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1990 TEMPERATURE SURVEY OF EXPORT AVOCADOS

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INTRODUCTION

Transport and shipping temperatures of export avocados were measured for the third consecutive season. All 1990 shipments except the first three, were monitored and a detailed report was prepared.

During the past three years major breakthroughs were accomplished. These can be summarised as follows:

* The temperature management system has been tested on a semi-commercial basis and streamlined to such an extent that it became the standard system for the total avocado export industry.
* The problem areas in the cold chain have been identified, quantified and rectified to such an extent that virtually no direct losses occurred due to temperature management.
* Other factors such as age of the fruit, total heat load in the container and ventilation is becoming more and more important as temperature *per se* is better controlled.

The 1990 survey covered 22 containers shipped on 16 vessels and more than 2 million temperature readings were taken. In this report, however, only representative data to illustrate specific important findings is summarised. Procedures, materials and methods are not discussed, as it forms an integral part of the official report obtainable from the authors.

ROAD TRANSPORT

Refrigerated transport is not designed, or capable, to reduce the product temperature throughout the total load by more than 2°C. The date in Figure 1 proves that pulp temperatures can be maintained accurately if the correct procedures are applied. These are:

* Proper precooling of all the fruit to within 2°C from the carrying temperature.
* Proper calibration of all cooling and controlling equipment.
* Proper precooling of the refrigerated trailer and reducing temperature increases during loading.

Unfortunately Figure 1 represents only about 40% of all avocado fruit delivered to Cape Town during 1990. If the date in Figures 2, 3 and 4, describing the three different

shipping temperature regimes for the season, are considered, it becomes clear that:

* The average mean temperature of the fruit on the outside of the pallets was within 2°C of the shipping temperature and the standard deviation from the mean was more than 1°C. However ± 30% of the fruit on the outside were more than 2°C above the shipping temperature. This situation was aggravated by the fact that temperatures taken in the inside of the pallets were on an industry average basis between 2°C and 5°C higher than on the outside of the pallet.
* If the 2°C cooling that normally takes place during road transportation is considered, it is clear that 36% of the fruit of the 7,5/5,5°C and 6/5,5°C regimes were loaded into the refrigerated truck at more than 2°C above the optimum temperature. More than 60% of the fruit of the 5,5°C regime was loaded at more than 2°C above optimum.

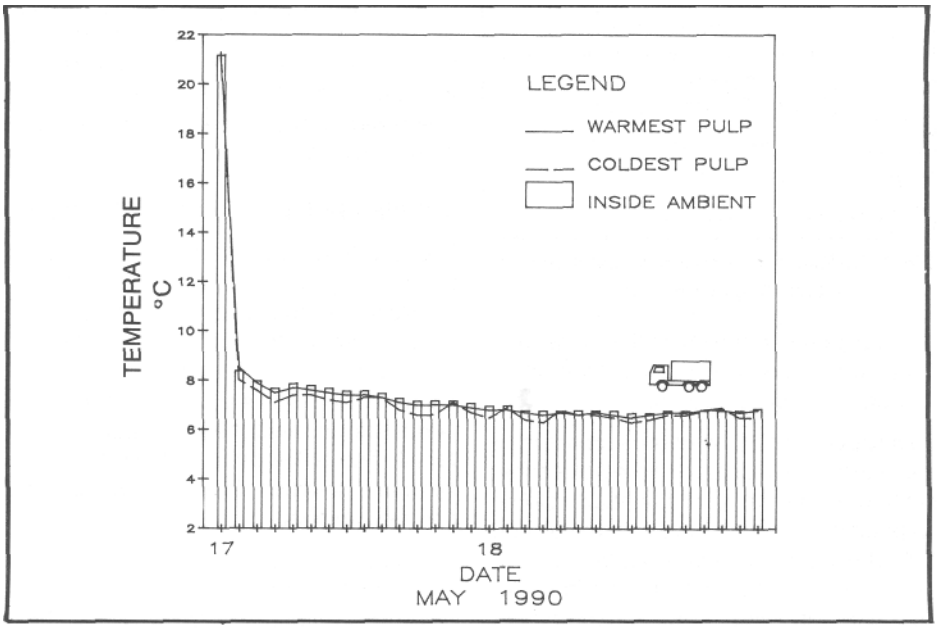

Fig 1 Pulp and air temperatures in coldest and warmest position road motor transport via ICS to ship.

