

# Pretty in pink

A simple solution brings a blush to the cheeks of pink grapefruit – and solves a chilling export dilemma.



Higher levels of lycopene in the coloured part of the rind reduce the fruit's sensitivity to chilling injury.

**REMEMBER** how your mother used to say that too much of a good thing is bad? Nothing could be truer for grapefruit in the cold chain. In the fresh fruit export industry, cold sterilisation is a way of eliminating pests such as the false codling moth larvae. But when it gets too cold, typically below 4,5°C, the rind of grapefruit pits or scalds – a phenomenon known as chilling injury.

Many countries have their own protocols that govern the handling of fruit exported to them. These include cold chain requirements. Japan, for example, demands that citrus exports have to be kept at -0,6°C for 12 of the days it is in transit. The American and Chinese requirements are even more extreme, extending the period to 24 days.

For grapefruit, these requirements are clearly too much of a good thing.



## LYCOPENE TO THE RESCUE

In an attempt to resolve the chilling injury conundrum, researchers have found that yellow grapefruit cultivars are more susceptible to chilling injury than the pink ones. It turns out that the pink cultivars are naturally protected by a molecule called lycopene, the same molecule that gives 'Star Ruby' grapefruit its pink colour. Higher levels of lycopene in the coloured part of the rind reduce the fruit's sensitivity to chilling injury.

This significant finding about lycopene in grapefruit led to a Post-Harvest Innovation Programme project in which Citrus Research International (CRI) collaborated with Spanish citrus researchers at CISC-IATA in Valencia, to find ways to increase the production of lycopene in 'Star Ruby' grapefruit in order to reduce incidences of chilling injury.

To achieve this goal, three objectives were set:

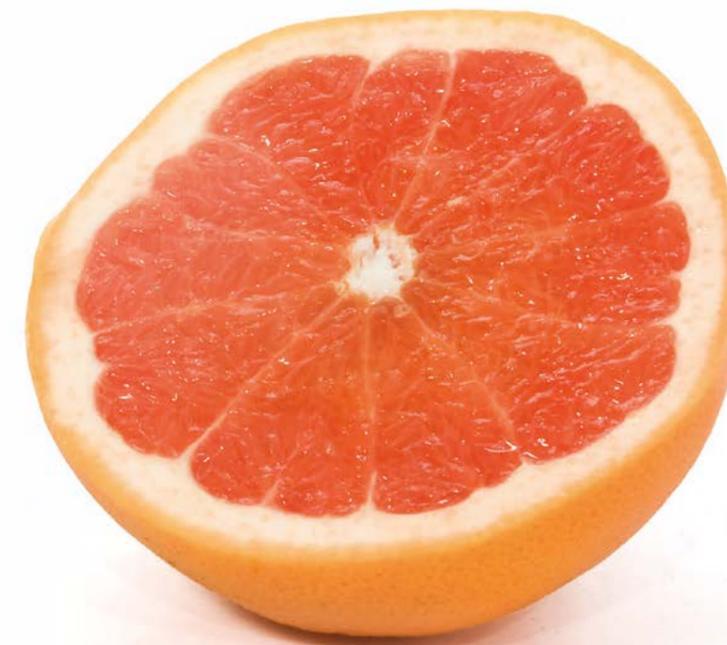
- Find ways to influence pre-harvest fruit development to increase lycopene content in two diverse climates, namely Kakamas (desert) and

## THE LOWDOWN ON LYCOPENE

Apart from making 'Star Ruby' grapefruit pink, lycopene also colours tomatoes red. It is not, however, responsible for the colour in strawberries.

The synthesis of lycopene in grapefruit occurs in semi-shade conditions and differs significantly from the synthesis in other fruit species such as tomatoes.

In addition to being a pigment, lycopene is also a carotenoid (the pigment in citrus fruit that colours the rind and pulp) and an extremely potent antioxidant. Its health benefits include reducing the risk of prostate cancer.



Hoedspruit (subtropical). Grapefruit from Kakamas is exported to the USA, while Hoedspruit's produce goes to China and Japan.

- Develop post-harvest treatments to increase lycopene.
- Develop colour charts and sorting techniques that can be used in the pack house to decide which fruit should be sent to which markets, depending on whether or not there is enough lycopene present in the rind to withstand cold sterilisation temperatures.

Dr Paul Cronjé, who is seconded to the Department of Horticultural Science at Stellenbosch University by CRI,

led the South African part of the study. The Spanish researchers were Dr Lorenzo Zacarías, Dr Maria-Jesus Rodrigo and Dr Joanna Lado.

