



Handling guideline for the export of 'Star Ruby' grapefruit to the USA

Dr. Paul Cronje
Citrus Research International

Export of grapefruit to the USA has recently become a possibility through inclusion of the Northern Cape in the USA export programme. Although South African citrus producers have been shipping grapefruit for many years to Japan under a cold steri protocol, there is a limited amount of information available on the ability of grapefruit to tolerate the compulsory longer cold-sterilisation treatment required for the export of citrus fruit to the USA. Internationally published studies indicate that there is a very high risk of chilling injury associated with shipping grapefruit below 0°C

for extended periods, which could be more problematic under commercial export conditions. In addition, the South African citrus industry does not have experience of shipping grapefruit from semi-arid regions under cold-sterilisation conditions of more than 24 days. Therefore, there is an urgent need to develop handling guidelines for grapefruit to be exported to the USA to reduce the risk of chilling injury. The practises used in the grapefruit export program to Japan give us the closest estimation of which factors to control in order to minimise the incidence of chilling injury to 'Star Ruby' grapefruit under commercial cold-sterilisation conditions. Symptoms of chilling injury of citrus fruit manifest as pitting or scalding of the rind (see Photo 1), when cold storage temperature is below 0°C for an extended duration.



Photo 1. Pitting symptoms due to chilling injury of a 'Star Ruby' grapefruit with poor colour (right) development.

All producers and exporters who plan to ship 'Star Ruby' grapefruit to the USA in 2010 should therefore take note of the very high risk involved in this undertaking. Commercial realities in the cooling and shipment of fruit to the USA result in higher risk, compared to that of the Japan programme. This higher risk is due to aspects such as pre-cooling and the use of a lower setpoint temperature (-1.5°C) during loading of the ship, to ensure all

temperature measurement points corresponds to the USA protocol, before the official start of the 24-day cold-sterilisation period. Additionally, logistic delays of getting fruit tin-to the USA, viz. loading in Cape Town, calibration/correct start-off temperature on all decks in the ship, offloading in the USA, could increase the fruit's exposure time at -0.5°C to more than 30 days.



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Internal fruit quality

The importance of internal quality measurements (maturity indexing) is largely to determine the harvest window as it is known that fruit from the beginning and end of the picking window are more susceptible to chilling injury. Harvesting of the fruit for the USA program should only start 10-14 days after the fruit reached the suggested internal quality (Table 1) and developed the suggested colour specification (Table 2). Furthermore, it is

advised to keep within a 4-week picking window from the start of the harvest of FULLY coloured fruit with the suggested internal quality specifications. Well-coloured 'Star Ruby' fruit (which have lower chilling susceptibility) have a lower °Brix compared to poorly-coloured fruit. Therefore, the relationship between rind colour and internal quality with regard to chilling injury is the inverse.

Table 1. Suggested internal quality specifications for 'Star Ruby' grapefruit to be exported to the USA.

Internal quality	Minimum standard
Minimum juice content	45%
Minimum °Brix	9.5°Brix
Minimum sugar to acid ratio	7.0:1
Minimum acid %	~
Limit for seed content - Star Ruby	5

External fruit quality

Good rind colour development (red pigments = carotenoid) is thought to be very important in minimising the incidence of chilling injury of 'Star Ruby' grapefruit. Therefore, strict adherence to the colour specification is required during the packing of grapefruit for the USA market. However, the minimum amount of red colour development necessary to significantly reduce the risk of chilling injury

has not been determined. Exposure of fruit to ethylene will not increase the amount of carotenoid pigments (and therefore the chilling resistance), but will unmask the carotenoid pigments by removing the green chlorophyll pigments. The amount of carotenoids is determined in the orchard, with sun-exposed fruit having visibly lower levels compared to fruit developing in semi-shaded and shaded parts of the canopy.

Table 2. Suggested external quality specifications for 'Star Ruby' grapefruit to be exported to the USA.

