Temperature Variations and Differences in Port-hole Containers

[1]S.A. Oosthuyse, [2]M. Oosthuizen, [2]B. Henning, and [3]L. Aucamp
[1]*HortResearch SA, P.O. Box 3849, Tzaneen 0850*
[2]*PPECB, P.O. Box 15289, Panorama 7506*
[3]*Inter Trading Fruit Corporation, P.O. Box 1720, Parklands 2121*

ABSTRACT

Prior to vessel loading, fifteen thermocouples were placed at various positions in two containers filled with pallets of mangoes. Air and pulp temperatures were monitored during the sea voyage from Cape Town to Europe.
In both containers, return air temperature (RAT) was an underestimate of average air temperature. This indicates that respiration of the fruits was elevated (Oosthuyse, 1997b). The temperature differences found clearly signify poor air movement through the pallets at the door-end of the containers, and a marked reduction in delivery air cooling with pallet height. The accentuation thereof (temperature differences) was apparently commensurate with the extent to which fruit respiration was elevated.
It is recommended that measures to avoid situations which may effect enhanced fruit respiration during container shipment be taken. These include the adherence to transit temperature specifications, the avoidance of delays in placing fruits in cool-storage after harvest, and the evasion of situations during transit which may effect a rise in fruit temperature. Methods to force delivery air movement through and limit air movement around the pallets in the containers are to be considered in further studies.

UITTREKSEL

Voor mango vrugte op 'n boot gelaai is, is termokoppels in verskillende plekke in twee houers vol palette geplaas. Lug- en pulp-temperature is gedurende die seereis tussen Kaapstad en Europa gemonitor. RAT (return air temperature) was by beide houers 'n onderskatting van die gemiddelde lugtemperatuur. Dit dui aan dat vrugrespirasie verhoog het (Oosthuyse, 1997b). Temperatuurverskille dui baie duidelik op 'n swak vloei van lug deur die palette aan die openingskant van die houers en 'n merkbare vermindering in voorsiening van afgekoelde lug met betrekking tot palethoogte. Die beklemtoning van die temperatuurverskille was oënskynlik eweredig aan die mate waarin vrugrespiraise verhoog het.
Daar word dus aanbeveel dat maatreëls geneem word teen situasies waarin vrugrespirasie verhoog word gedurende houerverskeping. Dit sluit die volg van vervoer-temperatuurspesifikasies, die vermyding van oponthoude om vrugte nadat dit gepluk is in koelkamers te berg, asook van situsies gedurende die vervoerperiode, wat die vrugte se temperatuur mag verhoog. Metodes om lugbeweging deur die palette te forseer, en dit om die palette te verminder, word in verdere navorsing oorweeg.

INTRODUCTION

Delivery air temperature (DAT) for a stack of containers and return air temperature (RAT) of individual containers are recorded on vessels carrying mangoes from South Africa to Europe. Temperature management involves the manipulation of the DAT of a stack.

In mango, container temperatures have been managed for many years despite there not being clarity on the rela-

