasions each year. After removal from store, the cases were held at air temperatures for seven days to simulate normal marketing conditions, and then inspected for storage disorders.

Firmness was measured by means of a Magness penetrometer. Five fruits from each case were taken as a sample and readings were made on opposite sides of the fruit with the $\frac{7}{16}$ in. plunger. The mean of the 10 readings was recorded.

III. RESULTS.

The results are summarised in Table 3. It will be noted that removal dates of the experimental fruit varied from year to year, but that they fell into five definite groupings, which for ease of comparison have been designated Removals 1 to 5. Actual removal dates are shown in Table 2.

Table 2.
DATES OF REMOVAL OF EXPERIMENTAL FRUIT FROM STORE.

Removal.	1953.	1954.	1955.	1956.
1 .. ..	..	..	Aug. 1	July 30
2	Aug. 31	Aug. 30	Sept. 5	Aug. 27
3	Sept. 14	..	..	..
4 .. ..	..	Oct. 4	Oct. 3	Oct. 2
5	Oct. 19	Oct. 20	..	..

IV. DISCUSSION.

(1) 1953 Results.

No superficial scald was present in the fruit examined and only a small number of fruit was affected by mould.

The total wastage consisted mainly of fruit affected by radial water core. This disorder was described by Carne (1948). It develops in ripening fruit, and even though cool storage will delay its onset, the fruit often develops breakdown while in store. If it does not develop as breakdown in store, it usually causes rapid deterioration of the fruit when it is removed at atmospheric temperatures.

More breakdown was encountered in fruit from young trees than in fruit from old trees, large fruit from young trees being particularly susceptible. Fruit from the first pick (Maturity 2) was less affected by breakdown than that from the second pick (Maturity 3). There was no evidence of immaturity disorders and the fruit remained in a fairly satisfactory condition until Oct. 19, 1953 (Removal 5) and subsequently for a week under atmospheric conditions.

The firmness of the fruit on removal was affected by maturity, storage time and age of the tree from which it was harvested. Fruit remained firmer the earlier it was picked and decreased in firmness with increase in the length of the storage period. Fruit from old trees was firmer than that from young trees.

(2) 1954 Results.

In view of the absence of immaturity disorders in fruit from the 1953 investigations, for the 1954 investigations in addition to the two picking dates previously used—viz., Maturity 2 and Maturity 3—an earlier pick was made on Feb. 17, 1954 (Maturity 1).

Some superficial scald was present in fruit from these investigations, particularly in fruit from the first pick. This effect of maturity on the incidence of superficial scald has been reported for the Granny Smith variety by Tindale and Huelin (1939) and Stevenson (1957).

Total wastage consisted mainly of fruit affected by mould and superficial scald. Internal radial water core, which constituted a large part of the total wastage in the 1953 investigations, affected very few fruit. A trend which indicated a reduction in the total wastage present with increase in maturity of the fruit was observed. However, this trend was not significant when the results were analysed. Fruit from young trees had less wastage than that from old trees and total wastage increased with increase in the length of the storage period.

The firmness of the fruit on removal was affected by maturity, storage time and age of tree. Fruit remained firmer the earlier it was picked and decreased in firmness with increase in the length of the storage period. Fruit from old trees was firmer than that from young trees.

Table 3.

ADJUSTED MEAN PERCENTAGES OF DEFECTS AND FIRMNESS OF DELICIOUS APPLES AFTER REMOVAL FROM COOL STORE.

