# Eighth Annual Chapman Phytosanitary Irradiation Forum

## Phytosanitary irradiation of citrus - an African perspective

Cherin Balt, Karin Hussey,
HEPRO Cape (Pty) Ltd

With thanks to
Dr Paul Cronje, Jade North, Prof V Hattingh

Effect of Irradiation levels on Internal and External Citrus Fruit Quality

CRI-Dept of Horticultural Science
Univ. Stellenbosch

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# Phytosanitary irradiation of citrus

- The objective of this trial series was to determine the best treatment protocol to achieve the phytosanitary requirements as well as maintaining fruit quality.

- Established fact : Citrus is sensitive to irradiation between 200Gy and 500 Gy

- Minimum dose required to sterilise FCM larvae is
  - 60Gy and 16 days at 2.5°C
  - Or standalone treatment at 100Gy

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# Phytosanitary irradiation of citrus

Different cultivars of export quality fruit were chosen at early and late seasonal stages

Pre-trial dosimetry performed to establish minimum and maximum positions

Small stacks of boxes irradiated in standard cartons at doses of 200Gy, 300Gy, 400Gy and 500Gy (DUR 1.3:1)

Stored at 2°C or 7°C

For 40 or 60 days
prior to evaluation
of internal and
external quality


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# Phytosanitary irradiation of citrus

**Summary of Treatments**

| | |
|---|---|
| **Season 1 Early** | |
| 1. Irradiated 4 cv (Nules, Lemons, Navel, Grapefruit ) | May June 2015 |
| 2. Quality evaluations after 40 and 60 days | June July 2015 |
| **Season 1 Late** | |
| 3. Irradiated 4 cv (Navel, Mandarin, Valencia, Lemons) | August 2015 |
| 4. Quality evaluations after 40 and 60 days | September October 2015 |
| 5. 1st season report January | March 2016 |
| **Season 2 Early** | |
| 6. Irradiated 4 cv (Nules, Lemons, Navel, Grapefruit | May June 2016 |
| 7. Quality evaluations after 40 and 60 days | June July 2016 |
| **Season 2 Late** | |
| 8. Irradiate 4 cv (Navel, Mandarin, Valencia, Lemons) | August 2016 |
| 9. Quality evaluations after 40 and 60 days | September October 2016 |
| 10. Final report January | March 2017 |

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# Phytosanitary irradiation of citrus

Doses 200Gy, 300Gy, 400Gy, 500Gy

Removed 10 fruit per carton immediately to evaluate internal and external quality

Thereafter half fruit in each carton marked to enable unbiased selection after 40 and 60 days' cold storage

3 cold storage regimes were used:

1. Commercial controls (22 days at -0.6°C plus rest of storage at 7°C)
2. Combination Treatment (18 days at 2°C  plus rest of storage at 7°C)
3. Experimental Control (whole period at 7°C)

4. Thereafter evaluations done at 0, 40 and 60 days

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# Phytosanitary irradiation of citrus

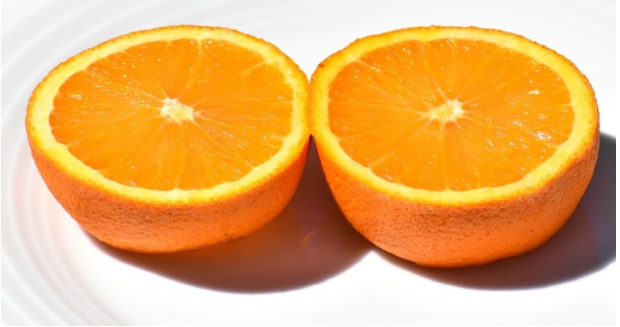
**Internal Quality Evaluation**

Juice %
Total Soluble Solids expressed as °Brix
Citric acid
Malaic acid
Tartaric acid

**External Evaluation**

Rind Disorders
Colour measurement

**Taste**



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# Phytosanitary irradiation of citrus

The external fruit quality, evaluated as incidence of rind disorders and grouped as “pitting”, indicates a progressive reaction to the increased irradiation dose.

This was especially true for sensitive cultivars

In the two cultivars most affected by irradiation, the development of rind disorders was already evident at 200 Gy (‘Nova’ and ‘Turkey’), but for the second group of cultivars i.e. lemon, ‘Nadorcott’ and ‘Nules’, the increased negative impact only become significant after 300 Gy.

Some cultivars such as the ‘Midknight’ Valencia and ‘Star Ruby’ grapefruit show a remarkable tolerance to irradiation even at 500 Gy.

The incidence of rind disorder can vary within one season for the same cultivar

# Phytosanitary irradiation of citrus


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# Phytosanitary irradiation of citrus

**External Evaluation  Quality measurement**
**Rind Disorders (0-3 RDI ) and colour**

Post harvest conditions after irradiation i.e cold storage at 2°C for 18 days plus 7°C for the remainder of the cold storage duration or 7° C contributed to rind disorders although not always significantly.

