Temperature Maintenance Efficiency of Road Motorised Transporters Containing Mangoes

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ABSTRACT

Thermocouples were placed at various positions in the trailer of refrigerated motorised transporters (RMT's) carrying mangoes to Cape Town Harbour from packhouses in the Tzaneen region. Air and fruit pulp temperature rose during the period of transit by 1.5 to 2°C. Fruit pulp and air temperature differed very little, this indicating that the fruit were not a source of heat. Air temperature differences existed between pallets, which signifies uneven distribution of cool-air in the trailers. Floor temperature was markedly greater than pallet air temperature and oscillated with time. This indicates that a source of heat was the trailer floor. The sides and ceiling of the trailers may also have been a source of heat.

The data show that air temperature maintenance of the RMT's is not efficient. Enhanced air circulation within the trailer and a reduction in delivery air temperature during transit ("temperature management procedures") may improve the situation.

INTRODUCTION

The arrival of soft mangoes at fruit warehouses in Europe was a problem experienced during the 1996/97 export season. Such arrivals occurred despite temperatures being as specified during the sea voyage to Europe. Oosthuyse (1992, 1994) previously showed that mangoes experiencing elevated temperatures for various periods prior to their placement in cool-storage ripen at an increased rate during cold-storage.

In view of this finding, the temperature maintenance efficiency of a number of refrigerated transporters of mangoes to Cape Town docks was assessed.

MATERIALS AND METHODS

A Grant Squirrel temperature recorder was placed in the trailer of each of three RMT's at the time of loading. The RMT's were loaded with mangoes procured from different locations in the Tzaneen region. 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. The 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