	Mould.				Superficial Scald.				Soggy Breakdown.				Internal Radial Water Core.				Withered Fruit.*				Total Wastage.†				Firmness.				
	1953	1954	1955	1956	1953	1954	1955	1956	1953	1954	1955	1956	1953	1954	1955	1956	1953	1954	1955	1956	1953	1954	1955	1956	1953	1954	1955	1956	
Removal 1—																													
Maturity 1			0.5	3.2	..	..	16.3	7.3	..	..	Nil	Nil	..	..	Nil	0.2	..	..	..	..	2.8	..	..	16.8	10.7	..	..	13.04	11.25
Maturity 2			1.6	2.2	..	..	4.3	Nil	..	..	Nil	Nil	..	..	Nil	0.5	..	..	..	..	4.5	..	..	6.2	2.7	..	..	12.58	10.54
Maturity 3			0.6	4.1	..	..	Nil	Nil	..	..	Nil	Nil	..	..	Nil	0.5	..	..	..	..	2.6	..	..	0.6	4.6	..	..	11.46	10.04
Old Trees			0.3	3.6	..	..	3.7	1.5	..	..	Nil	Nil	..	..	Nil	0.6	..	..	..	..	3.7	..	..	4.0	5.7	..	..	12.08	10.58
Young Trees			1.7	2.9	..	..	6.7	3.2	..	..	Nil	Nil	..	..	Nil	0.2	..	..	..	..	2.8	..	..	8.6	6.3	..	..	12.64	10.64
Removal 2—																													
Maturity 1			0.1	1.2	1.5	..	1.0	34.4	6.8	..	Nil	Nil	Nil	..	Nil	Nil	..	..	..	..	4.1	..	1.1	36.0	8.3	..	16.3	14.12	11.33
Maturity 2	3.8	0.6	1.0	1.0	Nil	Nil	5.9	2.6	1.8	Nil	Nil	Nil	Nil	0.1	Nil	Nil	..	..	..	..	5.7	5.6	0.7	6.9	3.6	14.2	15.7	12.62	10.92
Maturity 3	0.3	0.4	1.3	3.6	Nil	0.1	0.1	Nil	0.7	0.1	Nil	Nil	Nil	Nil	Nil	Nil	..	..	..	..	4.9	1.0	0.6	1.6	3.6	13.2	15.3	11.71	10.29
Old Trees	0.4	0.2	1.0	2.8	Nil	0.1	7.2	3.0	0.4	0.1	Nil	Nil	Nil	Nil	Nil	Nil	..	..	..	..	5.8	0.8	0.4	8.4	5.8	14.0	16.0	12.72	10.94
Young Trees	3.7	0.6	1.2	1.1	Nil	0.7	13.6	3.4	2.2	Nil	Nil	Nil	Nil	Nil	Nil	Nil	..	..	..	..	4.0	5.9	1.3	14.8	4.5	13.4	15.6	12.92	10.75
Removal 3—																													
Maturity 1 .. ..					..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Maturity 2	1.0	..	..	..	Nil	..	..	..	1.3	..	..	..	6.2	..	..	..	..	..	..	..	..	8.5	..	..	..	13.5	..	..	..
Maturity 3	1.7	..	..	..	Nil	..	..	..	0.5	..	..	..	8.6	..	..	..	..	..	..	..	..	10.9	..	..	..	12.6	..	..	..
Old Trees	1.6	..	..	..	Nil	..	..	..	0.2	..	..	..	1.7	..	..	..	..	..	..	..	..	3.5	..	..	..	13.2	..	..	..
Young Trees	1.0	..	..	..	Nil	..	..	..	1.5	..	..	..	13.3	..	..	..	..	..	..	..	..	15.8	..	..	..	12.9	..	..	..
Removal 4—																													
Maturity 1			0.7	1.9	1.0	..	2.4	34.5	3.8	..	Nil	Nil	Nil	..	Nil	Nil	..	..	..	..	12.0	..	3.1	36.5	4.8	..	15.4	15.21	11.71
Maturity 2			2.0	2.0	1.9	..	0.6	9.4	0.8	..	Nil	Nil	Nil	..	0.1	Nil	Nil	..	..	..	13.2	..	2.8	11.9	2.7	..	15.0	14.29	11.17
Maturity 3			1.0	2.0	4.8	..	0.3	0.1	Nil	..	Nil	Nil	Nil	..	Nil	Nil	..	..	..	..	8.7	..	1.3	2.6	4.8	..	14.2	12.96	10.83
Old Trees			0.6	1.4	3.3	..	0.3	8.8	1.3	..	Nil	Nil	Nil	..	0.1	Nil	Nil	..	..	..	14.9	..	1.0	10.6	4.6	..	15.3	13.94	11.28
Young Trees			1.8	2.6	1.3	..	2.3	15.6	2.3	..	Nil	Nil	Nil	..	Nil	Nil	..	..	..	..	7.7	..	4.1	18.5	3.6	..	14.5	14.36	11.19
Removal 5—																													
Maturity 1			0.4	..	..	..	3.5	..	..	0.3	..	..	..	..	Nil	..	..	..	..	..	..	..	4.3	..	..	..	15.8	..	..
Maturity 2	2.4	1.9	..	..	Nil	1.2	..	..	1.8	0.1	..	..	2.3	Nil	..	..	..	..	..	..	..	6.5	3.2	..	..	12.6	15.6	..	..
Maturity 3	0.7	2.8	..	..	Nil	0.1	..	..	5.7	0.6	..	..	6.7	Nil	..	..	..	..	..	..	..	13.1	3.4	..	..	12.2	12.2	..	..
Old Trees	0.9	1.3	..	..	Nil	0.9	..	..	1.5	0.3	..	..	2.3	Nil	..	..	..	..	..	..	..	4.7	2.5	..	..	12.7	15.4	..	..
Young Trees	2.2	2.0	..	..	Nil	2.5	..	..	6.1	0.4	..	..	6.6	Nil	..	..	..	..	..	..	..	14.9	4.9	..	..	12.1	14.0	..	..