This aspect should be of great concern to the industry, as research has indicated that not more than 10% of the total volume shipped per sailing should be more than 2°C above the optimum shipping temperature. This means that the maximum of 10% deadline fruit, as determined commercially by the industry, was exceeded by between 26% and 50%.

* Inadequate precooling in the production area can be considered as the major reason for mixed maturities, soft fruit and waste in the market place. The cold chain, although often accused, cannot rectify a problem that was initiated in the packhouse.

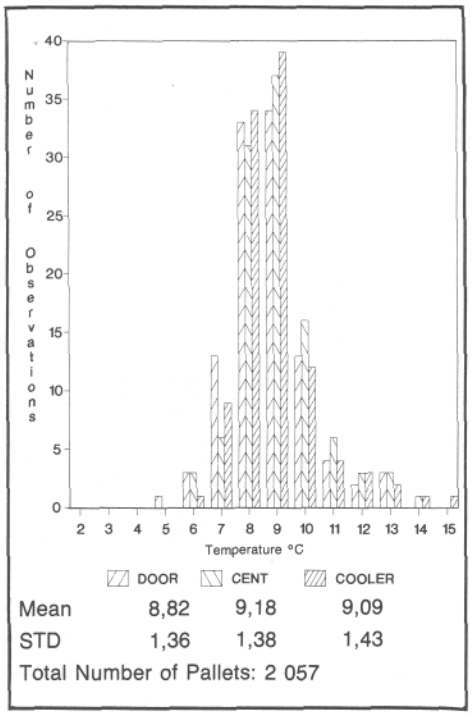

Fig 2 Temperature frequency distribution of avocados shipped at 7,5/5,5°C.

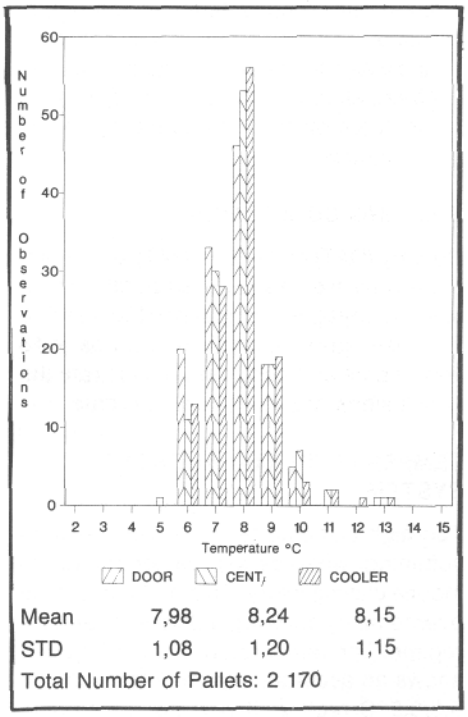

Fig 3 Temperature frequency distribution of avocados shipped at 6,0/5,5°C.

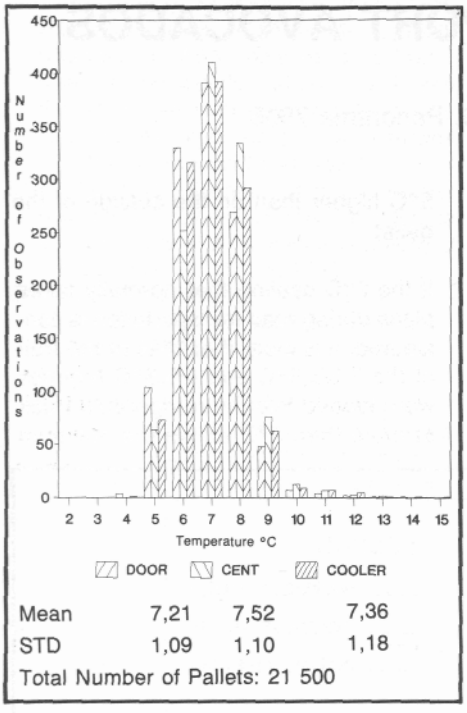

Fig 4 Temperature frequency distribution of avocados shipped at 5,5°C.

