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Factors involved in fruit quality

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INTRODUCTION

The South African avocado industry is largely dependant on the European markets and relies on sea export for a large part of its sales. The time/temperature relationship is the most important determining factor of fruit quality and condition. A longer storage period increases the percentage decay (Vorster, Toerien & Bezuidenhout, 1987). Soft arrivals and cold damage are major problems and might lead to lower prices on the overseas markets.

Low temperature is the major commercial method used to prolong the shelflife of South African export avocados. Successful cold storage is dependent on knowledge of the physiology of the fruit, the physical principles and mechanism of cold storage and effective postharvest management.

The following research findings were found to play major roles in the management of cold storage avocados:

- Early season fruit with a low oil content, is more sensitive to low temperatures than late season fruit (Toerien, 1986; Vorster, Toerien & Bezuidenhout, 1987). The optimum temperature and storage periods of avocados vary with cultivars (Vakis, 1982; Vorster, *et al,* 1987). Optimum temperature and storage periods vary with the stage of fruit development (Bezuidenhout, 1983).
- Chilling sensitivity of Fuerte and Hass avocados is a function of the stage of climacteric development. Avoca dos on the climacteric rise and the climacteric peak were found to be the most sensitive. The least sensitive stage is the post-climacteric stage (Kosiyachinda & Young, 1976).
- Fruit reaction to cold storage may be preconditioned by orchard conditions (Smith, 1985).
- The potential for physiological disorders in avocados varies throughout the season. Because of this exporters run a variable risk of physiological problems, which can be compounded by low temperature storage over certain periods (Bower, 1986).
- Increased moisture loss and resultant stress during storage, increase the polyphenol oxidase (PPO) activity and visual symptoms of physiological disorders, as well as the prevalency of pathological disorders (Bower & Cutting, 1987).
- According to Lyon (1973), chilling injury can be reduced by high humidity, which

may suppress the expression of symptoms by reducing desiccation of necrotic tissues. Temperature and time interact in the development of cold storage injury (Vorster, Toerien & Bezuidenhout, 1988).

- Relatively higher temperatures during the early storage stages and lower temperatures during the later stages of storage, tend to decrease physiological disorders when compared to the traditional temperature regime of 5,5°C for the total storage period (Vorster, *et al*, 1987).

From a commercial point of view, the packing period for a specific vessel -especially the quality difference between the first pick and deadline fruit -elicited some questions and were investigated.

Whitney, Wolstenholme and Hofman (1986) postulated that Ca-related disorders mostly arise from internal Ca-distribution problems. Shear (1975) lists 35 physiological disorders in fruit and vegetables associated with Ca-nutrition. Poovaiah (1985) emphasized the Ca-nutrition of target organs such as fruit, rather than whole plant nutrition. Chaplin & Scott (1980) associated the chilling injury susceptibility of avocados to low levels of calcium.

Vorster & Bezuidenhout (1988) found that avocados with pulpspot have a lower Ca-concentration in the fruit compared to fruit with no pulpspot symptoms. Work conducted by Whitney, *et al* (1986) on vigorous and non-vigorous trees (moderate root infection by *Phytophthora cinnamomi)* showed that non-vigorous trees produced fruit with significantly higher Ca-concentrations than vigorous trees of the same cultivar. This appeared to be related to less competition from the spring vegetative growth flush. Based on this, fruit from a orchard with vigorous trees was compared to fruit from a orchard with non-vigorous trees, from a quality point of view.

MATERIALS AND METHODS

Experiment 1

Fuerte avocados were selectively picked based on fruit-set. A distinction was made between a first set and a later fruit-set. The fruit picked on March 31, 1988 went through the commercial packing line of the packhouse at Westfalia Estate. Fruit was stored for 28 days at two different temperature regimes, which included a 5,5°C for the total storage period and a 7,5°C for three weeks, followed by a 5,5°C for one week. After this storage period the fruit was left to ripen at ambient temperature, after which it was internally and externally inspected for various physiological and pathological disorders.

Experiment 2

Fruit quality from first pick, for a specific ship (picking date Monday, May 2, 1988) was compared to fruit of the deadline pick for the same vessel (picking date May 6, 1988). Fruit was obtained from the commercial packing line of the packhouse and stored under simulated exporting conditions. Fruit was removed from the experimental cold room on the date of arrival of the commercial fruit in Zeebrugge, France. The firmness of the fruit was measured. The fruit was ripened at ambient temperature and evaluated as

previously described.