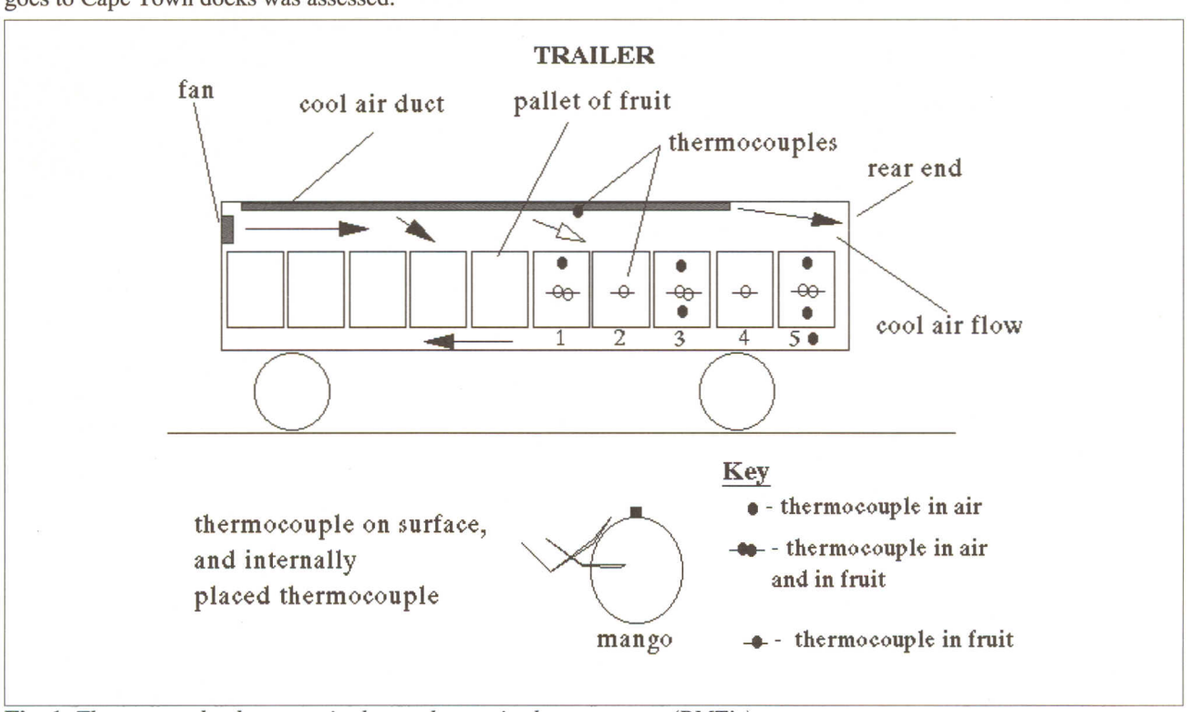

Fig. 1 *Thermocouple placement in the road motorized transporters (RMT's).*

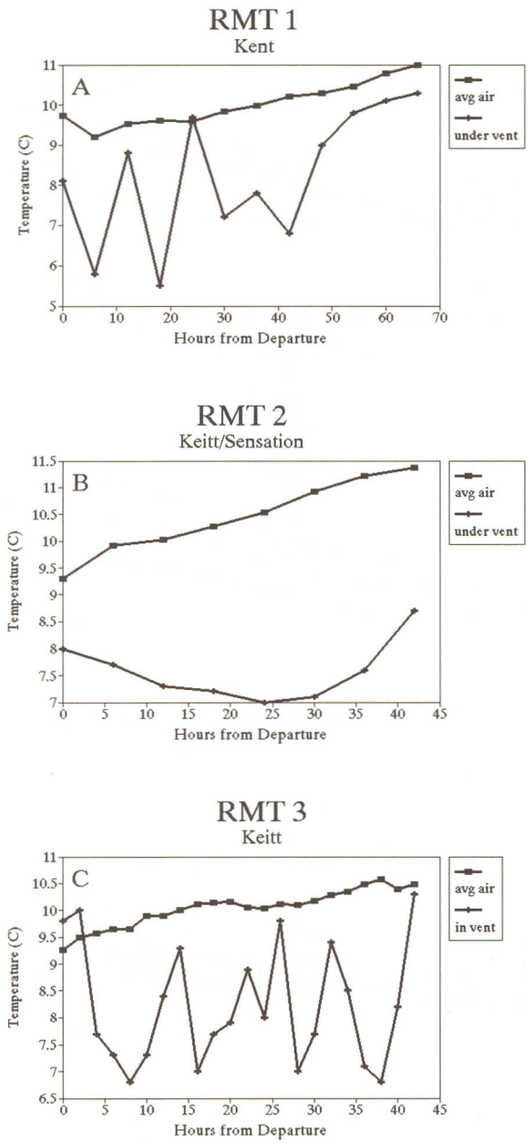

Fig. 2 *Average pallet air temperature and air temperature in the air duct (delivery air temperature).*

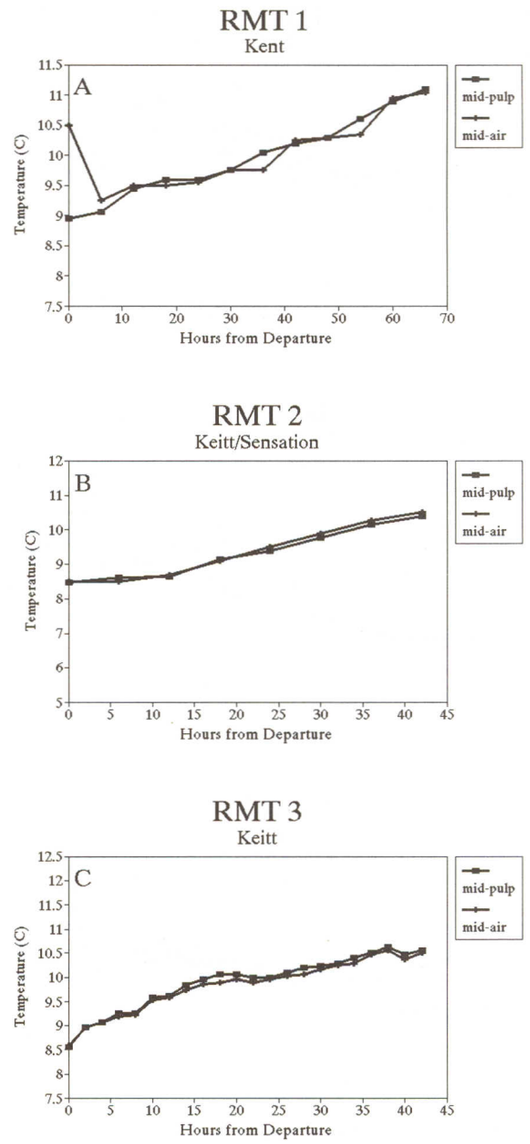

Fig. 3 *Average pulp temperature and average temperature of the thermocouples placed on the fruits from which pulp temperature was measured.*

placed in the central row. The "high" thermocouples were placed in the row immediately beneath the top carton row in the pallet. Where fruit surface air temperature and pulp temperature were recorded, both temperatures were taken from the same fruits. Thermocouples were stuck to the surface of certain fruits and were also inserted to a depth of 2.5 to 3 cm into the same fruits (see Fig. 1). Thermocouples were placed in five adjacent pallets on one side of the trailer and in the pallets closest to the rear-end of the trailer. One thermocouple was placed in the cool-air duct on the ceiling of the trailer (DAT thermocouple), and one was placed above the floor beneath the pallet closest to the door (floor thermocouple).

