Current and New Tools for Controlling Postharvest Decay of Fresh Citrus

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Control Options

Diplodia stem-end rot

- Preharvest - No reliable replacement yet for Benlate or Topsin
  - **However, copper, Aliette, and phosphorous acid products to reduce Brown rot**
- Postharvest control measures
  - **Good sanitation practices**
  - **Careful handling**
  - **Good sanitation practices**
  - **Use of fungicide**
    - Must be effective against latent organisms such as Diplodia and Anthracnose

Thiabendazole (TBZ)

- Controls stem-end rot and green mold
  - **Some effectiveness against anthracnose**
  - **Does not control sour rot or black rot**
- Recommended concentrations:
  - **1000 ppm (0.1%) as a water suspension**
  - **2000 ppm (0.2%) in a water-based wax**
- Not very soluble in water
  - **Constant agitation required**
- Include a sanitizer (e.g., chlorine) with recirculated solutions

Imazalil

- Especially effective against green mold.
  - **Diplodia and Phomopsis - generally less effective than TBZ.**
  - **Some activity against black rot.**
  - **Ineffective against sour rot and brown rot.**
- Recommended concentrations
  - **1000 ppm (0.1%) as a water suspension**
  - **2000 ppm (0.2%) in a water-based wax**
- Not compatible with chlorine.

SOPP

- Sodium o-phenylphenate, also called
  - **2 Phenylphenol**
  - **O-phenylphenol (OPP)**
- Effective against green mold & sour rot
  - **Little to no control of Diplodia or Phomopsis stem-end rot, or black rot**
- Recommended concentration:
  - **2% aqueous solution, pH at 11.5–12.0 is the most effective treatment**
  - **Some include 0.2% sodium hydroxide for pH control, and 1% hexamine to minimize phytotoxicity**

Fludioxonil

- Effective against green mold and Diplodia stem-end rot
- Much less green mold sporulation control compared to imazalil
  - **Combined with azoxystrobin (Graduate A+) = Good sporulation control**
- Compatible with chlorine

Phosphites

- 'Ruby Red' grapefruit
  - **Inoculated for Brown rot**
  - **Natural infections of diplodia**

Treatment	Brown Rot (%)	Diplodia SER (%)
Control	45.0 a	23.8 a
TBZ	40.6 b	6.9 b
Potassium Phosphite	8.1 c	4.4 b
Potassium Phosphite + TBZ	13.1 c	0.6 b
75 F	38.5 a	9.6 a
120 F	17.9 b	5.0 b

Two weeks after inoculation

Phosphites

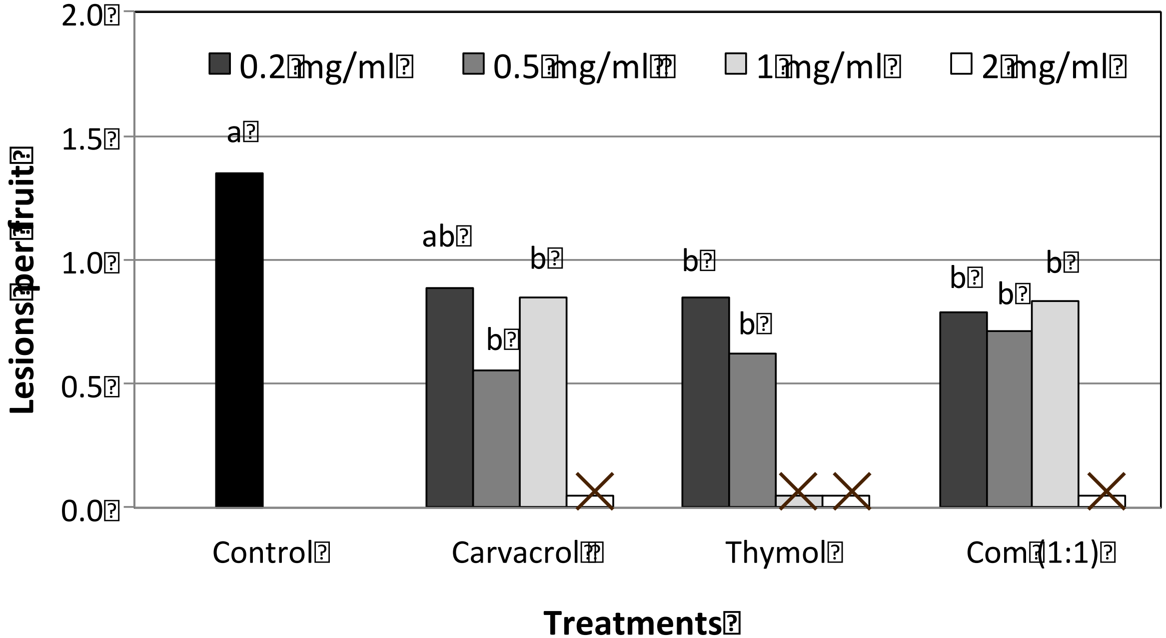
- 'Murcott' tangerine fruit
  - **Inoculated for Brown rot**
  - **Natural infections of diplodia**