SHIPPING CONDITIONS

Delivery (DAT) and return (RAT) air temperatures, as well as fruit temperatures for specific voyages, are given in Figures 5 to 7. These figures are part of a series of 16 sets of data and serve only to illustrate the conclusions drawn from all the data.

TEMPERATURE MANAGEMENT SYSTEM

Too high shipping temperatures result in softening, whereas too low temperatures induce chilling injury. This problem can be overcome by applying a dual temperature regime. The temperature data in Figure 5 shows an accurate implementation of the 5,5/3,5°C regime. It is important to note that:

* The DAT can be changed and controlled accurately during the voyage. This proves that the strict temperature control required for the shipping of temperature sensitive products can be maintained in a commercial situation on the vessels.
* The RAT can be maintained within 1°C from the DAT and it shows a corresponding drop when the DAT is reduced.
* Coldest and warmest pulp temperatures followed the DAT and RAT respectively and did not show any increase during transfer into the container or during transfer into and out of the holding store.

It can, therefore, be concluded that both air and pulp temperatures can be kept within the prescribed optimum range. However, the fruit must be properly precooled to less than 2°C from the optimum carrying condition.

INSUFFICIENTLY PRECOOLED FRUIT

If all the fruit on a pallet is not cooled to the carrying temperature, heat from the centre moves to the top of the pallet. During transfer into the container, when there is no cooling, this heat results in an increase in RAT. If this situation occurs, temperatures as described in Figure 6 can result. The following deviations from the optimum situation (previous paragraph) can be identified:

* A sharp increase in RAT during transfer into the container which persisted for the full duration of the voyage. The difference between RAT and DAT slowly increased to more than 2°C.
* In order to correct the RAT increase, cold air at 4°C was introduced on various occasions. This had a negligible effect on both RAT and fruit temperature.
* The air temperature off the cooler was controlled accurately throughout the voyage. The DAT at container level was within the 5,5 ± 0,5°C specification for the first part of the voyage, but although within specification during the 4,0 + 0,5°C phase, the DAT tended to approach 5,0°C. This resulted in virtually no drop in pulp temperature in comparison to an almost 2°C decrease that can be obtained, as is shown in Figure 5.
* A steady increase in pulp temperature towards the end of the journey shows that heat of respiration was accumulating. It is suspected that poor ventilation through the pallet

has resulted in this temperature increase.

Temperature distribution through the pallet when shipped at 5,5/4,5°C

The data in Figure 7 summarises the air and pulp temperatures at the back (door) end of the container. This data illustrates the following very important aspects in the long distance transport of avocados:

* The difference between warmest and coldest pulp temperatures at the time of loading the container was approximately 0,5°C. This difference increased to almost 2°C after seven days and was not reduced during the rest of the voyage.

It is of the utmost importance to realise that the equipment used in transportation or shipping, cannot cool or recool produce that was either loaded too warm or warmed up in transit.

* The fact that the fruit at the bottom of the pallet, where the cold air was delivered, responded fairly well-to the DAT, but not the top fruit, is proof of insufficient air circulation through the pallet. The top fruit stayed at virtually the same temperature throughout the voyage, despite a 2°C drop in DAT.

  Fruit quality evaluations in the market place have proved undoubtedly that more physiological disorders occurred in the upper layers of the pallet. This is the direct result of elevated pulp temperatures during the voyage.

