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PROGRESS REPORT:

COLD STORAGE TEMPERATURE REGIMES AND TOLERANCE OF AVOCADO FRUIT TO COLD STORAGE

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Abstract

Nine different temperature regimes for 'Fuerte' and 'Hass' avocados grown in the Natal Midlands were tested throughout the 1993 harvesting season with the aim of selecting suitable regimes for the whole season. Due to the very low incidence of cold storage disorders in both 'Fuerte' and 'Hass' fruits, it was not possible to establish any definite trends w.r.t. temperature regimes. In 'Fuerte' fruit the incidence of external disorders decreased with increasing maturity. High tolerance of the fruit to cold storage was probably as a result of high Ca accumulation in the fruit brought about by low vegetative vigour and good cropping of the trees and the resultant decrease in vegetative-reproductive competition.

INTRODUCTION

Considerable progress in temperature management during shipping of South African avocados has been made in recent years. The concept of a declining temperature regime was first proposed by Toerien (1986). An integrated approach and the stepping down of temperatures according to fruit maturity was proposed by Vorster et al. (1990). Stepped down temperature regimes are currently used during export of South African avocados by sea.

Due to climatic and latitude differences, avocados grown in the Natal Midlands are harvested approximately two months later than those grown in the Transvaal. Specific cold storage temperature regimes are therefore necessary for Natal avocados. Nine different temperature regimes were tested throughout the Tuerte' and 'Hass' seasons in an attempt to find regimes which will produce firm fruit with minimal external and internal chilling injury after a 4 week refrigerated storage period.

MATERIALS AND METHODS

'Fuerte'

Cartons of fruit were taken from the pack line at Everdon estate near Howick, a cool, humid mesic mistbelt area. They were stored at nine different temperature regimes for 3, 4 or 5 weeks (Table 1). Fruit of mass 236305 g (counts 14 and 16) were used. Every week during the harvesting season (19/5/93 to 14/7/93) 10 cartons of fruit were placed in each treatment. After the designated period in cold storage (Table 1), fruit firmness was measured with a firmometer (Swarts, 1981) and placed in a room at 20°C to ripen. When the fruit was eating ripe, as determined by a firmometer (Swarts, 1981), the fruit was rated internally and externally for mechanical damage, pathological and physiological disorders.

'Hass'

The same procedure was followed as for Tuerte' fruit, with temperature regimes 1 and 3 being altered (Table 2). Fruit was placed in each treatment for 13 weeks (21/7/93 to 13/10/93).

TABLE 1. Temperature regimes used for 'Fuerte' fruit

Regime	Temperature (°C)				
	Week 1	Week 2	Week 3	Week 4	Week 5
1	8.5	8.5	7.5	6.5	-
2	8.5	7.5	6.5	5.5	-
3	8.5	7.5	5.5	4.5	-
4	7.5	7.5	6.5	5.5	-
5	7.5	7.5	5.5	4.5	-
6	5.5	5.5	5.5	5.5	-
7	4.5	5.5	7.5	7.5	-
8	7.5	7.5	6.5	-	-
9	7.5	7.5	6.5	5.5	5.5

TABLE 2. Temperature regimes used for 'Hass' fruit

Regime	Temperature (°C)				
	Week 1	Week 2	Week 3	Week 4	Week 5
1	6.5	5.5	4.5	3.5	-
2	8.5	7.5	6.5	5.5	-
3*	8.5	7.5	5.5	4.5	-
4	7.5	7.5	6.5	5.5	-
5	7.5	7.5	5.5	4.5	-
6	5.5	5.5	5.5	5.5	-
7	4.5	5.5	7.5	7.5	-
8	7.5	7.5	6.5	-	-
9	7.5	7.5	6.5	5.5	5.5

* After 6 weeks, this treatment was changed to: 7,5 °C; 6,5 °C; 4,5 °C; 3,5 °C.

