

Phytosanitary irradiation of fruit: Update and new research directions

Anuradha Prakash
PI Forum 2018



CHAPMAN
UNIVERSITY



Outline

- Effect on fruit quality and physiology
 - Pummelo
 - Apples
- New research directions



Phytopsanitary Irradiation of Fruit

A close-up photograph of a wasp on a piece of fruit, likely a mango, with its wings spread. The wasp is dark brown with lighter-colored wings. The background is a soft-focus, warm-toned surface, possibly the fruit's skin.

- **Non-thermal/non-chemical treatment**
- **Quality dependent on**
 - **Extrinsic factors:**
 - Dose: PI doses are low
 - Temperature
 - Handling
 - Storage time and conditions
 - Atmosphere/Packaging
 - **Intrinsic factors:**
 - Variety and cultivar
 - Maturity stage
 - Climacteric versus non-climacteric
 - Composition

Many fruit exhibit high radio-tolerance



A few are not tolerant:

Seedless Kishu Mandarins



Quality depends on dose



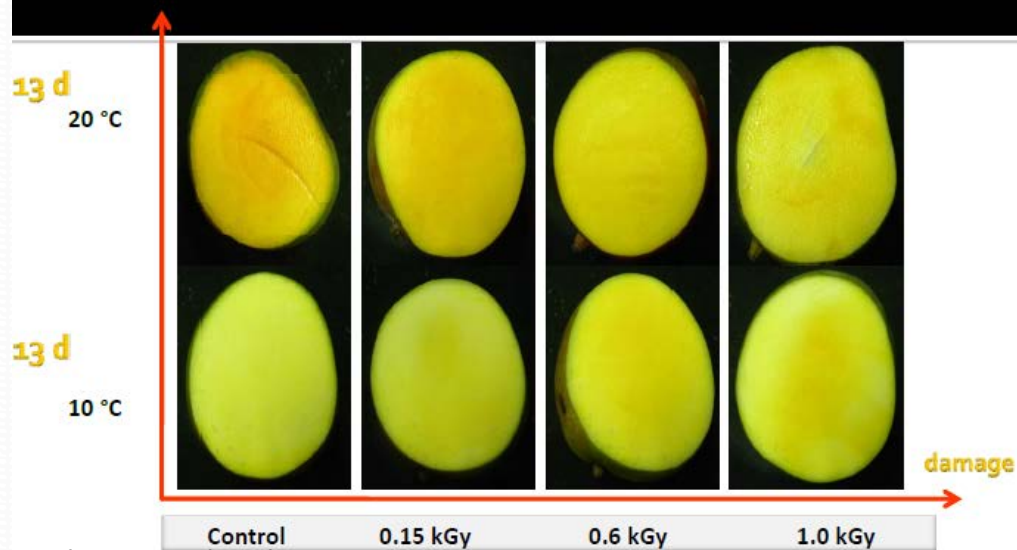
<https://doi.org/10.1016/j.postharvbio.2013.07.018>

Dr. Edmundo Mercado Silva

And variety



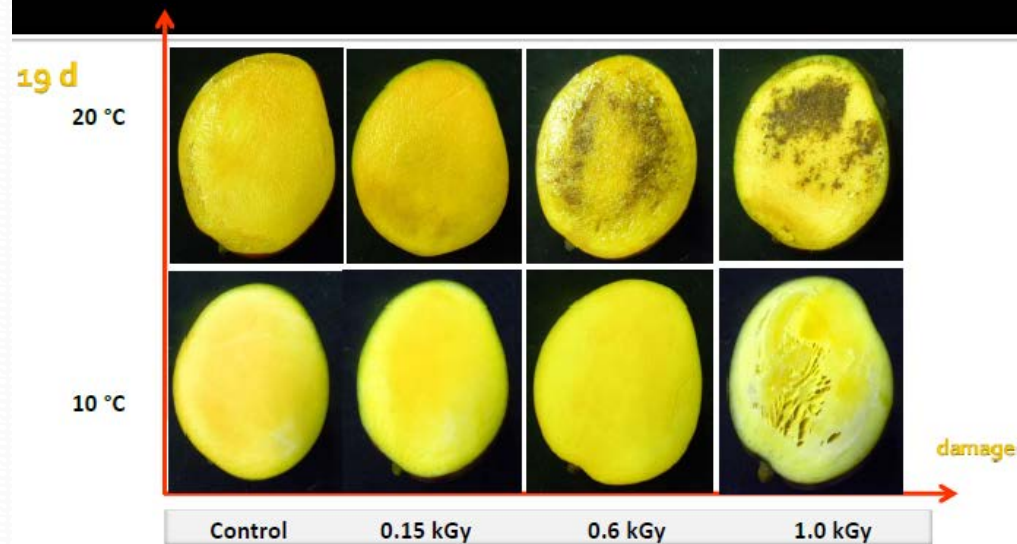
Internal visual quality (Kent)