* It can also be seen from the data that the DAT was reduced to as much as ± 1°C below the optimum (so-called cold blasts) during the voyage. The reason for this is that the RAT from each and every container is constantly considered. Should the RAT increase to more than 1°C, the DAT is reduced by 0,5° for five hours out of every 12 hour period. The inconsistent DAT therefore proves that an attempt was made by the refrigeration engineer to control the temperatures within the specified optimum.

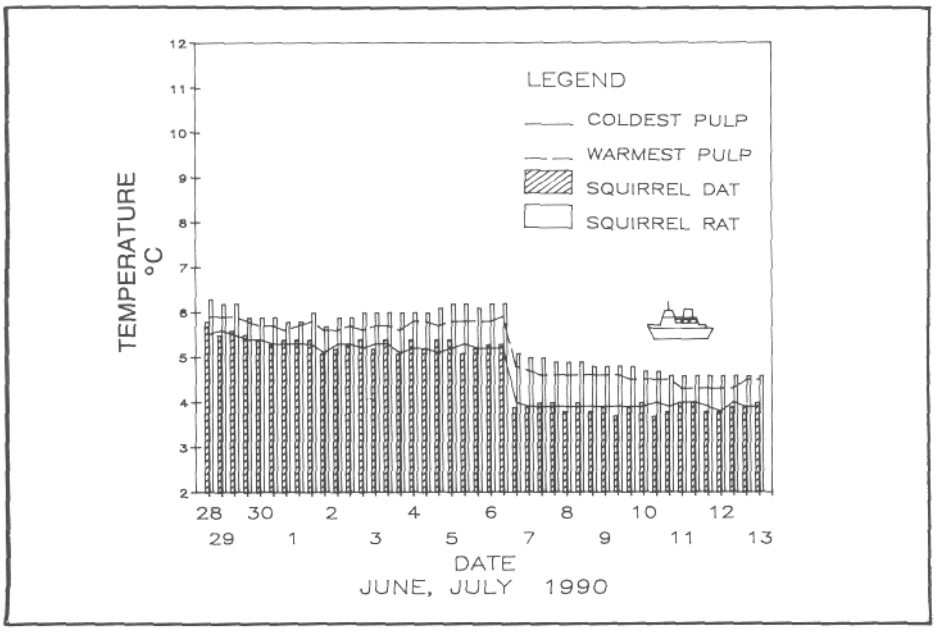

Fig 5 Delivery and return air and coldest, warmest pulp temperatures during the voyage of Winterberg A903.

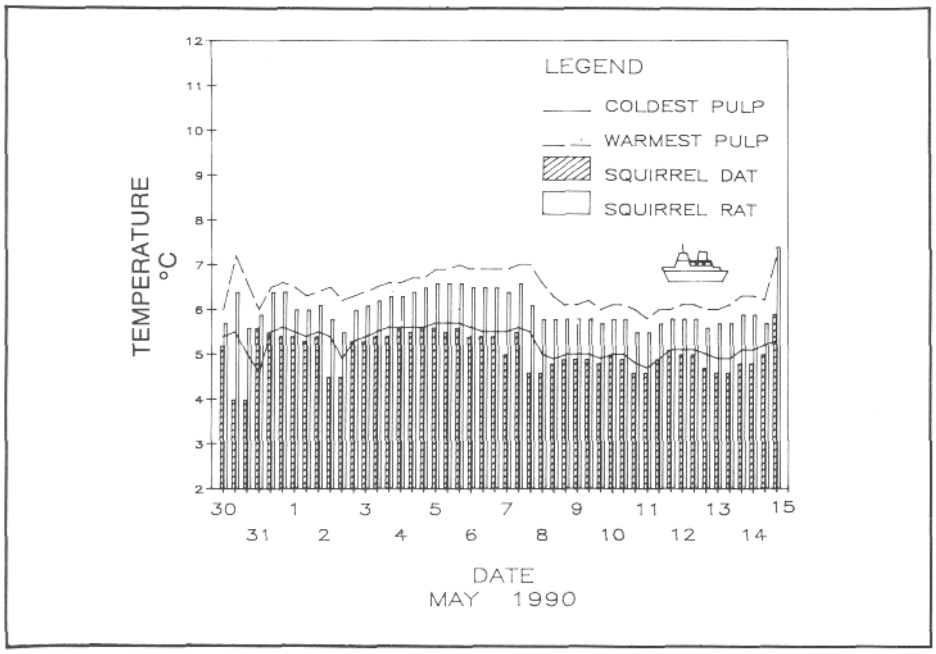

Fig 6 Delivery and return air and coldest, warmest pulp temperatures during the voyage of Heemskerck A900.

