EFFECT OF "STOP-DROP" SPRAYS ON THE COOL-STORAGE BEHAVIOUR OF QUEENSLAND GROWN DELICIOUS APPLES

Gardner, Marth, and Batjer (1939*a*, 1939*b*), working with alpha naphthalene acetic acid (NAA), reported excellent colour development from treated trees in a number of American apple varieties. They felt this could be attributed to factors other than the additional time the fruit remained on the tree. They then suggested that in the desire to take full advantage of this colour development, the fruit may become too mature for best storage results. Edgerton and Hoffman (1951) found 2,4,5-trichlorphenoxypropionic acid (2,4,5-TP) effective as a "stop-drop" spray on McIntosh apples, with a longer effective period than NAA. Hoffman and Edgerton (1952) reported that early 2,4,5-TP sprays resulted in measurably riper fruit at harvest and that both NAA and 2,4,5-TP treated fruit were not significantly softer than untreated controls. Thompson (1952) showed that early 2,4,5-TP sprays more effectively increased fruit maturity of the Williams apple variety than those applied closer to normal harvest time. Abbott (1953*a*, 1953*b*), studying the fruit-ripening effect of 2,4,5-TP with the Worcester Pearmain variety, obtained good quality ripe fruit 12 days earlier than normal. Storage quality was impaired following treatment, but not sufficiently so as to interfere with normal marketing. Hatton (1955) reported early-colouring fruit of the Delicious variety from 2,4,5-trichlorphenoxyacetic acid (2,4,5-T) sprays, always accompanied by advanced maturity, this fruit storing as well as the untreated if harvested before post-maturity. Bowen (1957) found no intensification of skin colour or hastening of fruit maturity with either NAA or 2,4,5-TP sprays used on the Gravenstein variety. Unpublished results of Stevenson (1960) showed marked increase in colour development in the Granny Smith variety from both NAA and 2,4,5-TP but no significant effect on firmness of the fruit.

As a result of the work of Bowen (1957), "stop-drop" sprays are now widely used by apple growers in the Stanthorpe district in south-eastern Queensland to prevent preharvest drop of the Gravenstein variety. In addition, sprays of 2,4,5-TP have been shown to be more effective over a longer period than NAA sprays, and are therefore recommended for commercial use. Growers, however, claim that 2,4,5-TP seriously impairs harvesting quality. With Delicious becoming the major variety grown in the Granite Belt, large quantities of this variety are now being cool-stored. As some growers have begun using "stop-drop" sprays with this variety, these investigations were designed to determine whether preharvest sprays of either NAA or 2,4,5-TP have any deleterious effect on the cool-storage behaviour of the Delicious variety.

In order to obtain good quality fruit from long storage, the fruit must be picked and stored before the peak of the climacteric is reached. Post-climacteric fruit has only a short storage life and is subject to various storage disorders. Poor

storage behaviour attributed to apples treated with "stop-drop" sprays could be a result of these substances hastening maturity so that the fruit for storage is harvested after the climacteric is reached. Recognizing this fact, Hall and Sykes (1953) recommended that hormone-sprayed pears for cool storage should be picked at the same time as, or even a little earlier than, untreated fruit. In this experiment, therefore, the fruit was picked on a number of occasions during the effective period of NAA and 2,4,5-TP sprays which were applied at the time they would normally be used under commercial orchard conditions to prevent preharvest fruit drop.

Methods and Materials

Fruit for the experiment was obtained from three orchards in the Granite Belt, surrounding Stanthorpe. These orchards were selected as representative of the different growing environments within the area. Two widely separated and varying blocks of trees were selected in each orchard and treatments were applied to a number of replicated trees in each block. Three treatments were used and the sprays were applied to each tree on February 15, 1961. Treatments were as follows:—

(i) Untreated control.

(ii) 2,4,5-TP spray—20 p.p.m.

(iii) NAA spray—10 p.p.m.

The rate of coverage used for each treatment was 2 gal per tree at 200 lb/in^2 Fruit for storage was picked on three separate occasions—

First Pick (Maturity 1)	February 16, 1961.
Second Pick (Maturity 2)	February 22, 1961.
Third Pick (Maturity 3)	March 1, 1961.

Three half-bushel cases from each picking date were taken from each of the three treatments from each of the six blocks making a total of 54 half-bushel cases for each of the three picks. The fruit was packed in the field and railed to Brisbane, where it was stored at the Food Preservation Research Laboratory, Hamilton, at 34°F. Removals of fruit from store were made on three occasions:—

Removal 1	August 1, 1961.
Removal 2	September 4, 1961.
Removal 3	October 2, 1961.

After removal from the storage chamber, the fruit was held at atmospheric temperature for seven days to simulate normal marketing delays and was then inspected for disorders. Firmness was measured by means of a Magness penetrometer, using the $\frac{7}{16}$ in. plunger. Five fruits from each case were taken as a sample and readings taken on opposite sides of each fruit. The means of the 10 readings were recorded.