## WHAT THE STUDY FOUND

Firstly, it was confirmed that the redder the grapefruit, the less susceptible it was to chilling injury. Lycopene was indeed the secret weapon.

The pre-harvest experiments were done in Kakamas, Hoedspruit and Valencia in Spain and involved covering the fruit with paper bags. "We found that this increased the lycopene content in the rind, but only when the fruit was shaded during stage 2



### PROJECT TITLE

Increased lycopene content in the fruit flavedo to reduce chilling injury of grapefruit during cold sterilisation shipments

### PRINCIPAL INVESTIGATOR

Dr Paul Cronjé

### CONTACT DETAILS

+27 21 808 2689  
+27 84 447 1047  
paulcronje@sun.ac.za  
Skype: paul.j.r.cronje

### DURATION

Two years

### PHI-2 CONTRIBUTION

R310 184

### LEAD INSTITUTION

Citrus Research International and Stellenbosch University (Department of Horticultural Science)

### BENEFICIARY

The citrus industry

### FOCUS AREA

Pre-harvest disposition to post-harvest disorders

### PRESENTATIONS AND PAPERS DELIVERED

One

### PUBLICATIONS

One



1 Dr Paul Cronjé.

USA

Using the results of this study, producers are enjoying great success with exporting grapefruit with high lycopene content to the lucrative USA market, where prices are up to 30% higher than elsewhere in the world.



growth, which is from December to January in South Africa," says Dr Cronjé. The team furthermore found that direct sunlight seemed to burn away the lycopene pigment, leading to fruit rind that is susceptible to chilling injury.

An important finding was that lycopene content can only be increased in the orchard. Current techniques to increase the pink colour, such as pre-harvest Ethephon and post-harvest ethylene gas treatments, only remove the green in the rind. "The answer to our research question was therefore simple," says Dr Cronjé. "The only way to increase the lycopene content is to give the fruit shade while it develops."

Based on these findings, the research team's pre-harvest recommendations are to manage the orchard well with irrigation and initial fertilisation to ensure good canopy development that allows the fruit to grow in the shade. Due to the extreme temperatures in the Kakamas area, shade netting could be used to ensure

the development of evenly pink grapefruit.

Post-harvest recommendations include selective harvesting. To this end, pickers in the orchards and packers in the pack houses should be trained to use the colour charts to select fruit that is pink enough to withstand cold sterilisation temperatures.

The results of this study have handed producers two extremely useful and practical tools to increase export production. The first is low-cost technology to increase lycopene content in 'Star Ruby' grapefruit. The second is colour charts that enable producers to select their target market based on the colour of their fruit. Depending on how pink the grapefruit is, producers can decide to ship it under normal (4-10°C) or sterilisation (-0,6°C) temperatures. ●

### COLOUR TALKS

One of the outcomes of the 'Star Ruby' grapefruit study was colour charts that are now being used in pack houses to help make export decisions.

It is suggested that fruit that is completely pink (number 1 on the chart) or more than 80% pink (number 2) could be exported to the USA.

Fruit with a 60% to 80% pink cover (numbers 3 and 4 on the chart) can be exported to Japan, provided it is waxed or treated with TBZ. Because Japan requires a shorter cold sterilisation period, there is a lower risk of chilling injuries.

However, fruit that is less than 60% pink (numbers 5 to 8 on the chart), should not be shipped under cold sterilisation treatment temperatures and should preferably be exported to non-steri markets.

### WHAT ARE STERI MARKETS?

South Africa is the world's largest exporter of fruit via shipping – more than 60 countries receive our produce by sea. An increasing and significant portion of South African citrus is exported to so-called steri markets, such as Japan, China and the USA.

Steri markets are countries that prescribe the use of cold treatment to ensure that they don't import pests along with the fruit that arrives in their ports. Although South Africa

also uses cold treatment to eliminate pests and diseases, the local treatment conditions are not always the same as those prescribed by other countries.

Treatment conditions include 12 days at ±0,6°C for fruit fly disinfestation (*Ceratitis capitata* and *Ceratitis rosa*) and 22 days at below -0,3°C or 0°C for false codling moth (*Thaumatotibia leucotreta*).



1 'Star Ruby' grapefruit, depleted of lycopene, scars easily when chilled.  
2 'Star Ruby' grapefruit that grows in full shade develops high levels of lycopene. Exposure of the fruit surface to direct sun 'bleaches' the lycopene from the rind resulting in higher susceptibility to chilling injury.