Experiment 3

Fuerte avocados were picked from vigorous growing trees (Westfalia block 34B - *Phytophthora* rating 0) as well as non-vigorous growing trees (Westfalia block 27 *Phytophthora* rating 2). *Phytophthora* rating is based on a scale from 0 (no symptoms) to 10 (dead tree). No major differences were observed in the soil analyses. The fruit went through the commercial packing line and was stored at 5,5°C for a period of 28 days. Fifty per cent of the fruit was stored in the commercial coldroom (packhouse) and the rest in the experimental cold-rooms. Then the fruit was ripened at ambient temperature and evaluated as previously described.

RESULTS

Experiment 1

(Figure 1)

Fuerte avocados of the first set were less sensitive to low storage temperatures than fruit from the same trees at a later set. Significantly (P = 0,05) less external cold damage was observed on the more mature fruit. Significantly (P = 0,05) more cold damage was observed on fruit stored at 5,5°C for the total storage period in comparison to fruit stored at 5,5°C for three weeks followed by 5,5°C for one week.

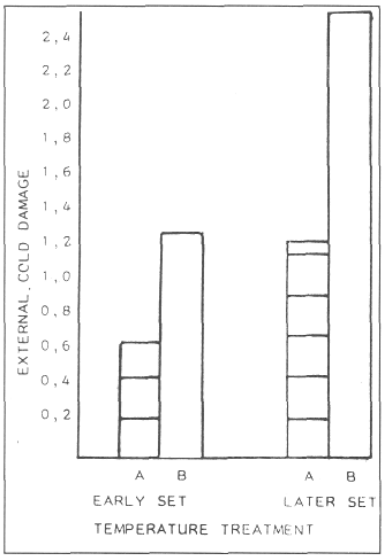

Fig 1 The incidence of external cold damage on fruit selectively picked, based on fruit-set. An early and later fruit-set was distinguished. Two different temperature regimes were used: A 7,5°C (3 weeks); 5,5°C (1 week). B 5,5°C (4 weeks).

Experiment 2

(Figure 2)

Significantly (P = 0,05) less external cold damage was observed on deadline fruit, in comparison to fruit picked during the first day of picking for a specific vessel. Deadline fruit was significantly more firm than fruit picked during the first day of picking at the end of the storage period (day of arrival of the vessel in Zeebrugge).

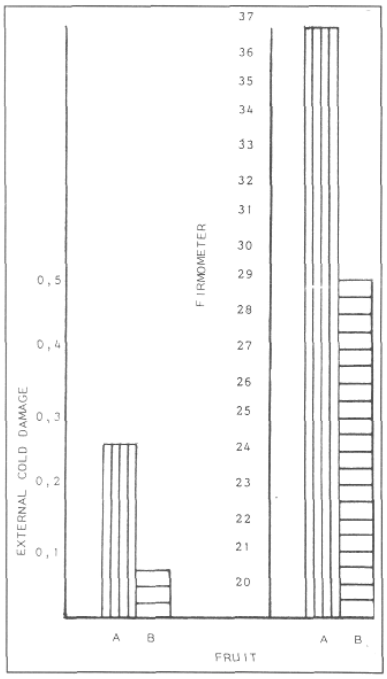

Fig 2 A comparison between fruit picked during the first pick for a vessel (Monday May 2, 1988) and the deadline-pick (Friday May 6, 1988), with external cold damage and firmness of the fruit as criteria. Storage temperature: 6,5°C (1 week); 5,5°C (3 weeks).

Experiment 3

(Figure 3)

Significant (P = 0,5) differences were observed in physiological disorders in fruit obtained from block 27 compared to block 34B at Westfalia. Fruit from block 27 appeared to be less sensitive to low storage temperatures. More grey pulp was observed in fruit from block 34B. No significant differences were observed in fruit stored in the commercial coldroom, compared to fruit stored in the experimental coldrooms.

