APRC PROJECT REPORT

Project SP112: Strategies to improve the textural quality of CA-stored Cox apples

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Background

This 3-year project began in June 1997 and is directed towards an improvement in the textural quality of Cox apples stored under controlled atmosphere conditions. Three approaches were taken in the first year of the project:

1. Investigation of the effect of ReTain™ on fruit quality
2. Effect of temperature on loss of firmness in fruit removed from CA storage
3. Influence of water loss on textural properties of fruit in CA storage

Progress made in each of these areas was summarized in the previous 6-monthly report to APRC and a more comprehensive account of progress was given in issue number 18 of APRC News. This report covers the period from January-June1999 inclusive.

1998 experimental programme

1. Investigation of the effect of ReTain™ on fruit quality

The objectives of the work on ReTain™ were described in the previous 6-monthly report along with the experiment details. These are reiterated briefly as follows:

Objectives

- To confirm the effects of ReTain™ on fruit quality obtained in the 1997 trial carried out in a commercial orchard.
- To measure the effects of ReTain™ on yield, fruit size and red colour.
- To compare the quality of ReTain™-treated and untreated apples stored separately or mixed in the same container
- To measure the effects of ethylene removal from the storage containers on the quality of ReTain™-treated and untreated apples.

Experiment details

The 1998 experiment was carried out in a Queen Cox M.9 orchard planted in 1979. ReTain™ sprays were applied on 13 August 1998 which was 4 weeks prior to the anticipated harvesting date of Cox for long-term storage. The product was applied at 0.73 g litre^{-1} in combination with a proprietary surfactant at 1 ml litre^{-1}. Two litres of solution were applied to each tree using a knapsack sprayer. There were 2 chemical

treatments, ReTain™ and untreated control, and 3 harvest date treatments allocated to 2-tree plots and replicated 6 times in a latin-square design. Fruit was harvested on 3, 16 and 29 September 1998 i.e. before, during and after the optimum period for long-term storage.

At each pick fruit from each plot was weighed and samples removed for immediate measurement of internal ethylene concentration, starch pattern, soluble solids concentration, firmness and background colour. Samples of 100 fruit were removed from the crop from each plot for storage in 1.2% O_2 and <1% CO_2 at 3.5°C. ReTain™-treated and untreated fruit were stored together and separately, and with and without ethylene removal.

Results

Effects of ReTain™ , harvest dates and storage treatments on the accumulation of ethylene in storage cabinets were described in the previous report.

Yield, fruit size and red colour.

There was no overall reduction in yield following the application of ReTain™ and effects on fruit size were only minor compared with effects of picking date. Delaying the harvest of fruit from unsprayed trees from 3 to 19 or 29 September increased the percentage of fruit with a diameter of 65 mm or more from 26% to 49 and 69% respectively. Although a lower percentage of fruit in this category was recorded for ReTain™-treated fruit at picks 2 (45%) and 3 (60%) the overall effect of ReTain™ just failed to reach significance at the 5% level of probability. Late picking was associated with a marked increase in red colour development on fruit from sprayed and unsprayed trees. The overall effect of ReTain™ was to reduce red colour at the second and third pick. The percentage of unsprayed fruit with greater than 20% of surface colour increased from 42% (pick 1) to 69% (pick 2) and 71% (pick 3). Figures for ReTain™-treated fruit were 45% (pick 1), 60% (pick 2) and 62% (pick 3). Although ReTain™ application reduced red colour and tended to reduce fruit size it should be borne in mind that the intention is to harvest treated fruit later than unsprayed fruit in order to compensate for the delayed maturation of fruit by ReTain™. This aspect will be considered later in the report.

Harvest maturity

The application of ReTain™ delayed markedly the ripening of fruits on the tree as indicated by a lower concentration of ethylene inside the fruit (over 100-fold lower in ReTain™-treated fruit at pick 3), delayed loss of starch, greenness and firmness and slower accumulation of soluble solids. With data for only 3 picks it is difficult to judge the extent of the delay in maturation caused by ReTain™ application and the effect varied for the different maturity parameters. It is estimated that ReTain™ application retarded fruit maturity by 7-14 days.