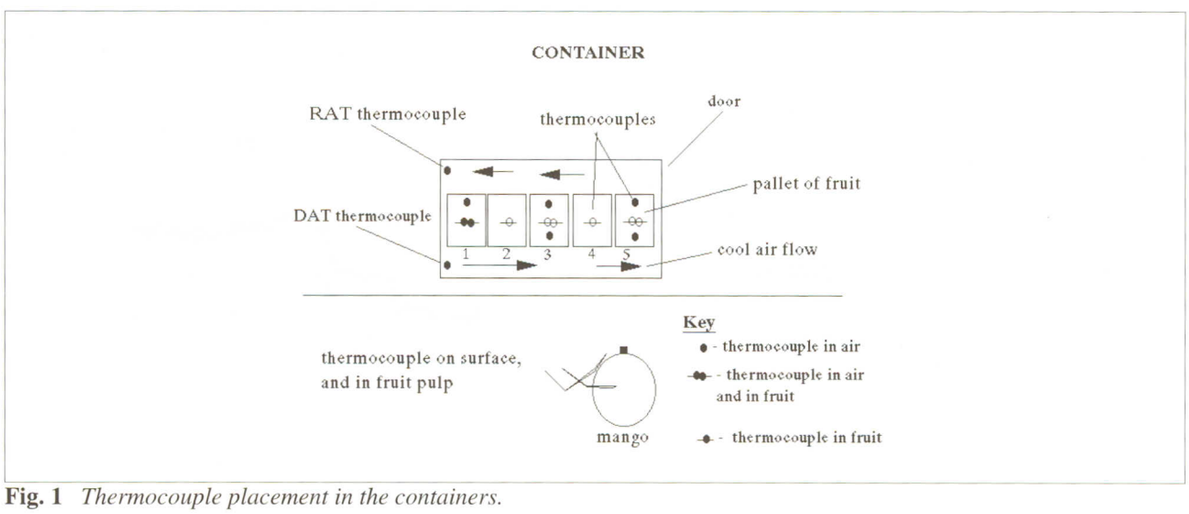

Fig. 1 *Thermocouple placement in the containers.*

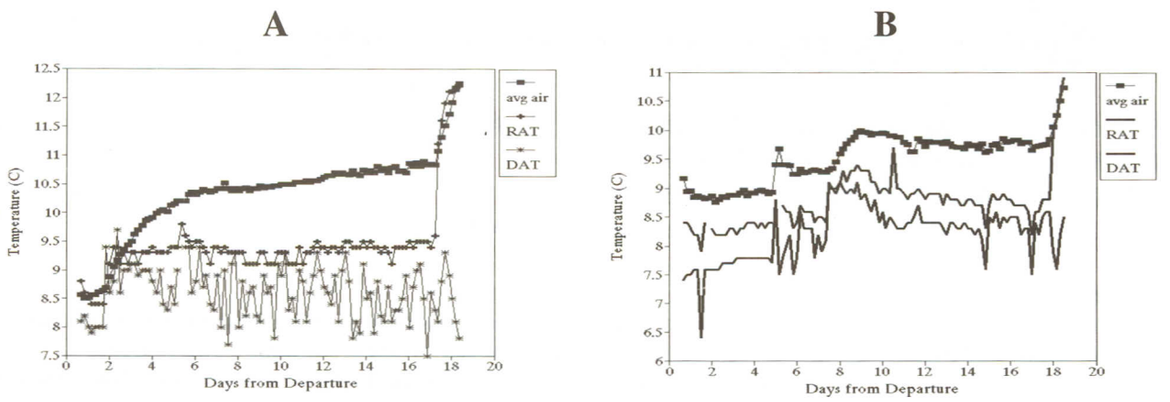

Fig. 2 *Average pallet air temperature in relation to return air temperature (RAT) and delivery air temperature (DAT).*

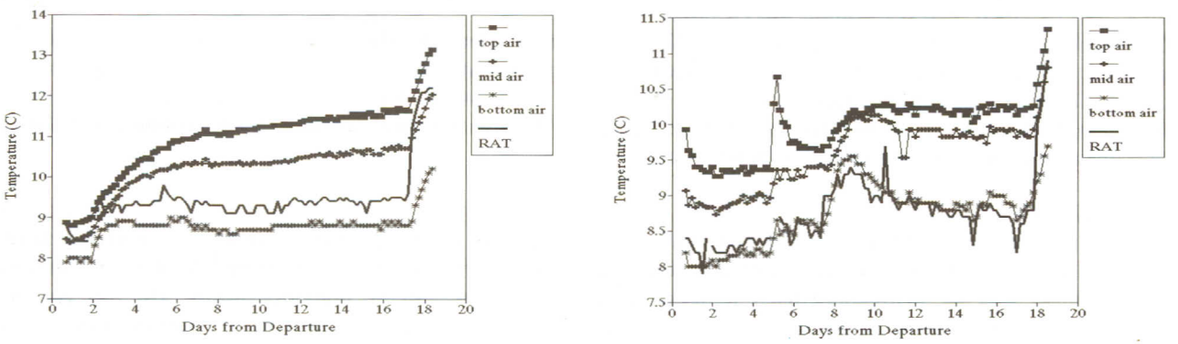

Fig. 3 *Average temperature of the air-thermocouples at the various heights in the pallets and RAT.*