* The percentages of withered fruit in the years 1953, 1954 and 1955 were very small and are not shown.

† Totals for 1956 do not include withered fruit.

(3) 1955 Results.

As in previous investigations, only a small number of fruit was affected by mould and in this year's experiments no internal radial water core was present.

Total wastage comprised mainly superficial scald, which was very severe in fruit from the first pick. Less scald was present in fruit from the second pick, while that from the third pick was not affected. Wastage decreased with increase of maturity at picking and increased with storage time. Fruit from old trees had less wastage than that from young trees.

The firmness of the fruit on removal was affected by maturity, storage time and age of tree. Fruit remained firmer the earlier it was picked. However, two results obtained during this year's investigations did not support previous results—fruit from young trees was firmer than that from old trees, and the fruit increased in firmness with length of storage. These facts cannot be satisfactorily explained, although some shrivelling of fruit did occur, particularly

Analysis of Table 3.

Significance of Differences in Total Wastage.

1953.

Removal 3 and Removal 5 significantly greater than Removal 2 (5% level).
Young trees significantly greater than Old trees (1% level).

1954.

Removal 5 significantly greater than Removal 2 (5% level).
Young trees significantly greater than Old trees (5% level).

1955.

Removal 2 significantly greater than Removal 1 (5% level).
Removal 4 significantly greater than Removal 1 (1% level).
Young trees significantly greater than Old trees (1% level).
Maturity 1 significantly greater than Maturity 2 and Maturity 3 (1% level).
Maturity 2 significantly greater than Maturity 3 (1% level).

1956.

Removal 3 significantly greater than Removal 1 and Removal 2 (1% level).
Old trees significantly greater than Young trees (5% level).

Significance of Differences in Firmness.

1953.

Removal 2 significantly greater than Removal 5 (1% level).
Removal 3 significantly greater than Removal 5 (5% level).
Removal 2 significantly greater than Removal 3 (5% level).
Old trees significantly greater than Young trees (5% level).
Maturity 2 significantly greater than Maturity 3 (1% level).

1954.

Removal 2 significantly greater than Removal 4 and Removal 5 (1% level).
Old trees significantly greater than Young trees (5% level).
Maturity 1 significantly greater than Maturity 2 and Maturity 3 (5% level).
Maturity 2 significantly greater than Maturity 3 (1% level).

1955.

Removal 4 significantly greater than Removal 2 and Removal 1 (1% level).
Removal 2 significantly greater than Removal 1 (1% level).
Young trees significantly greater than Old trees (1% level).
Maturity 1 significantly greater than Maturity 2 and Maturity 3 (1% level).
Maturity 2 significantly greater than Maturity 3 (1% level).

1956.

Removal 4 significantly greater than Removal 1 (1% level).
Maturity 1 significantly greater than Maturity 2 and Maturity 3 (1% level).
Maturity 2 significantly greater than Maturity 3 (5% level).

with fruit from young trees. It is possible that moisture losses accompanying shrivelling make the fruit more resistant to penetration by the test plunger and this may have accounted for the increasing firmness of the fruit. Shrivelling of apples during storage was discussed by Smock and Neubert (1950, pp. 240-241), who attributed it to too low a relative humidity in the storage chamber. As the fruit used in these experiments was stored in a commercial cool store, with loading and unloading constantly being carried out, control of relative humidity was not possible.

(4) 1956 Results.

Total wastage increased with increase in the length of the storage period, but there were no significant differences in the amount of wastage from young and old trees. Wastage decreased with increase in maturity at picking and increased with length of the storage period. A large number of fruit was badly affected by withering, which became more pronounced with increase in storage time. Maturity had no effect on withering but fruit from old trees was more affected than that from young trees. Superficial scald was moderately severe in fruit from the first pick but disappeared in later picks. The length of storage period had no effect on the incidence of superficial scald. Fruit from old trees was less affected than that from young trees. Only a small amount of mould was present.

V. CONCLUSIONS.

The results obtained from the 1953 experiments indicated that the optimum picking date for long storage of the Delicious variety, grown on the Granite Belt, was between the end of February and the first week in March. In the experiments conducted during the years 1954, 1955, and 1956, when an earlier picking date was used, considerable superficial scald was encountered. This disorder was greatly reduced in the later picks, and from the results obtained in those years, the first week in March appears to be the more suitable, since some scald was present in fruit picked at the end of February.

Throughout the four years' investigation, fruit from old trees generally stored better than that from young trees and was less affected by disorders. When the fruit was held later than the end of September, withering of the fruit became serious and its effect became more apparent the longer the storage period. For this reason it is inadvisable to hold this variety in cool store after the end of September.

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