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THE INFLUENCE OF THE TIME TEMPERATURE INTERACTION ON THE SHELF-LIFE AND INTERNAL QUALITY OF AVOCADOS

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INTRODUCTION

The quality of South African avocados on European markets is variable, soft fruit and/or cold damage being the major problems. Physiological disorders, which are also problematical, have often been associated with low temperature storage (Chaplin, Wills and Graham, 1982; Eaks, 1976).

Temperature management which included adaptation of the temperature regime throughout the season (Vorster, Toerien & Bezuidenhout, 1987) and the implementation of declining temperature regimes over the storage period (Toerien, 1986; Vorster, *et al*, 1987). This approach was implemented experimentally during the 1986 season and on a larger scale during the 1987 picking season. These principles proved to be changes in the right direction (Milne, personal communication).

In theory the time-temperature interaction can be predicted to have a great influence on fruit quality. This is based on two principles, viz:

(a) The optimum temperature and storage periods of avocados vary with the stage of development (Bezuidenhout, 1983).

(b) The sensitivity of the avocado to low temperatures varies depending on the stage of climacteric (Kosiyachinda and Young, 1976).

The questions that were dealt with are:

How streamlined are the systems of the different growers from picking to pre-cooling, packing and consignment, and what is acceptable?

For how long can fruit be stored after arrival overseas and still be of acceptable quality?

Experiments were conducted to answer these questions.

MATERIALSAND METHODS

Experiment IA and B (Figure 1)

Fuerte avocados of count 14 (mass range 226 g to 305 g) were picked on May 21 and June 4, 1987 and precooled to16°C. Treatments included the following:

Storage period (days)

Treat-ment	16°C	7,5°C	5,5°C	3,5°C	Total storage period
I	1	6	7	7	21
II	3	4	7	7	21
III	5	2	7	7	21
IV	1	6	14	7	28
V	3	4	14	7	28
VI	5	2	14	7	28