Treatment	Brown Rot (%)	Diplodia SER (%)
Control	17.5 a	11.9 a
TBZ	15.6 ab	1.9 b
Potassium Phosphite	3.1 c	4.4 b
Potassium Phosphite + TBZ	6.3 bc	3.2 b
75 F	14.8 a	7.5 a
120 F	6.3 b	1.7 b

Two weeks after inoculation

Essential oil solution dip on CBS development

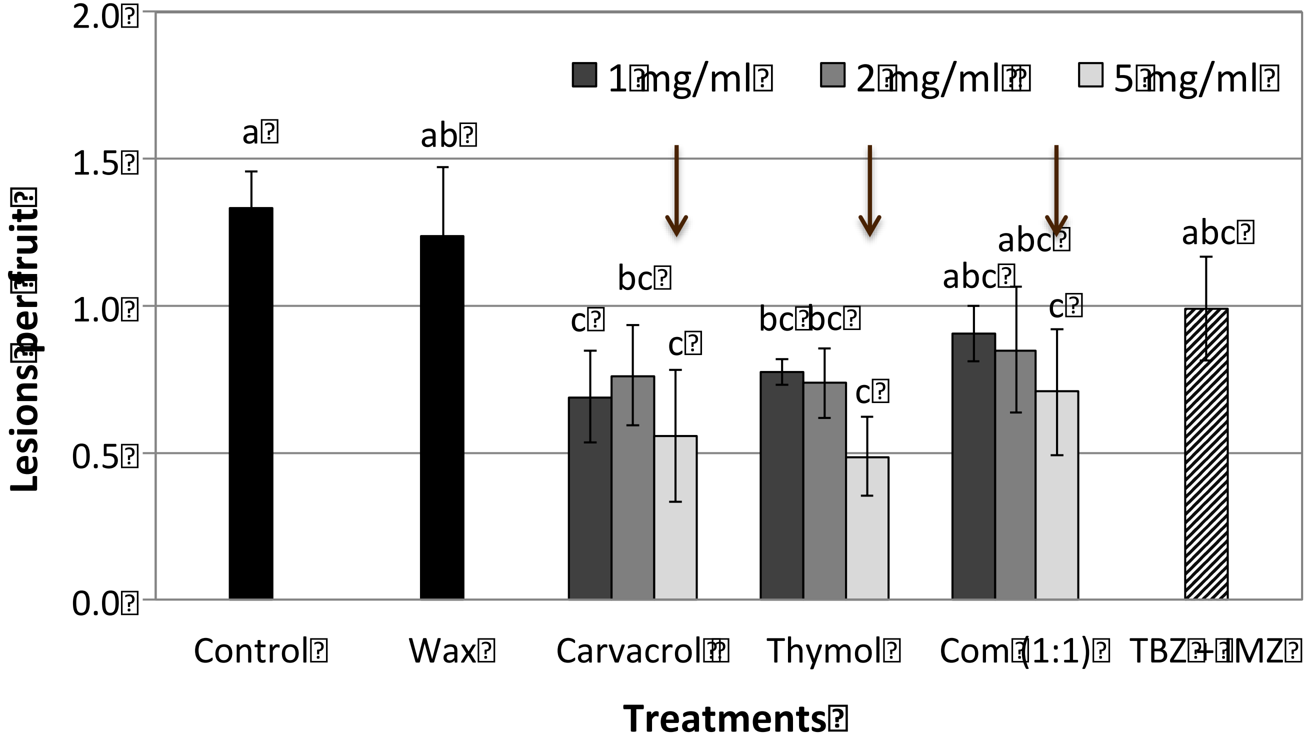
Effects of thymol and carvacrol dip on CBS lesion development on **asymptomatic** fruit