Dr. Edmundo Mercado Silva

Moreno *et al.*, (2007) mango 'Tommy Atkins' a 1.5 kGy: NO HAY DAÑO

Internal visual quality (Tommy Atkins)



Moreno *et al.*, (2007) mango 'Tommy Atkins' a 1.5 kGy: NO HAY DAÑO

Chandler Pummelo



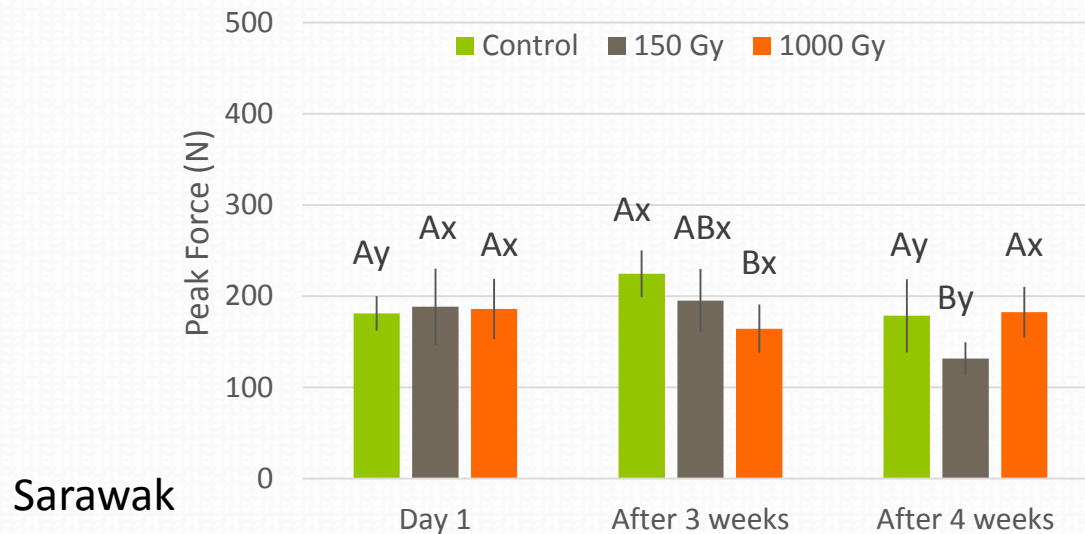
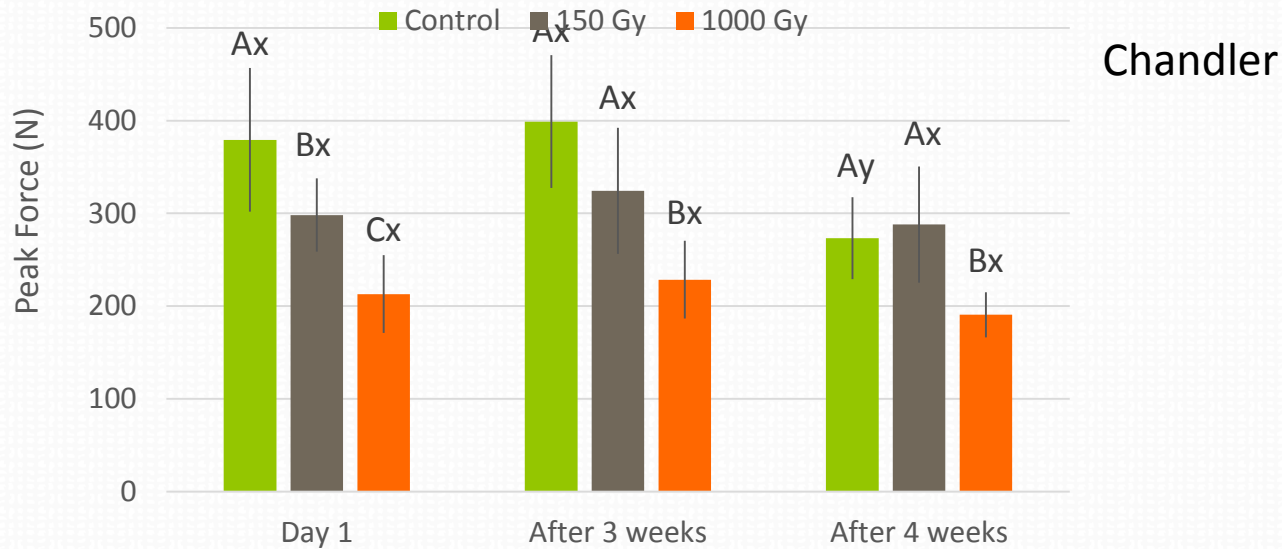
Sarawak Pummelo