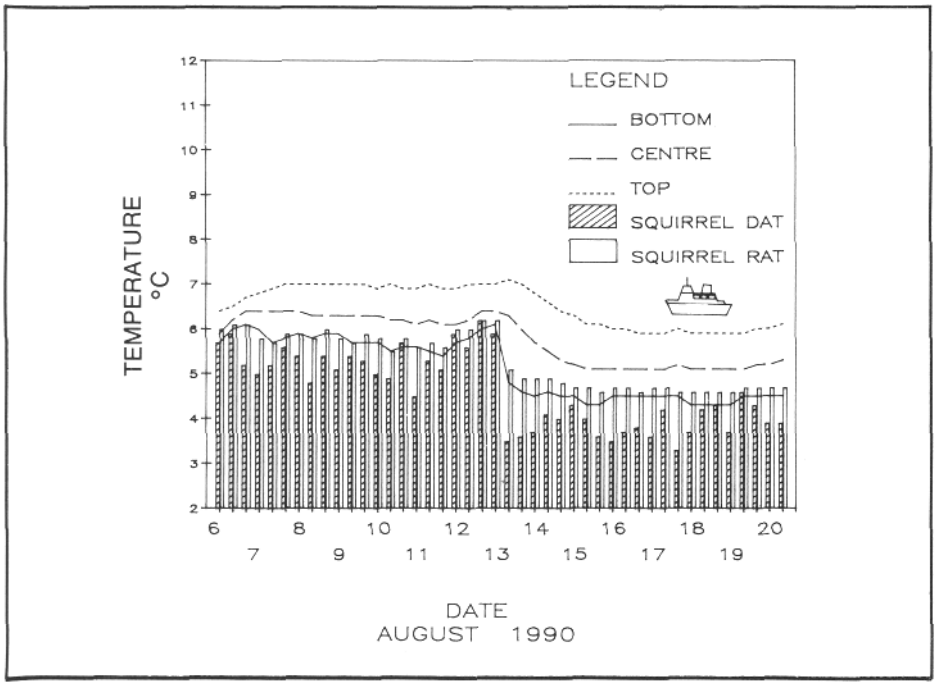

Fig 7 Bottom, centre and top pulp and delivery, return air temperatures at door side of container on Sederberg A907.

SUMMARY

1. Although the average mean temperature of the fruit on the outside of the pallet was within 2°C from the carrying temperature, approximately 30% of all deliveries arrived above this temperature. This means that as much as 60% of the fruit was not adequately precooled at the packhouse prior to dispatch.
2. It was found that the temperature of the fruit in the centre of the pallet could be between 2°C and 5°C higher than the outside fruit. This confirms the conclusion that the fruit was not adequately precooled.
3. The temperature management system where the DAT is reduced by 2°C seven days prior to discharge can be effectively applied if the fruit is properly precooled at the packhouse.
4. It is impossible to reduce pulp temperature to the carrying temperature if the fruit was not effectively precooled prior to refrigerated transport.
5. Inadequate ventilation through the pallet resulted in a steady increase in pulp temperature of fruit in the top layers of the pallet. This situation becomes worse in fruit that was not effectively precooled and has resulted in quality losses.

CONCLUSION

The 1990 temperature survey confirms the results of the 1988 and 1989 surveys that

good quality fruit can only be achieved with effective precooling and correct temperature maintenance throughout the total transport chain.

It also confirmed that the present avocado carton, the stacking configuration and pallet density do not allow for effective air circulation throughout the pallet.

ACKNOWLEDGEMENTS

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