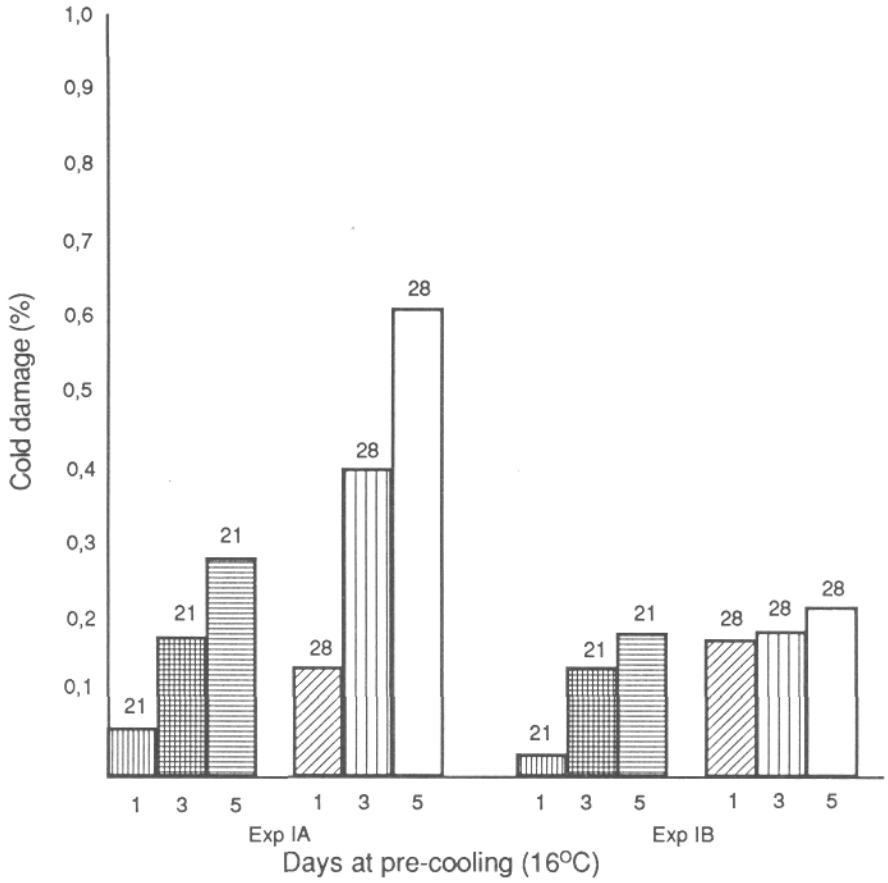

Fig 1 The influence of time of pre-cooling (16°C) on the incidence of external cold damage after storage periods of 21 and 28 days respectively. A temperature regime of 7,5°C (7,5 and three days respectively, depending on the period of pre-cooling), 5,5°C (14 days in the case of a total storage period of 28 days and seven days in the case of a total storage period of 21 days) and 3,5°C (seven days).

The total storage periods of 21 and 28 days could be compared, in addition to the effect of the different periods of pre-cooling. Ten cartons per treatment were used in every experiment. The fruit was left to ripen at room temperature. It was then inspected externally and internally for cold damage, pulp spot, grey pulp, vascular browning, anthracnose and stem end rot.

Experiment II

Pinkerton (experiments IIA, IIB and IIC) and Hass (IID) of count 14 were obtained from the commercial packing line of the packhouse at Westfalia Estate. Fruit was treated as follows:

After these periods the fruit was left to ripen at ambient temperature, cut and evaluated as previously described,

STATISTICAL ANALYSIS

Experiments were based on a completely random design and were analysed by the Kruskal Wallis test (Steel and Torrie, 1960).

RESULTS

Experiment IA (Figure 1)

Cold damage

An increase in external cold damage was observed, the longer Fuerte avocados were kept in pre-cooling (16°C) before cold storage. Statistically significant differences (P = 0,05) were observed between fruit pre-cooled for one day, compared with fruit pre-cooled for five days (total storage period 21 days), with more cold damage occurring after the longer period. Highly significant differences were found between fruit stored one day and three days (P = 0,01) in pre-cooling; one and five days (P = 0,01) and three and five days (P = 0,05) with a total cold storage period of 28 days. The longer storage period (28 days) resulted in more cold damage than the shorter storage period (21 days).

Treatment	Days	Temperature	Days	Temperature	Total storage period (days)
1	21	5,5°C	–	–	21
2	28	5,5°C	–	–	28
3	28	5,5°C	7	3,5°C	35
4	28	5,5°C	14	3,5°C	42
5	28	5,5°C	21	3,5°C	49

Experiment IB (Figure 1)

Although not always significant the. same tendency was observed as in experiment IA.

Experiment II

Physiological disorders

A very drastic increase in physiological disorders, such as grey pulp and vascular browning, were observed the longer the fruit was stored.

Experiment IIA (Pinkerton) Grey pulp (Figure 3)

Although the increase in grey pulp between the fruit stored for 21 and 28 days was not statistically significant, a highly significant increase (P = 0,01) was observed between 21 and 35, and 28 and 35 days respectively.

Vascular browning

(Figure 2)

Although not statistically significant, a definite tendency towards more vascular browning after long storage periods, was observed.

Experiment IIB (Pinkerton)

Grey pulp (Figure 3)

A significant increase in grey pulp (P = 0,05) was observed when the storage period was extended from 21 to 28 days.