Pummelo study

- 0, 250, 1000 Gy, stored for 3 weeks at 12C followed by 1 week at ambient
- Most quality factors not impacted by irradiation:
 - Soluble Solids content
 - Titratable Acidity
 - Weight loss
 - Juiciness
 - Color

Pulp firmness decreased with dose, storage time and temperature



Sensory scores

(Dislike extremely=1, Like Extremely=9)



Chandler

Control

150 Gy

1000 Gy

Day 1 after irradiation



3 weeks



4 weeks



Key results

Pummelos irradiated at 150 Gy can maintain quality similar to non-treated pummelos when ***stored at appropriate storage conditions.***

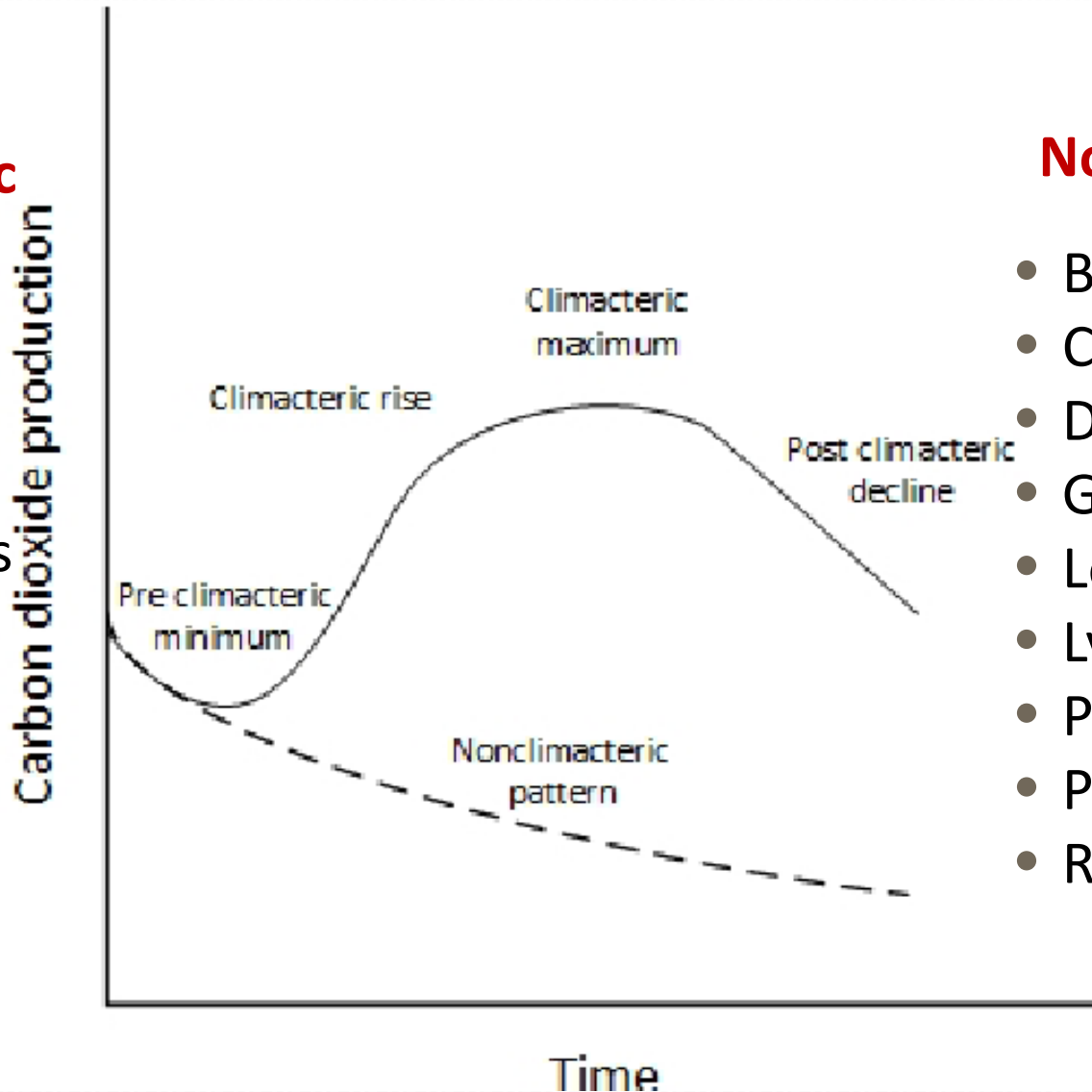
Quality dependent on

- Variety
- Dose
- ***Handling***



Climacteric

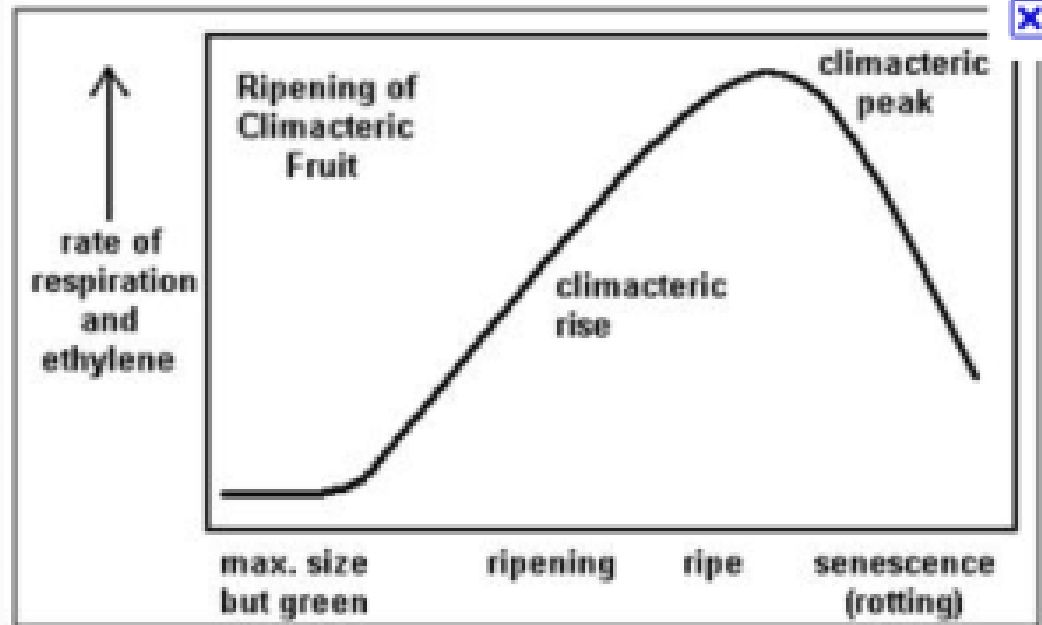
- Apples
- Figs
- Guava
- Mangoes
- Papaya
- Peaches