- Thymol, carvacrol, and the combination (1:1) at 2 mg/ml resulted in phytotoxic peel injury, with the most severe damage caused by thymol which also caused peel injury at 1 mg/ml

Essential oil mixed in wax on CBS development

Effects of thymol and carvacrol mixed in wax on **lesion development** on **asymptomatic** fruit



- On fruit that were asymptomatic before treatment, coating with shellac containing 5 mg/ml of thymol, carvacrol, and the combination (1:1) reduced the number of lesions formed on fruit significantly ($p<0.05$)

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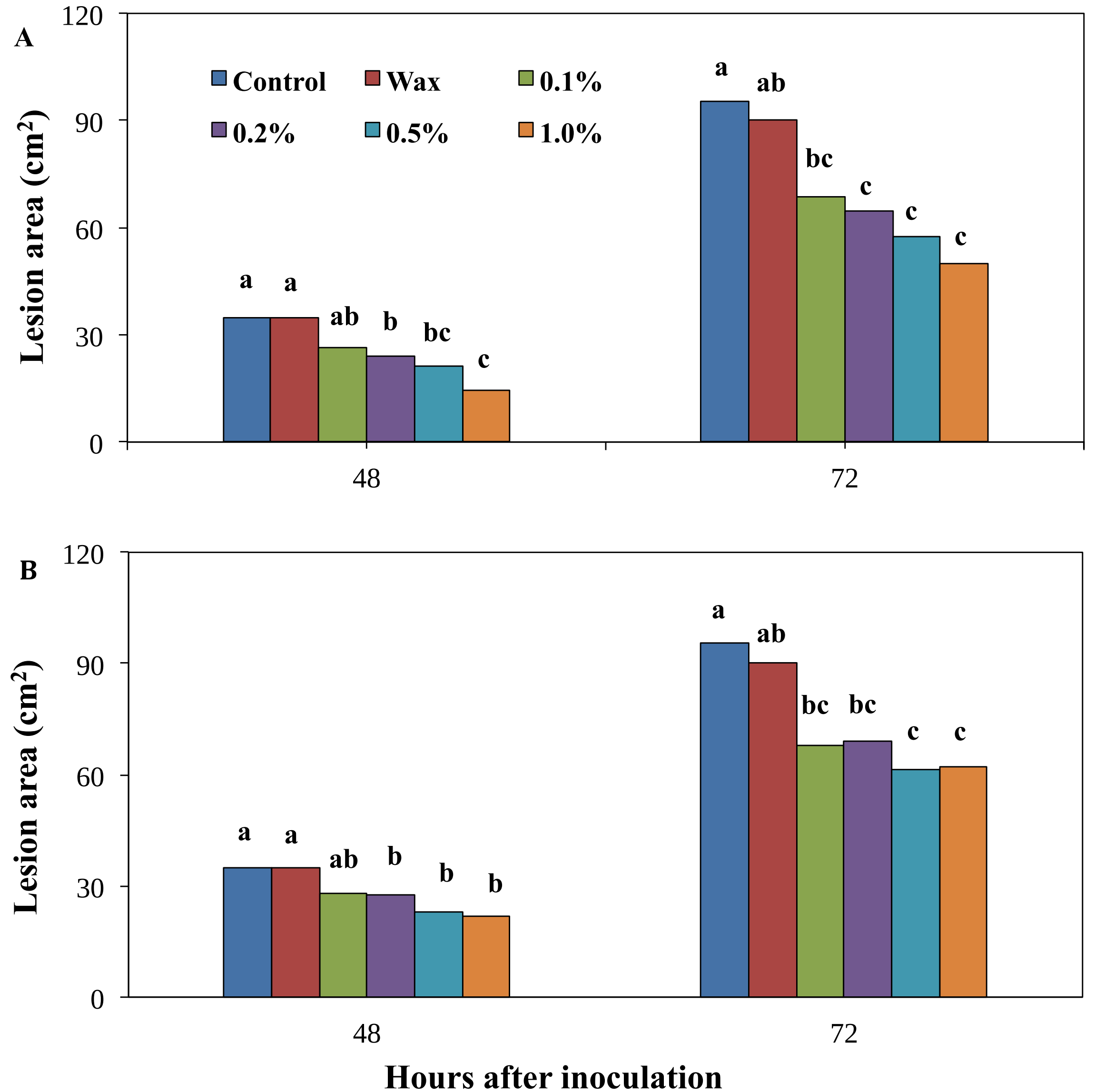
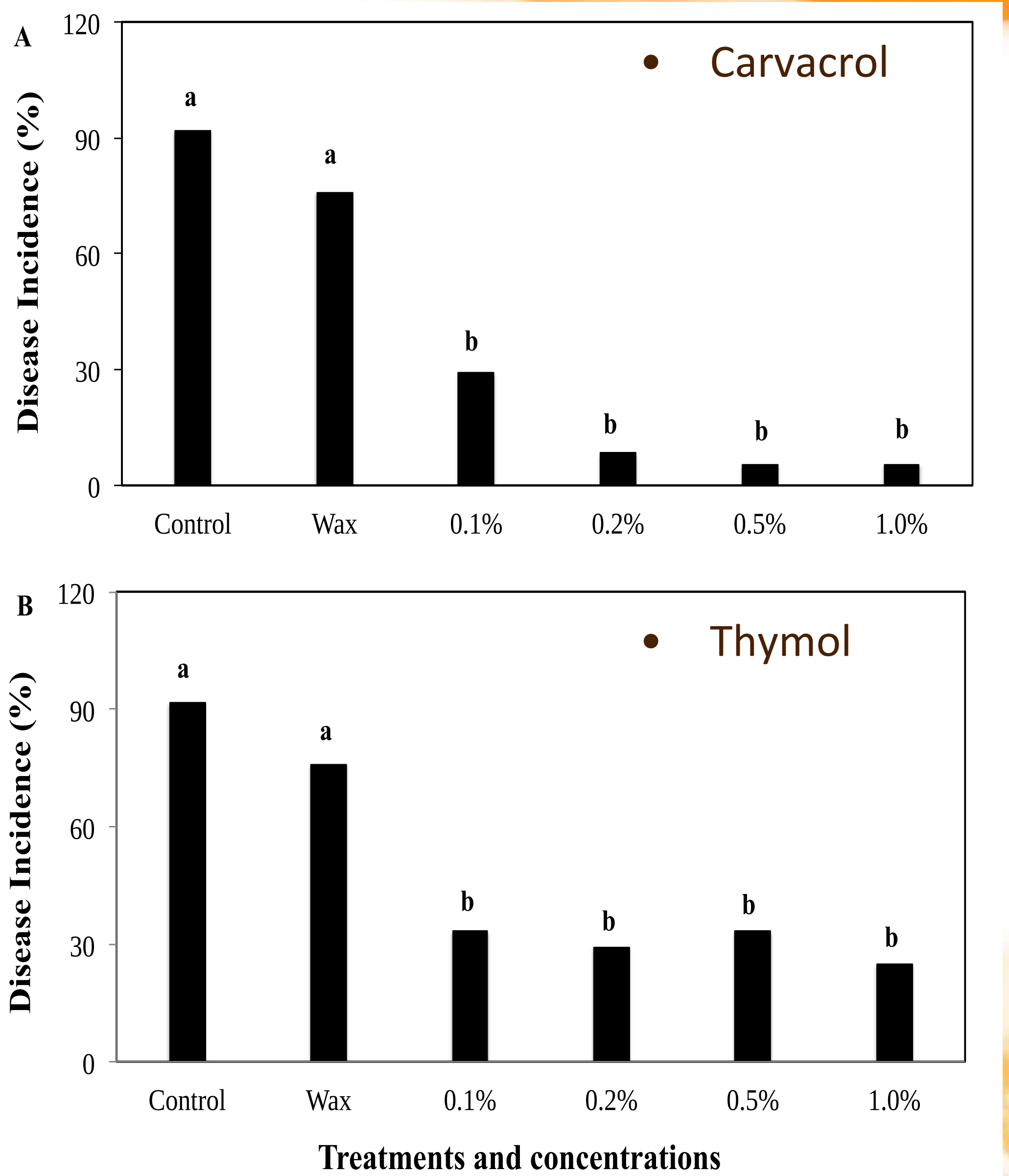
Essential oil mixed in wax on diplodia development