RESULTS

The incidence of cold storage disorders in fruit from Everdon Estate was extremely low in 1993, when this study was carried out, which makes identification of trends related to the different temperature regimes difficult to identify. However, the following trends came to light:

'Fuerte'

Treatments 9 and 7 (Table 1) generally produced fruit with the highest incidence of disorders, although the incidence of disorders in these treatments was very low, viz 1 to 3 percent. It was expected that these treatments would cause the most chilling injury. Treatment 9 was a 5-week regime and cold storage disorders are known to increase with time in storage. Treatment 7 started at 4,5°C and increased to 7,5°C, so that the lowest temperature was when the fruit was most temperature sensitive. External cold damage decreased over all temperature regimes towards the end of the season, and pulp spot increased over all treatments, which is in agreement with the findings of Vorster et al. (1990).

'Hass'

The incidence of cold storage disorders was extremely low throughout the season, (even lower than for the 'Fuerte' fruit) which resulted in no definite trends emerging. Fruit firmness on removal from cold storage was acceptable (firmometer reading <35) for all temperature regimes through out the season. Firmometer readings on removal from cold storage were fairly uniform across all treatments, with few being significantly different from one another at the 5% level (Table 3).

DISCUSSION

At Everdon estate, fruit in the 1992 season was extremely susceptible to cold storage disorders. The 1993 season fruit was very tolerant to cold storage, as evidenced in this trial. We need therefore to analyse preharvest factors to determine the cause of the fluctuation in fruit quality. The 1992 crop was light, with vigorous vegetative growth. The 1993 crop was heavier and vegetative growth was less vigorous. This confirms industry experience that fruit physiological disorders are worse in seasons characterised by high tree vigour, usually associated with light cropping. The converse also applies.

Susceptibility to mesocarp disorders (van Rensburg and Engelbrecht, 1C85; Bower and Cutting, 1988) and chilling injury (Chaplin and Scott, 1980) have been associated with low calcium levels in avocado fruit. Calcium is transported to plant organs by mass flow in the xylem. Polar transport of indoleacetic acid (IAA) from an organ is also thought to affect Ca transport (Bangerth, 1979). Physiologically active organs such as developing shoots and fruit are vigorous exporters of IAA. In avocado trees, the spring flush overlaps to varying extents with fruit set and development. Fruit and new shoots therefore compete for resources, one of which is Ca. Because of their high physiological activity and transpiration rate, leaves and shoots are stronger sinks for Ca than fruit (Witney et al., 1990). It appears that in years of vigorous vegetative growth, less of the available calcium taken up by the tree is allocated to the fruit, resulting in a greater susceptibility to cold storage disorders.

TABLE 3.
Average firmometer readings for temperature regimes of 4 week duration placed in cold storage during August 1993.

4 August		12 August		18 August		25 August	
Regime	Firmometer	Regime	Firmometer	Regime	Firmometer	Regime	Firmometer
3	26.7 a	1	25.9 a	4	27.0 a	1	27.0a
6	26.9 a	3	26.6 a b	1	27.3 a	2	27.1 a
2	27.1 a	5	26.8 a b	7	27.4 a b	6	27.7 a
1	27.7 a	4	27.2 a b	3	27.4 a b	4	28.00 a
4	28.0 a	6	27.3 a b	2	27.9 a b	3	28.3 a
7	28.3 a	2	27.8 a b	5	28.2 a b	5	28.7 a
5	29.0 a	7	28.2 b	6	29.7 b	7	29.0 a

Values followed by the same letter do not differ significantly at P = 0,05.

It seems that the vegetative-reproductive balance in avocado trees is crucial in determining tolerance of the fruit to low storage temperatures. Cultural practices should be employed to reduce the vigour of the spring flush. Mulching to improve root health and application of soluble forms of Ca may also increase the amount of Ca allocated to the fruit.

Although it should be the aim of the grower to produce fruit tolerant of low storage temperatures, temperature management must still be available as a tool to control cold storage disorders in years of poor quality, and further research will be conducted in the 1994 season. It can also be concluded that the rationale behind the stepping down of fruit storage temperatures is sound and was beneficial in these trials, but is likely to be more beneficial in a problematical season (such as the 1992 season , and probably the 1994 season).

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