Non-climacteric

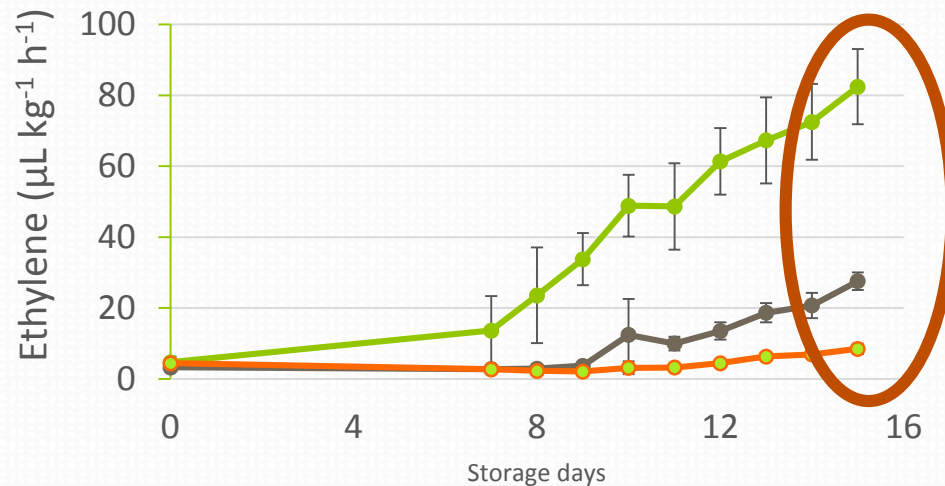
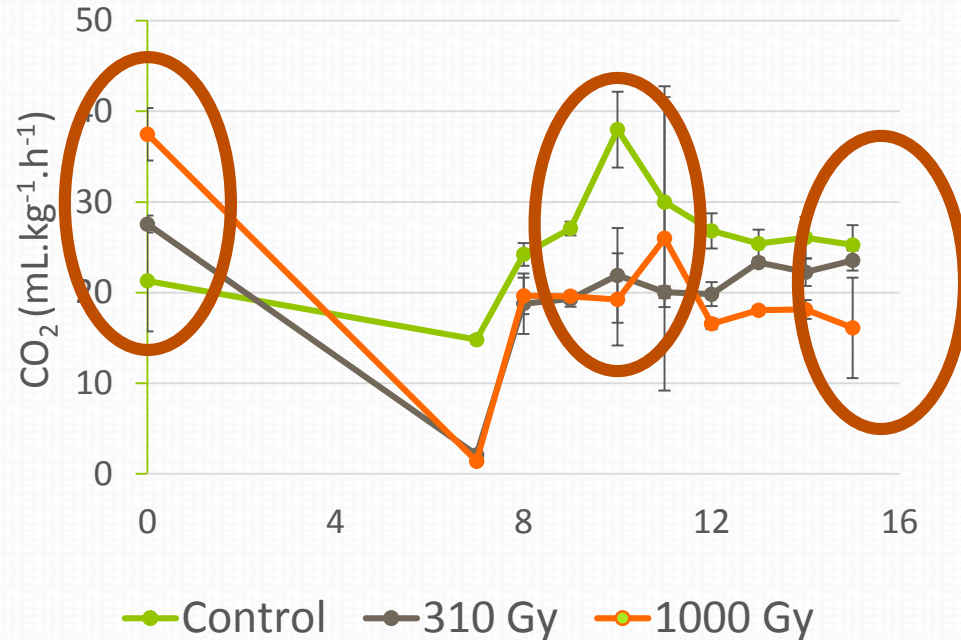
- Blueberries
- Cherries
- Dragon fruit
- Grapes
- Longan
- Lychees
- Pitaya
- Pomegranates
- Rambutan