In general the fruit quality was better at the 2°C than at the 7°C indicating a possible positive impact of the lower temperature of fruit reaction to the irradiation.

Storage 40 and 60 days chosen to mimic the commercial market window from  arrival to maximum cold storage duration before quality is drastically compromised

The higher incidence of disorders were expected at 60 days compared with the 40 days

# Phytosanitary irradiation of citrus

**Taste (Consumer Panel)**

Fruit blocks free of citrus rind were presented to the panel to eliminate influence of external attributes such as colour.

At day 40 no obvious differences in taste and other sensory attributes were recorded by the consumer panel.

**Internal Quality Evaluation**

Reduction in TSS (°Brix) and Citric acid was seen in most cultivars, however not always significantly.

The cultivars that were most susceptible to rind damage i.e. ‘Nova’, ‘Turkey’ and lemon had a more dramatic loss in citric acid and °Brix as irradiation dosage increased, which could have been a result of increased fruit respiration.

However, in some instances very low rind damage was seen but a reduction in acid and TSS was recorded which is indicative of a direct effect.

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# Phytosanitary irradiation of citrus

The cultivars used in this project could be grouped into four according to susceptibility:

- Very low susceptibility – Star Ruby grapefruit and Midknight Valencia orange
- Low susceptibility – Early and Late Navels (Washington and Navelate)
- Medium susceptibility - Nadorcott, Nules mandarin and lemons
- Very High susceptibility – Turkey Valencia orange and Nova mandarin.

# Phytosanitary irradiation of citrus

**Conclusion**

Two seasons confirm Significant variations between irradiation doses with an increased susceptibility from 300Gy upward

Cultivars responded differently to the same irradiation dose from an external as well as an internal view

Consumer panel did not report a negative taste

Postharvest storage temperature of 2°C after irradiation was in general more favourable to retard symptom development and resulted in better fruit quality in terms of rind disorders compared to 7°C

A visual example of the progressive nature of irradiation damage in citrus fruit during a 30 day storage period at room temperature .
Colour changes in the fruit during 5 day intervals

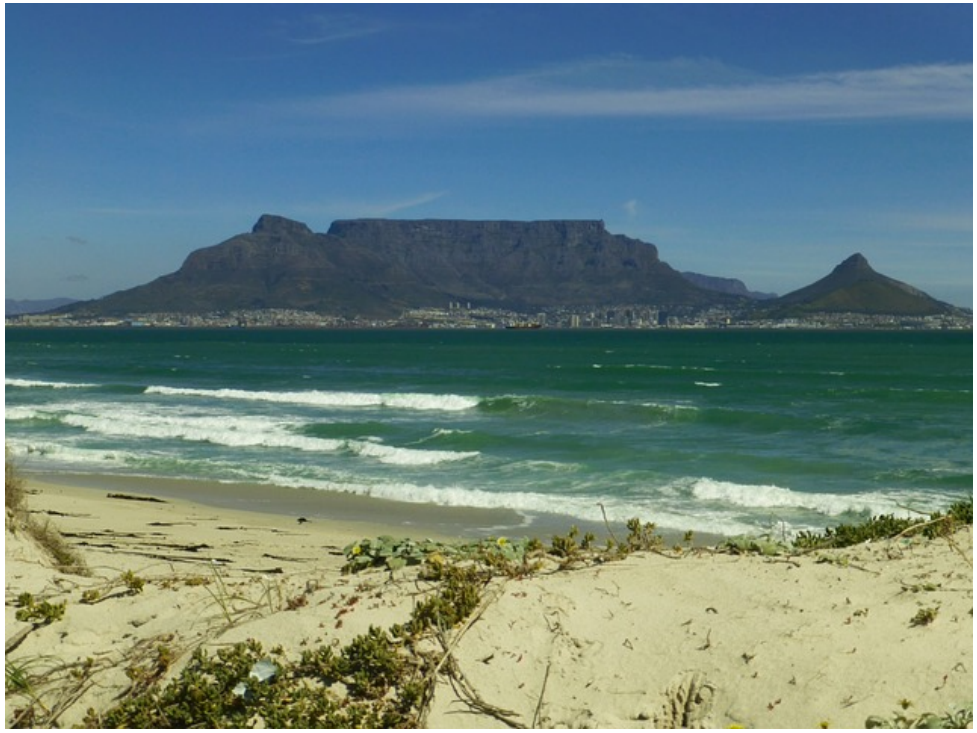
# Phytosanitary irradiation of citrus

A novel approach to phytosanitary irradiation combining low dose irradiation and refrigeration would assist in developing a protocol in a commercial situation without prohibitive damage and quality loss.

The DUR in a commercial situation may result in doses higher than those which the various cultivars can withstand.

However a combination of refrigeration and irradiation (La Croix and Follett, 2015 and Hofmeyr *et al* 2016) at lower doses so as not to exceed the 300Gy level (where most varieties showed increased susceptibility) and to ensure the sterility of insects would be of great commercial value.

# Thank you for your attention!



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