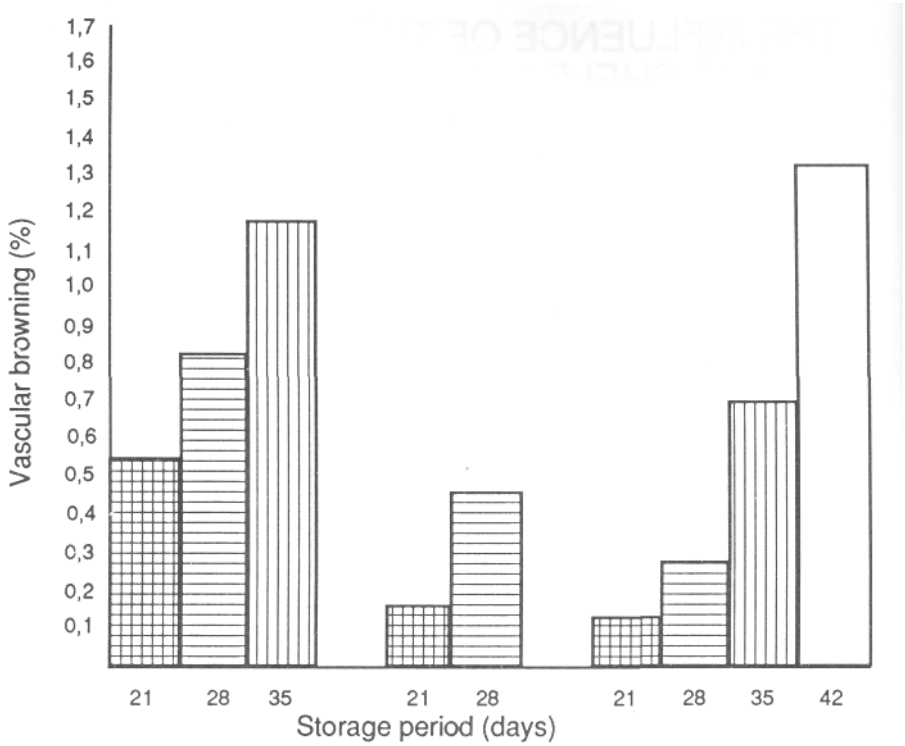

Fig 2 The incidence of grey pulp in Pinkerton avocados after different periods of cold storage. Periods of cold storage vary from 21 to 42 days. A storage temperature of 5,5°C was used for storage up to 28 days; 3,5°C was used for the periods after the original 28 days.

Vascular browning (Figure 2)

The increase in vascular browning, when the storage period was extended from 21 to 28 days, was significant (P = 0,05).