External quality	Minimum standard
Rind colour: CRI Colour Set 35(c)	Fruit rind colour should be fully developed prior to being packed with 90% of the fruit rind corresponding to print no. T1, with a 10 % tolerance of fruit until T3. Fruit with a pale or green area in-between the red should not be packed.
Fruit shape: CRI Sheepnose Set no. 41(b)	Print no. 5 with a 10% tolerance of print no. 6.
Sunburn	Remove ANY fruit with symptoms of sunburn as they are highly susceptible to chilling injury. (<i>No colour set available</i>).



Packhouse operations

All packhouse treatments that can cause physical damage to the rind should be avoided. Therefore check the number, softness and speed of brushes, as well as the time of the fruit on the brushes.

- Wax application
 - Good wax application/coverage can decrease symptom development of chilling injury. It is advisable to use a wax that have high solid contents and which have been previously successfully used in the USA programme.
 - Fruit with no wax application, as in the case of organically packed fruit, could be more susceptible to chilling injury due mainly to higher moisture loss

from un-waxed fruit. It is therefore highly recommended to use even stricter colour grading specifications for such un-waxed fruit.

- Fungicide treatments

The use of TBZ (thiabendazole) in the drench and in the wax at CRI recommended rates is strongly advisable (Table 3). However, TBZ should not be applied twice in the packline (fungicide bath and wax) as this could result in an exceeding of the maximum residue level for TBZ. TBZ is known to reduce the incidence of chilling injury in citrus fruit and can be applied as Tecto, Thiazole or ICA and UCP thiabendazole which are brand names of the registered TBZ formulations, with the same active ingredient.

Table 3. Suggested application time and concentration of TBZ during postharvest handling of 'Star Ruby' grapefruit to be exported to the USA.

Time of application	Amount of TBZ	Amount of water/wax	Concentration
Drench	2 Litres	1000 Litres water	1000 ppm
Wax	200 ml	25 Litres wax	4000 ppm

Transport from packhouse to Cape Town harbour

Several reports indicate an improved resistance to chilling injury of grapefruit after a 3-day "wilting/curing" treatment. However, this **practice** has not been fully documented in regard to time, environmental conditions and fruit weight loss necessary to significantly reduce chilling injury incidence, but appears to be beneficial and should be optional. If a producer chooses to employ this practise the following guidelines could be used:

- Wilting/curing of grapefruit takes place after packing of the fruit.
- Leave pallets in a shaded, well ventilated area of the packhouse.
- The fruit should be kept at ambient temperature (~20°C) for 3 days.

An increase in fruit pulp temperature due to direct sun exposure during transport from the packhouse to the harbour must be avoided as this will cause increased water and weight loss from the fruit and also negatively affect quality. If possible, fruit should be transported in Tautliner or refrigerated trucks. Refrigeration during transport to Cape Town is advisable, but should be between 10-15°C, to avoid condensation during unloading and inspection by the USDA. Therefore, fruit should not be cooled to a temperature near cold-sterilisation temperature in the packhouse, reefer, refrigerated road or rail truck, as this will not only cause condensation but also increased water loss after the mandatory USDA inspection because of a break in the cold chain.



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Pre-cooling, loading, shipment and off-loading

During this part of the postharvest chain, no access to the fruit is allowed as the fruit is under the cold-sterilisation protocol process until released by the USDA in Holt-terminal, Philadelphia, USA.

Post-USDA inspections in the USA

It is strongly advised that 'Star Ruby' grapefruit be distributed as soon as possible from the Holt-cold storage terminal (~1-4°C). Subsequent storage of the fruit at this low temperature could increase the susceptibility to the development of chilling injury. Avoid any additional exposure to temperatures below 4°C in the logistical cold chain, e.g. supermarket cold store.

Chilling injury severity is a factor of time x sub-optimal temperature and must therefore be the primary focus of all role-players to minimize the time that fruit is subjected to lower than optimum chilling temperatures as required in the postharvest cold treatment handling chain.

Grapefruit are more susceptible to chilling injury than oranges and the longer the period of shipment at sub-zero conditions, the greater the risk of chilling injury. All parties involved in handling 'Star Ruby' grapefruit to the USA should acknowledge the very high risk of exporting the fruit to this market.

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