Maturity stage at treatment is important for climacteric fruit



Ripening Stages	1 Unripe	2 Early ripe	3 Partially ripe	4 Ripe	5 Over ripe / Decay
Alphonso					
Ripening Period (Days)	1 - 4	5 - 6	7 - 11	12 - 17	18 - 19
Banganapalli					
Ripening Period (Days)	1 - 6	7 - 8	9 - 14	15 - 18	19 - 23
Phase	Pre-climacteric		Climacteric		Senescent

Irradiation impacts fruit physiology: Gala apples



California Apples



- Conventional phytosanitary treatments: fumigation (MeBr) and cold
- Market advantage of using irradiation

Gala apples after 8 weeks of storage



After 8 months, but *NOT* under controlled atmosphere



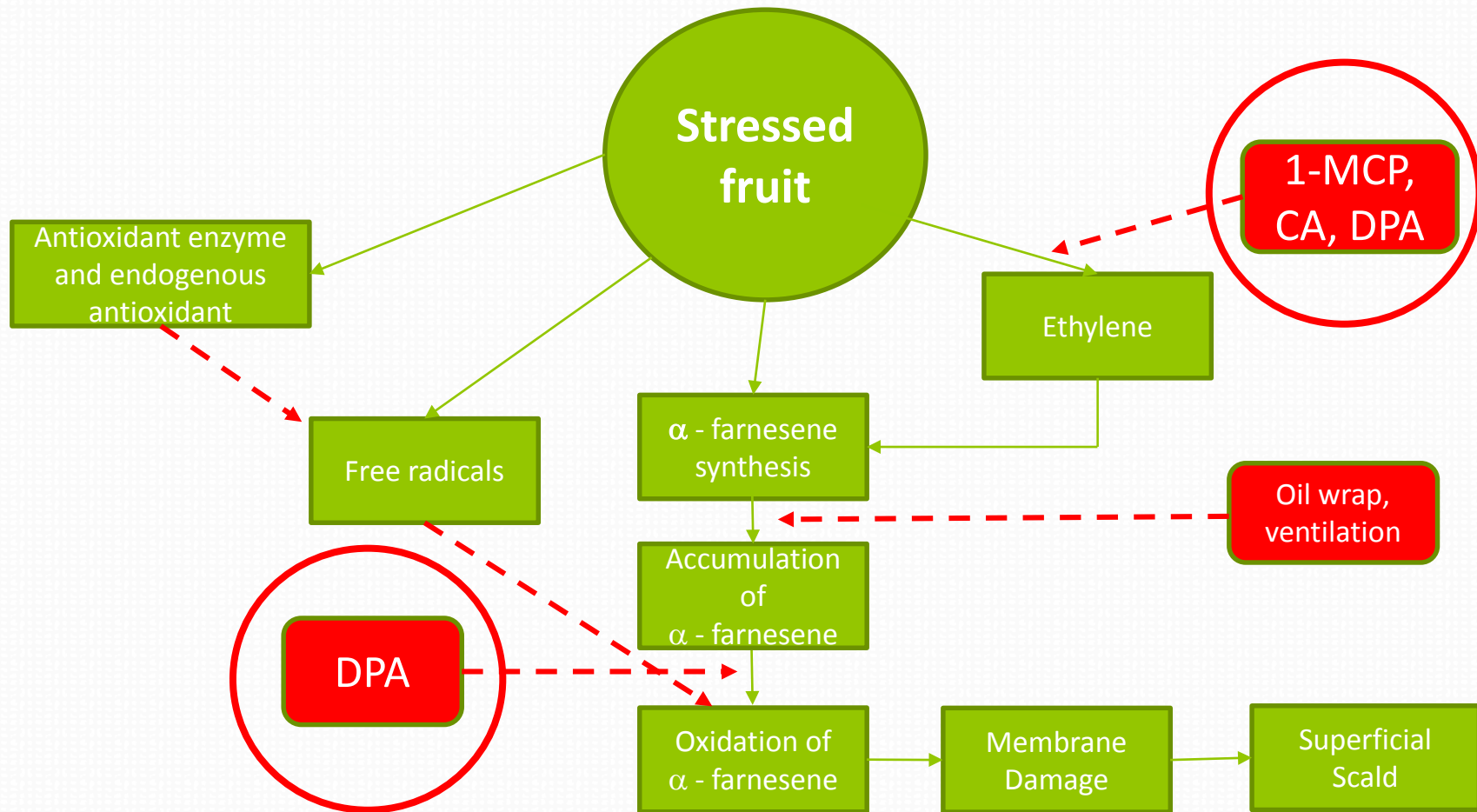
Granny Smith



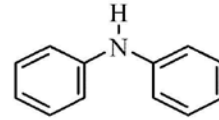
- Internal browning
- Storage or superficial scald
 - Storage scald develops after 2-4 month cold storage and following 3 to 4 days of warming of the fruit
 - Fumigation with MeBr



Superficial Scald development



Diphenylamine (DPA)



- Considered a health risk, EU has withdrawn authorization for DPA
- Can irradiation serve as an alternate treatment?



Control (fumigated) after 6 months



MeBr (48 mg/m³) after 6 months



Control (Irradiated) after 6 months