Effects of thymol and carvacrol mixed in wax on Diplodia decay of INOCULATED fruit **12 hrs. prior** to waxing



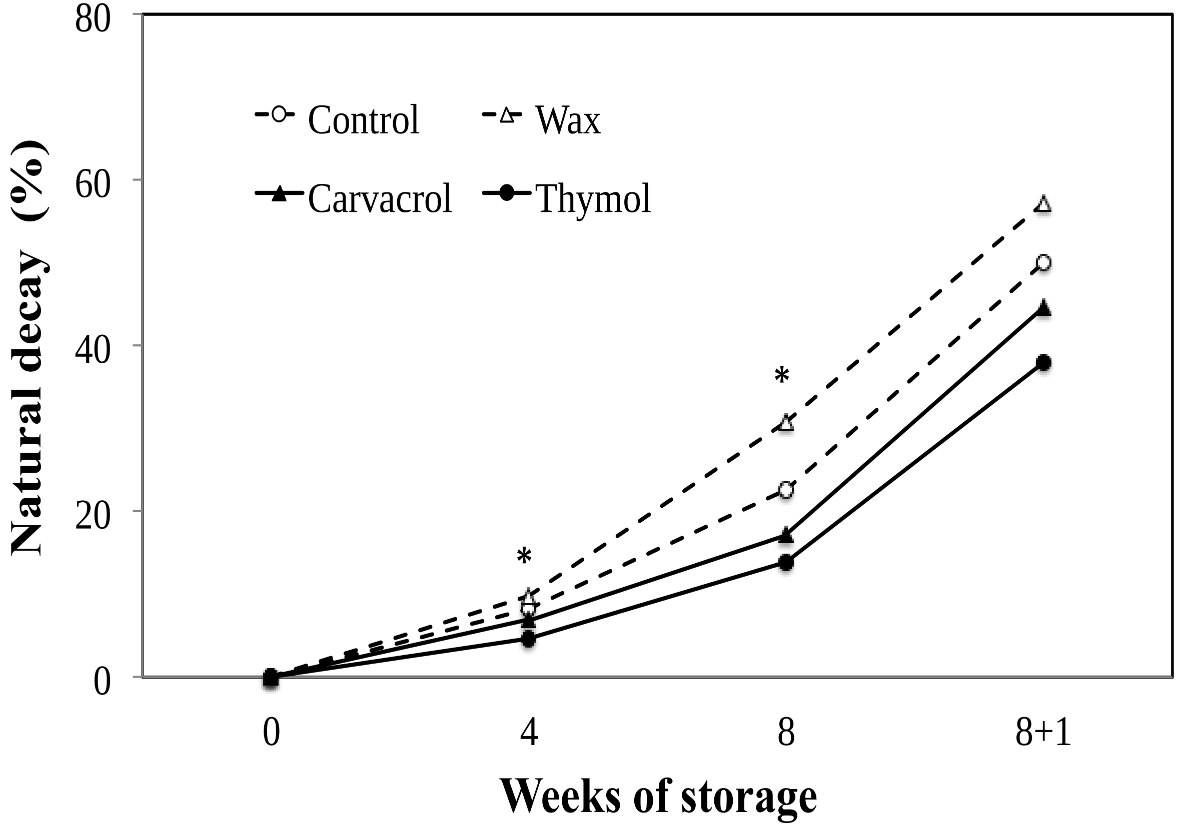
Essential oil mixed in wax on diplodia SER development