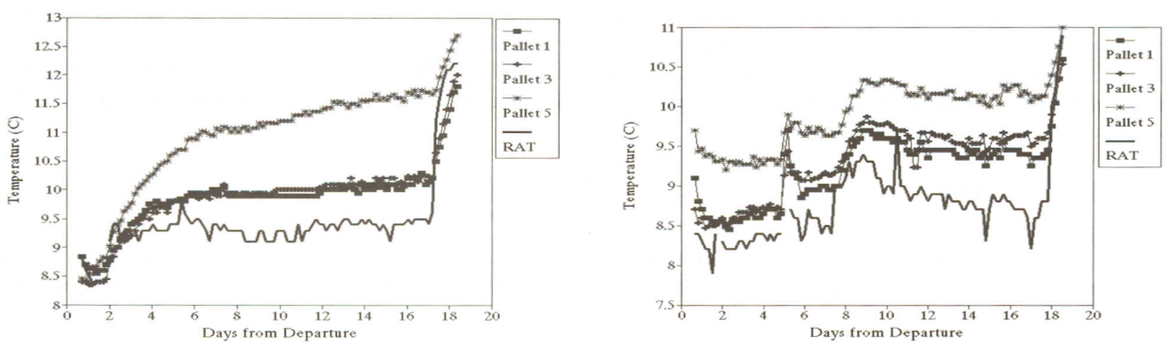

Fig. 4 *RAT and average temperature of the air-thermocouples in the pallets located at positions 1, 3 or 5.*

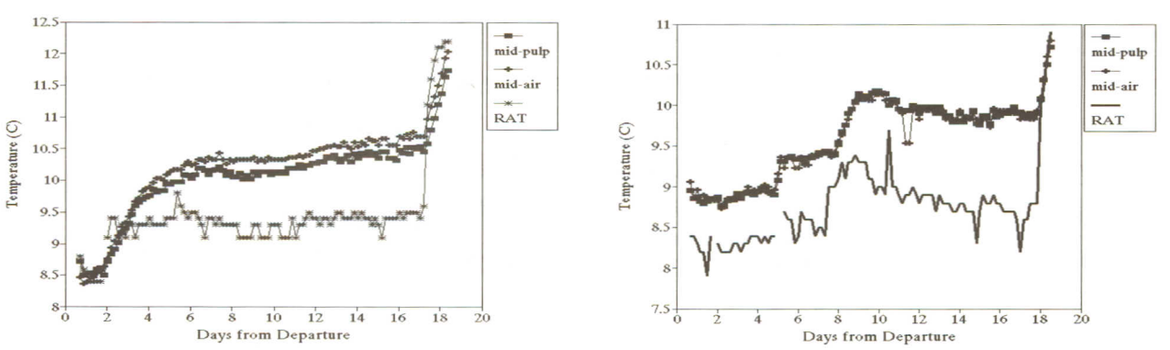

Fig. 5 *Average air temperature and average pulp temperature at the centre of the pallets.*

tionships existing between air or pulp temperature and DAT or RAT. In a previous study (Oosthuyse, 1997b), it was found that in certain instances RAT equals both average air and average pulp temperature. It was also observed that RAT is often less that average pulp or air temperature. These observations led to the conclusion that when respiration associated with fruit ripening is elevated, RAT is an underestimate of average pulp or pallet air temperature, but when fruit respiration is not elevated, RAT is an accurate indicator of pallet air or pulp temperature. It was stated that in the absence of elevated respiration, RAT measurements can be effectively used to manage the temperature of the fruit and air in the containers.

The aim of the present study was to further examine temperature associations in port-hole containers for the purpose of confirmation, and of gaining further insight of problems concerning temperature maintenance and cooling.