Storage quality

Effects of ReTain™ on the storage quality of fruit were similar in January and April, immediately ex-store and after 7 days at 18°C to simulate marketing. For each pick date ReTain™-treated fruit were greener and firmer than the unsprayed. On the basis of these quality criteria ReTain™-treated fruit picked on 29 September were equivalent to unsprayed fruit picked between 3 and 19 September. None of the fruit had received a pre-storage fungicide drench and consequently rotting reached an unacceptable level in fruit stored until April. The overall level of rotting for picks 1, 2 and 3 was 8.6, 15.0 and 33.9% respectively. *Penicillium spp.* were a major cause of wastage particularly in the later picked fruit. ReTain™ application reduced the incidence of *Penicillium spp* in fruit from pick 3 from 28.3 to 14.2%.

The benefits of ReTain™ on storage quality were maintained when ReTain™-treated and untreated fruit were stored in the same storage cabinet. This is an important result for the practical management of stores where it may have proved difficult to segregate sprayed and unsprayed fruit.

There were major benefits of ethylene scrubbing on the retention of firmness of ReTain™-treated fruit but little effect on unsprayed fruit. However 7% of treated fruits stored under low ethylene conditions until April developed core flush, and flesh breakdown was evident in 2.3% of fruits stored until April followed by 7 days at 18°C.

Picking dates

It is imperative that the harvesting of ReTain™-treated fruit is delayed in order to improve the quality over unsprayed fruit. **Picking sprayed fruit for storage at the same time as unsprayed fruit will produce fruit of inferior quality.** According to the information provided by the Quality Fruit Group in 1998 the average optimum date for harvesting Cox for long-term storage was 14 September which coincides with pick 2 of our experiment. As described earlier picking ReTain™-treated fruit on 29 September gave better storage quality than unsprayed fruit picked 2 weeks earlier. Important agronomic data are compared in the table below.

	% fruit 65 mm or above	% fruit above 20% red colour	% fruit above 50% red colour	Yield (kg tree $^{-1}$)	% soluble solids
Pick 2 Control	49.2	68.7	29.5	45.8	13.5
Pick 3 ReTain™	59.5	62.4	20.6	55.2	13.9

In this trial a 2-week delay in harvesting ReTain™-treated fruit did not compensate fully for the slower rate of red colour development. In other respects ReTain™ used in combination with a 2-week delay in harvesting gave important benefits in terms of yield, size and soluble solids content together with improved storage quality referred to earlier.

It is not yet possible to provide criteria that indicate the precise moment to harvest ReTain™-treated fruit for long-term storage. Picking at about 2 weeks later than

unsprayed fruit on the same site would appear to be the best approximation. A Streif index (Firmness (N)/(% soluble solids * starch score)) of 2.1 is commonly thought to indicate optimum time of harvest for unsprayed Cox. The ReTain^{TM}-sprayed fruit in this orchard had a Streif index of 1.4 at the final harvest (firmness of 80.2N, soluble solids concentration of 13.9 % and a starch pattern of 4). It is possible that a lower Streif index is acceptable as a guide to the harvesting of sprayed fruit. However, if the starch cover had been 70% instead of 67% the starch score would have been 3 as opposed to 4 and the Streif index would have been 1.9 and very close to the 2.1 'optimum' for unsprayed fruit. Further work is required to construct picking date criteria for ReTain^{TM}-treated fruit.

2. Effect of temperature on loss of firmness in fruit removed from CA storage

The additional resources allocated to the work on ReTain^{TM} meant that no further work was carried out on this aspect in the 1998/99 storage season. The results of the work carried out on fruit from the 1997 crop were presented at the EMRA Top Fruit Storage Members' Day held at HRI-East Malling on 23 March 1999.

3. Influence of water loss on textural properties of fruit in CA storage

Due to the recent absence, through illness, of the project leader responsible for this component of the work it is not possible to provide a report on progress. It is anticipated that this part of the project will re-start in September 1999.