Temperature was logged every six hours from the time of departure until that of arrival at Cape Town docks. The first vehicle carried Kent fruits (RMT 1), the second vehicle carried Keitt and Sensation fruits (RMT 2), and the third vehicle carried Keitt fruits (RMT 3).

RESULTS

Figs. 2A, 2B and 2C show average air temperature in the pallets in relation to the temperature of the air in the air duct (delivery air temperature or DAT). Air duct temperature was variable in two of the trailers, and was generally less than the temperature of the air around the fruits. Average pallet air temperature increased with time. The increase during the transit period varied from 1 to 2°C.

Figs. 3A, 3B and 3C show average pulp temperature and average temperature of the thermocouples which were placed on the fruits from which pulp temperature was measured. Air and pulp temperature increased with time. Air and pulp temperature differed very little at every stage. This

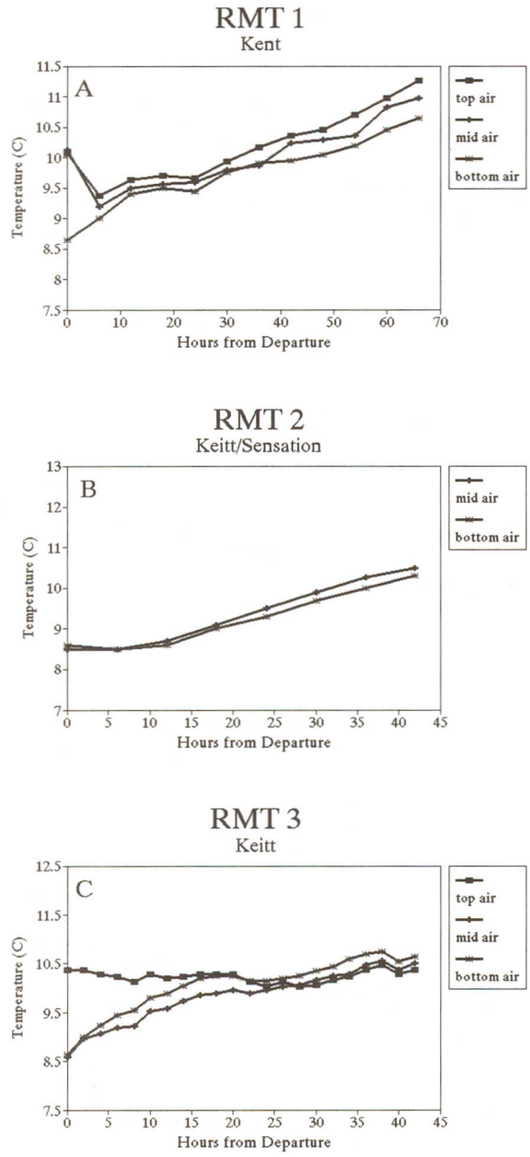

Fig. 4 *Average temperature of the air-thermocouples located at the various heights in the pallets ("top air" temperature in RMT 2 was not recorded).*