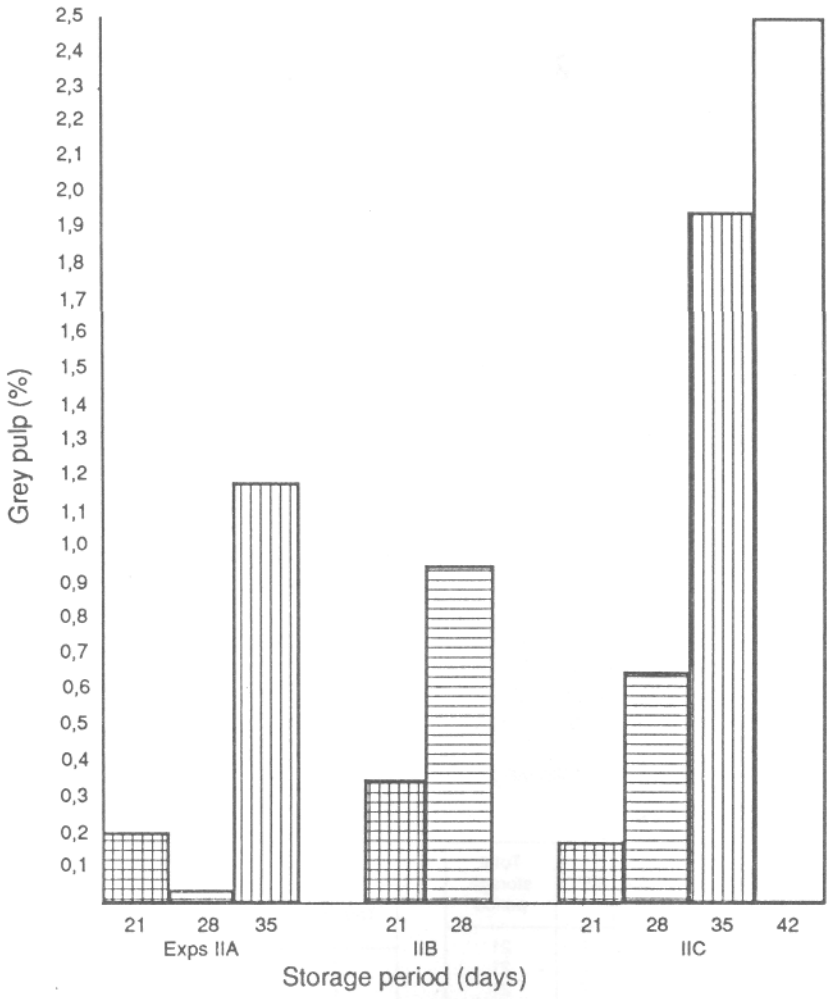

Fig 3 The incidence of grey pulp in Pinkerton avocados after different periods of cold storage. Periods of cold storage vary from 21 to 42 days. A storage temperature of 5,5°C was used for storage up to 28 days; 3,5°C was used for the periods after the original 28 days.

Experiment MC (Pinkerton)

Grey pulp (Figure 3)

Although not statistically significant, a definite increase in grey pulp was observed when the storage period was extended from 21 to 28 days. Highly significant differences (P = 0,01) were observed between storage periods of 21 days and 35 and 42 days respectively, and between 28 days and 35 and 42 days respectively. The increase in grey pulp from 35 to 42 days was also significant (P = 0,05).

Vascular browning (Figure 2)

Similar results to the above were obtained. A significant increase in vascular browning was observed the longer the fruit was stored.

Days to ripen (Figure 4)

Results are summarised in Figure 4. Highly significant decreases (P = 0,01) in shelf-life, the longer the fruit was stored, were obtained in all the experiments conducted,

Experiment IID (Hass)

A significant increase in grey pulp and vascular browning was observed the longer the fruit was stored beyond 21 days (Figure 5).

DISCUSSION

Time and especially the time-temperature interaction, is obviously a vital factor in an effort to achieve quality fruit on the overseas markets. Although the influence of the period of pre-cooling (16°C) on the sensitivity of Fuerte avocados to lower temperatures was done in only two experiments, there is a definite tendency for a longer period at 16°C (five days compared to one day) to give an increase in cold damage. According to Eksteen (personal communication), a high moisture loss through transpiration can be expected in a cold room at a temperature of 16°C. Air movement at this relatively high temperature will increase the rate of transpiration of the fruit, which will result in moisture loss. According to Lyons (1973), chilling injury can be reduced by a high humidity, which may simply suppress the expression of symptoms by reducing desiccation of necrotic tissues. Another possibility is the acclimatisation of fruit when exposed to progressively lower temperatures (Lyons, Raison & Graham, 1980). When an avocado is kept at a relatively high temperature, such as 16°C for a certain period, it may be that the fruit adapts to this temperature and that lowering of the temperature to 7,5°C or 5,5°C may therefore be a drastic cold shock.

The results in this report are preliminary and need to be repeated. However, the period of time that avocados are kept at a specific temperature, will have an influence on the ripening process of the fruit and its stage of development. This in turn, will affect the sensitivity of the particular fruit at a certain stage, to low temperatures. This is an important principle in the implementation of the concept of co-ordinated temperature management in the avocado industry.

Avocado growers should minimise the period of postharvest handling. What may happen in practice is the following: Fruit from grower A takes six days from picking until shipment. Fruit from grower B takes 13 days from picking until shipment. These fruits will differ completely in their stages of development. A temperature regime which is acceptable for the fruit of the one grower might lead to cold damage or soft fruit for the other grower.