MATERIALS AND METHODS

A Grant Squirrel temperature recorder was placed in each of two containers just prior to vessel loading. The specified temperature was 8°C. The placement of the 15 thermocouples and of the temperature recorder was identical in each instance. Fig. 1 shows the locations of the thermocouples. Thermocouples were placed in and/or on fruits in inner central cartons (vertical core) located at various heights within the pallets. The *low* thermocouples were placed in the carton-row just above the lowest carton-row. The *mid*-thermocouples were placed in the central carton-row. The *high* thermocouples were placed in the row immediately beneath the top carton-row in the pallet. Where *fruit surface* air and pulp temperature were recorded, both temperatures were taken from the same fruits. Thermocouples were stuck to the surface of certain fruits, and were inserted to a depth of 2.5 to 3 cm in the same fruits (see Fig. 1). Thermocouples were placed in the five pallets on one side of the container. One thermocouple was placed at the point at which air was extracted from the container (to measure return air temperature - RAT) and one was placed at the position of air entry into the container (to measure delivery air temperature - DAT).

Temperature was logged every six hours from the time of departure until that of arrival in Europe.

RESULTS AND DISCUSSION

Figs. 2A and 2B show average pallet air temperature in relation to return air temperature (RAT) and delivery air temperature (DAT). In both containers, average pallet air temperature generally increased with time, and always exceeded RAT and DAT. This indicates that respiration was elevated in both containers. The differences were more pronounced in the first container (A) than in the second (B). This indicates that fruit respiration rate was greater in A.

Figs. 3A and 3B show average temperature of the air-thermocouples at the various heights in the pallets and RAT. In both containers, air temperature increased with height in the pallet. At any stage, the difference between RAT and average air temperature at the bottom the pallets was relatively small. This signifies that much of the delivery air was not active in cooling the fruits in the pallets, it generally having bi-passed and not moved through the pallets.

Figs. 4A and 4B show RAT and average temperature of the air-thermocouples in the pallets located in positions 1, 3 or 5. Average temperature in Pallet 5, the pallet used which was closest to the door, was elevated. This was particularly so in A, and signifies a lack of air movement through the pallets at the door-end of the containers.

Figs. 5A and 5B show average air temperature in relation to average pulp temperature at the centre of the pallets. Average pulp or air temperature generally increased with time. Both temperatures exceeded RAT, the disparity being most marked in A. In each container, the difference between pulp and air temperature at any stage was small.

The data confirm **1)** that RAT may markedly underestimate actual container air or fruit pulp temperature, **2)** that DAT is a poor indicator of air or pulp temperature, and **3)** that pallet cooling by the delivery air is inefficient, particularly of the pallets at the door-end of the container.

To limit fruit respiration in the container, it is advised that growers adhere to transit temperature specifications, avoid delays in the placement of fruit in cool-storage after harvest (Oosthuyse, 1992, 1994, 1997a), and avoid situations during transit which might cause a rise in fruit temperature (when the fruit are transferred, for example). Methods to force increased delivery air cooling of the pallets are to be considered in future studies. These may include the blocking of the air spaces between the pallets in the containers.

ACKNOWLEDGEMENTS

Thanks are also due to Claude Tabanelli (Tzaneen Fruit Packers), Louis Aucamp (Intertrading), Bernard Henning (PPECB) and Martin Oosthuizen (PPECB) for their contributions.

LITERATURE CITED

OOSTHUYSE, S.A. 1992. Correlating pre-storage ripeness of mangoes with the proportion of good quality fruit present after four weeks of cold-storage. *S.A. Mango Growers' Assoc. Yearbook* 12:80-83.

OOSTHUYSE, S.A. 1994. Quality of mature Zill mangoes after long-term refrigerated storage as determined by pre-storage ripeness and cold-storage regime. *S.A. Mango Growers' Assoc. Yearbook* 14:37-42.

OOSTHUYSE, S.A. 1997a. Effect of cool-storage delays after harvest on the extent of ripening during and fruit quality after cool-storage. *S.A. Mango Growers' Assoc. Yearbook* 17:81-85.

OOSTHUYSE, S.A. 1997a. In transit temperature relationships of two shipping containers loaded with mangoes. *S.A. Mango Growers' Assoc. Yearbook* 17:90-94.