TABLE 1

EQUIVALENT PERCENTAGES OF DEFECTS AND FIRMNESS OF DELICIOUS APPLES AFTER REMOVAL FROM COOL STORE

—	Superficial Scald	Mould	Bitter Pit	Breakdown	Total Disorders	Firmness (lb)
NAA Spray—						
Removal 1	32·5	1·3	2·6	0·6	38·4	11·59
Removal 2	59·0	0·2	0·7	1·5	60·8	10·85
Removal 3	60·2	0·6	1·3	2·4	63·9	10·76
Maturity 1	68·1	0·3	1·4	0·7	68·8	10·88
Maturity 2	45·9	0·8	1·2	0·7	48·9	11·54
Maturity 3	37·1	1·0	2·1	3·2	45·1	10·87
2, 4, 5–TP Spray—						
Removal 1	30·8	0·8	4·0	0·3	34·5	11·42
Removal 2	48·5	0·3	1·2	0·9	50·6	10·71
Removal 3	51·8	0·2	0·8	3·2	56·0	10·63
Maturity 1	56·0	0·0	1·5	1·4	58·7	10·68
Maturity 2	39·7	0·3	2·9	0·8	42·4	11·55
Maturity 3	35·2	0·9	1·5	2·1	39·8	10·53
Control—						
Removal 1	23·2	0·4	4·2	0·9	27·6	11·35
Removal 2	52·5	0·6	1·3	1·2	55·5	10·87
Removal 3	48·2	1·2	1·8	2·1	52·0	10·40
Maturity 1	56·1	0·1	4·3	1·2	59·8	10·64
Maturity 2	35·2	1·3	2·0	0·8	38·4	11·36
Maturity 3	31·7	0·8	1·0	2·2	36·3	10·62

Superficial Scald—

Maturity 3 sig. less (5% level) than Maturity 2 sig. less (1% level) than Maturity 1.
Control sig. less (1% level) than NAA.
2, 4, 5–TP sig. less (5% level) than NAA.
Removal 1 sig. less (1% level) than Removals 2 and 3.

Mould—

No analysis of variance carried out.

Bitter Pit—

No analysis of variance carried out.

Breakdown—

No analysis of variance carried out.

Total Disorders—

Maturities 2 and 3 sig. less (1% level) than Maturity 1.
Control sig. less (1% level) than NAA.
2, 4, 5–TP sig. less (5% level) than NAA.
Removal 1 sig. less (1% level) than Removals 2 and 3.

Firmness—

Maturity 2 sig. firmer (1% level) than Maturities 1 and 3.
Removal 1 sig. firmer (1% level) than Removals 2 and 3.
No sig. difference between NAA, 2, 4, 5-TP or Control.

Results

The results are summarized in Table 1. Mould, bitter pit and breakdown incidence were very slight and for this reason no analyses of variance were made on these results. An inspection of the incidence of these disorders does not indicate any effect of treatment, maturity or length of the storage period. Superficial scald incidence was high, and treatment, maturity and length of the storage period had significant effects on the amount present. Scald decreased with increase in maturity. This effect has been recorded in investigations into the storage behaviour of many varieties and has been reported in the Queensland grown Delicious variety by Stevenson (1959). Fruit from the first removal had significantly less scald than that removed from store at a later date. The effect of treatment on scald incidence was significant. Untreated fruit had less scald than fruit from trees sprayed with NAA, and similarly fruit from trees sprayed with 2,4,5-TP had less scald than fruit from the NAA-sprayed trees.

An analysis of the number of total disorders present, comprising the total of superficial scald, mould, breakdown and bitter pit, also showed significant differences with respect to maturity, treatment and length of the storage period. Fruit from the second and third picks was less affected than fruit from the first pick and the number of disorders increased with increase in the length of the storage period. Untreated fruit and fruit from trees sprayed with 2,4,5-TP had fewer disorders than that from trees sprayed with NAA. Firmness was affected by both maturity and length of the storage period but there was no significant effect on firmness of treatment.

Discussion

The results show that storage life was deleteriously affected by NAA sprays when compared with untreated controls and 2,4,5-TP sprays, this being mainly due to the higher incidence of superficial scald. This supports Departmental recommendations which prefer 2,4,5-TP as a "stop-drop" spray to NAA but is at variance with grower opinion that 2,4,5-TP impairs harvesting quality.

It is proposed to carry out further investigations during the 1962 season to determine whether seasonal variation has any effect on the performance of 2,4,5-TP and NAA. Fruit will be picked over a wider range of maturities than those studied during 1961 to determine the effect of picking date on storage disorders within the experiment. As Stevenson and Blake (1961) obtained good scald control by chemical means in cool-stored Queensland Granny Smith apples, it is proposed to study the effect of post-harvest ethoxyquin dips on scald control on the Delicious variety.

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