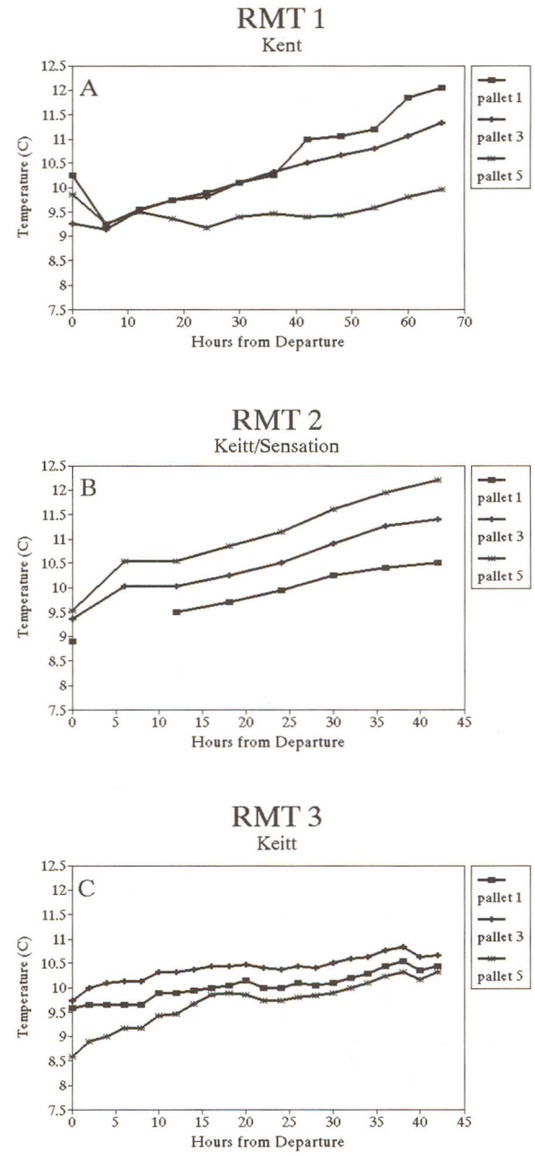

Fig. 5 *Average temperature of the air-thermocouples respectively located in Pallets 1, 3 and 5.*

indicates that the increase in pallet air temperature observed was not due to heat emanating from the fruits. The increase in these temperatures during the transit period varied from 1.5 to 2°C.

Figs. 4A, 4B and 4C show average temperature of the air-thermocouples located at the various heights in the pallets. Temperature increased with time. Differences in relation to height in the pallet were non-consistent between trailers and were relatively small at any stage.

Figs. 5A, 5B and 5C show average temperature of the air-thermocouples respectively located in Pallets 1, 3 and 5. Temperature differences at any stage were relatively pronounced, but were not consistent between trailers. This result indicates uneven air flow with respect to pallet position. Here, the increase in temperature during the transit period varied from 0.5 to 2.5°C.

Figs. 6A and 6B show the temperature of the thermocouple beneath Pallet 5 and average pallet air temperature. At times the difference was relatively pronounced. Moreover, floor thermocouple temperature increased and decreased with time, and was generally greater than average pallet air temperature. This indicates the presence of a "variable" heat source which influenced average pallet air temperature.

CONCLUSIONS

Air and pulp temperature increased in all of the refrigerated trailers examined. The data indicate that the source of heat was not the fruits themselves. The temperature of the air just above the trailer floor appeared to be elevated and oscillated with time. It might thus be concluded that a source

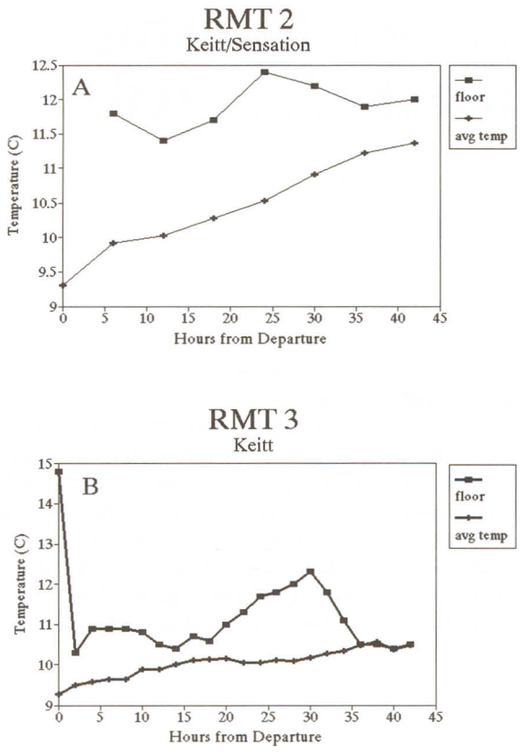

Fig. 6 *Temperature of the thermocouple beneath Pallet 5, and average pallet air temperature (floor temperature was not recorded in RMT 1).*

of the heat was the trailer floor. The sides and ceiling of the trailer may also have been a source of heat.

It is concluded that air temperature maintenance of the trailers is not efficient, and that this is probably due to inadequate air circulation and the presence of sources of heat within the trailers. The insistence of temperature management procedures during transit, and the improvement of air circulation within the trailers by introducing "octopus-leg" type cool-air ducts should enhance efficiency.

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