Treated with 1000 Gy after 6 months



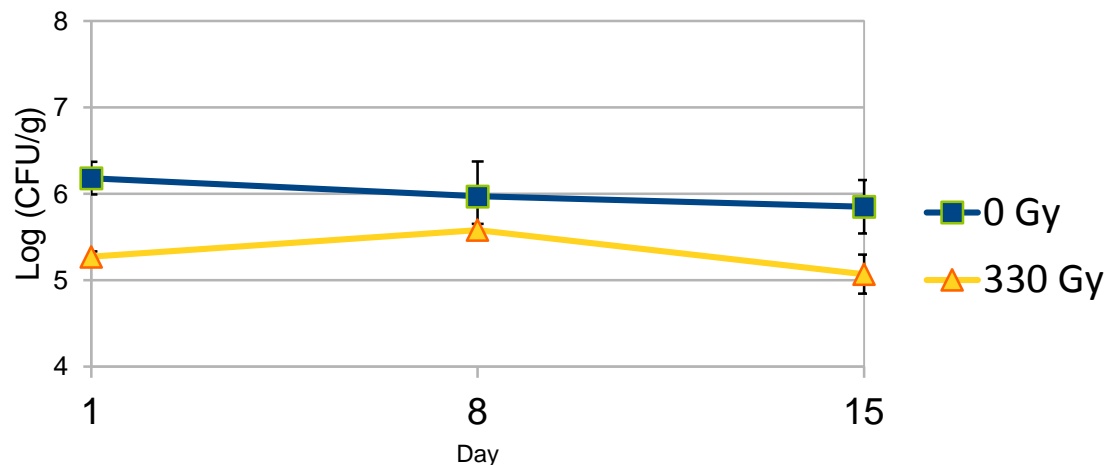
Treated with 310 Gy after 6 months



Compelling benefits especially when considered in toto

- Quality (much better compared to fumigation)
- Faster than cold treatment
- Alternative to MeBr/DPA/other chemicals
- Pathogen reduction

Listeria monocytogenes in Gala apples



Research needs

Determine impact on quality under commercial conditions of distribution and storage



Compare with conventional treatments



Control



400 Gy



Fumigated

Establish quality standards

- Identify most suitable varieties
- Determine ideal maturity at harvest and treatment
- Package configuration
 - Works best for the product
 - Works for distributors and retailers



- Explore the relationship between ethylene and fruit disorders
- Evaluate role of complementary technologies in reducing disorders in sensitive fruit



Use molecular tools

- What causes the reduction in ethylene?
 - Gene expression of the enzyme or post-translational enzyme activity
- Can we predict fruit response?
- Can we use genomics to identify cultivars most suited for treatment?
- Better yet, can we develop cultivars most suited for PI?



Thank you