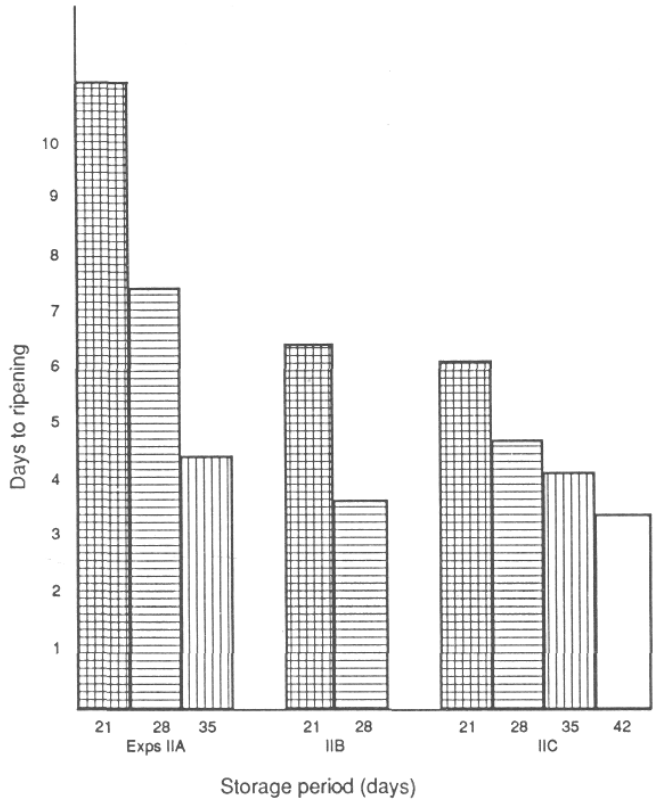

Fig 4 Days to ripening of Pinkerton avocados after different periods of cold storage. Periods of cold storage vary from 21 to 42 days. A storage temperature of 5,5°C was used for storage up to 28 days; 3,5°C was used for the periods after the original 28 days.

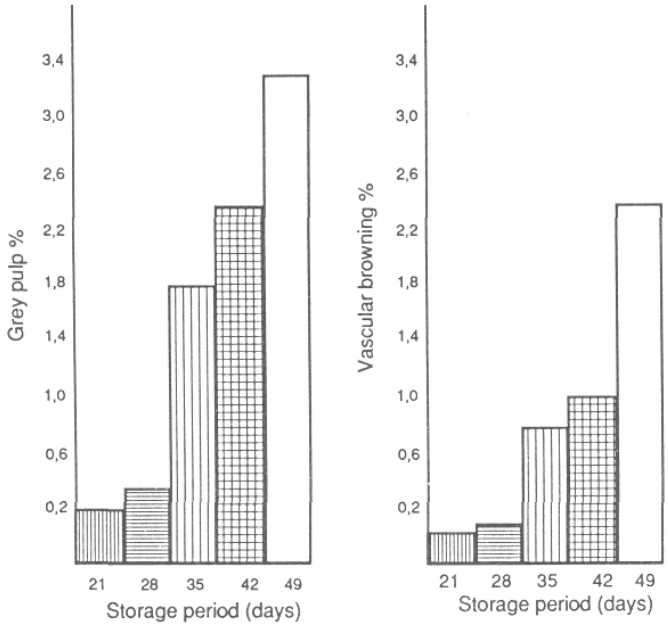

Fig 5 The incidence of grey pulp and vascular browning in Hass avocados after different periods of cold storage. Periods of cold storage vary from 21 to 49 days. A storage temperature of 5,5°C was used for the period up to 28 days; 3,5°C was used for the periods after the original 28 days.

There is no method of managing temperatures to the advantage of both growers. It might happen that the overseas market agent sells the soft fruit first. Firm fruit might then be stored at a low temperature and cold damage, as well as other physiological disorders, can be expected to result.

There is a regulation with regard to temperatures before fruit is inspected. However, even more important than a specific temperature within reasonable limits at the time of inspection, is the time from picking until consignment. At present there is no regulation which prevents an avocado grower from keeping his fruit for an unacceptable time under pre-cooling, or in his cold rooms, before consignment. Standardisation of this principle is essential in order to obtain the full advantage of temperature management.

From the results obtained, it is clear that time is one of the most important factors in determining fruit quality. A very drastic increase in physiological disorders was observed the longer the fruit was stored. The avocado industry must accept that there is only a limited time from picking until marketing. Therefore, the commercial chain from picking until marketing should be streamlined. If fruit is stored longer than a specific period, the quality can be seriously affected. A critical evaluation of such fruit on the overseas markets is needed as poor quality fruit has a depressing effect on marketing.

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