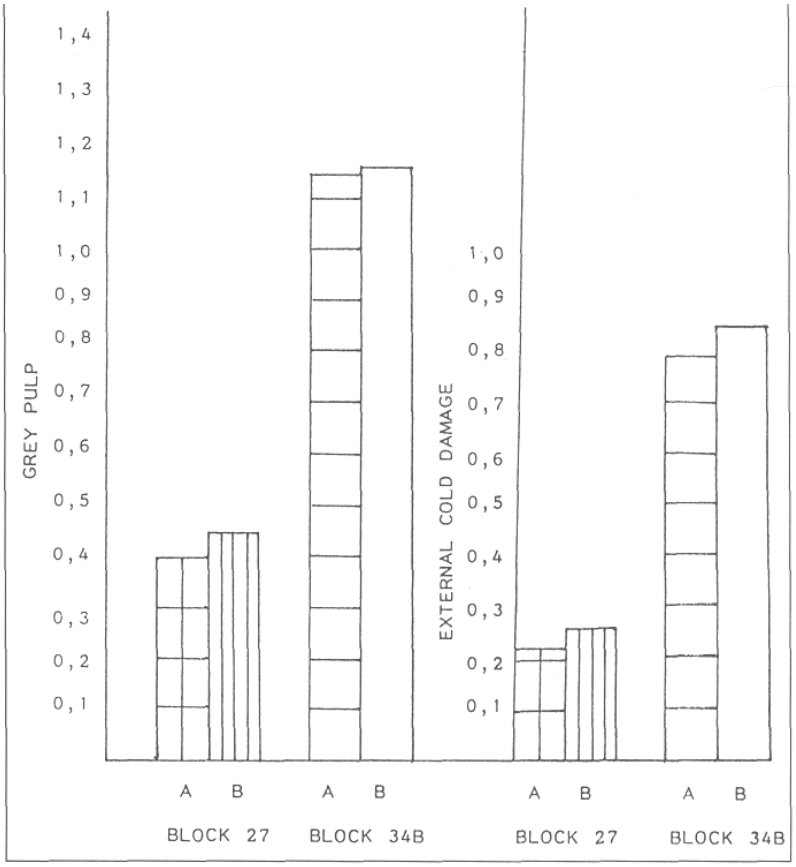

Fig 3 A comparison of Fuerte avocados from vigorous growing trees (Westfalia block 34B – *Phytophthora* rating = 0) and non-vigorous growing trees (Westfalia block 27 – *Phytophthora* rating = 2). External cold damage and the firmness of the fruit were used as criteria. Fruit was stored at 5,5°C in:
A Commercial coldroom (packhouse) and
B Experimental coldroom.

DISCUSSION

It is fairly easy to distinguish between at least three periods of fruit-set on a Fuerte avocado tree, before picking starts. Logically, fruit from the first set and the later fruit-set will differ in maturity. It is generally agreed that the optimum temperature and storage periods will vary with the development of fruit maturity (Bezuidenhout, 1983).

This concept was confirmed by the experimental results (Experiment 1). Fuerte with later fruit-set, was much more sensitive to low storage temperatures than the first set. A temperature regime which will be suitable for the first set may cause a lot of external cold damage on the less mature fruit of the later set. The principle of selective picking during the early stages of the picking season, cannot be underestimated. This is a very important concept in the implementation of post-harvest temperature management.

The time/temperature relationship cannot be over-emphasized in the strive for better fruit quality on the overseas markets. From the results (Experiment 2), it was clear that the fruit with the most problems from a quality point of view was the fruit picked on the first day of the scheduled picking for a specific vessel.

Should it be possible to start picking one day later for a specific vessel, it can be expected that more than ten per cent of a consignment will reach the market in a better condition. Temperature constraints are less important than time, in the strive to better fruit quality.

Another dimension combined with the temperature and time concept is the role of orchard factors in fruit quality. Results proved that fruit with a lower Ca-content has a higher potential for physiological disorders. It is clear that Ca-physiology is vitally important to the maintenance of fruit quality. Whitney, *et al* (1986) showed that non-vigorous trees bore fruit with a higher Ca-content than those from vigorous trees. Although there are many factors involved which result in a good quality fruit, there is a definite correlation between vigorous trees and the potential for poor quality fruit. The above-mentioned principle may be implemented in the concept of temperature management. If a particular orchard has a lower potential for physiological disorders, it will be logical to plan a picking programme where the orchards can be picked during the first days of harvesting for a vessel. The fruit will then be exposed to lower temperatures for a longer period, compared to the deadline-picked fruit, which normally tends to have more physiological disorders.

The RSA is 10 000 km away from the UK and Europe, where our main markets are situated. Export by sea takes approximately 28 days. With good temperature management and control it is possible to put a firm fruit (average firmometer readings of lower than 35) with a small amount of cold damage -on index less than 0,25 (one fruit with 30 per cent external cold damage in a count 12 carton) on the European markets.

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