Effects of thymol and carvacrol mixed in wax on Diplodia decay of INOCULATED fruit, immediately after waxing



Essential oil mixed in wax on Diplodia development

Effects of thymol and carvacrol mixed in wax on diplodia decay from NATURAL infections



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Recommended Degreening Conditions

	Florida
Temperature	28 to 29°C (82 to 85°F)
Ethylene	5 ppm
Humidity	90 to 96%
Ventilation (keep below 0.1% CO_2)	1 air change per hour
Air Circulation	100 CFM per 900 lb. bin

(CFM = cubic feet per minute)

Grierson & Newhall, 1953

Temperature

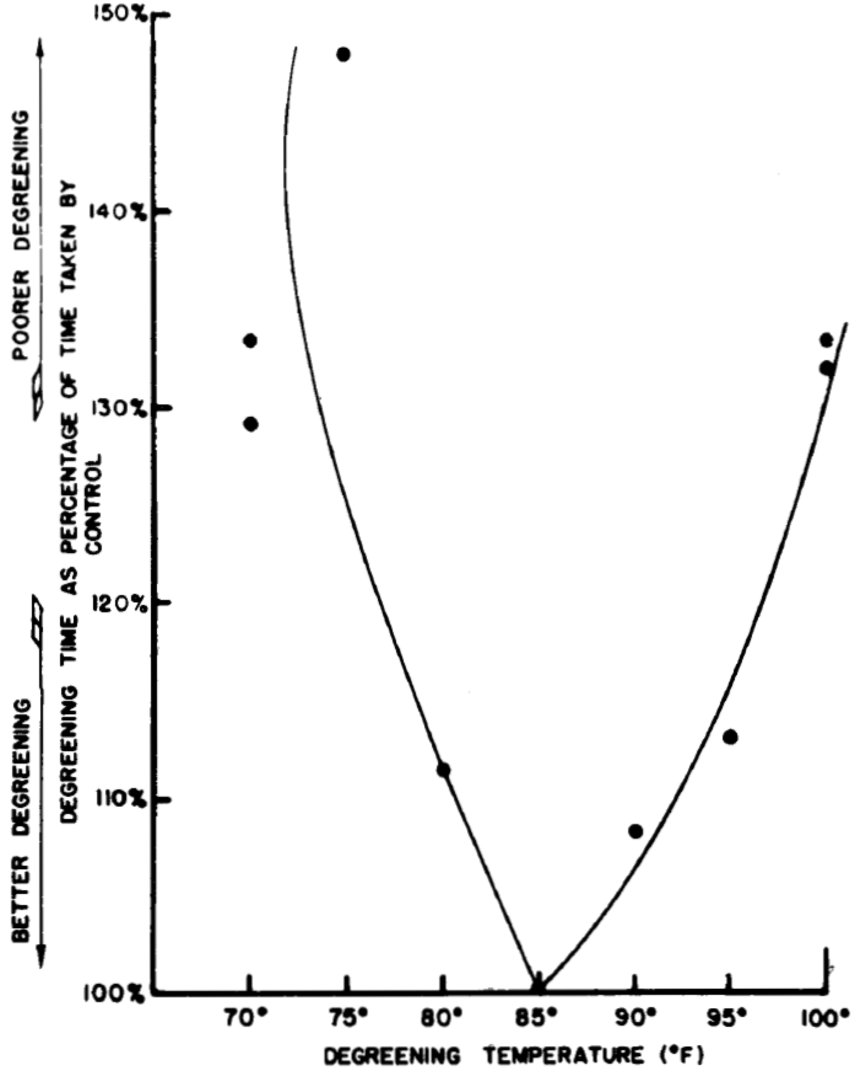

Fig. 3.—Effect of temperature on rate of degreening of Hamlin oranges. Adapted from Grierson and Newhall (*23*).

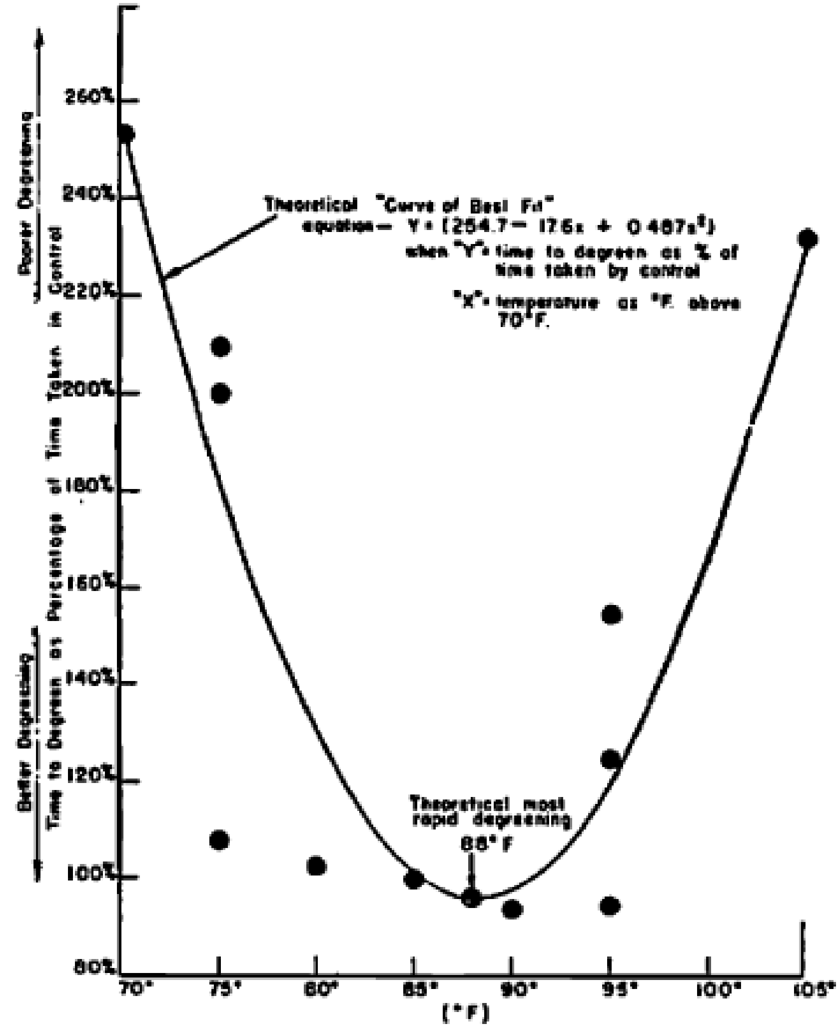

Fig. 3. Effect of Temperature on Rate of Degreening of Marsh Grapefruit.

Potential Problems

- Temperatures too high – above 85F, slows rate of chlorophyll degradation, but increases fruit metabolism, decay, and breakdown
- Too much water in the rooms – fruit stays wet = slower degreening & increased decay pressure
  - **Ethylene is not very soluble in water**

Ventilation & Carbon Dioxide

- Ventilation removes waste gasses (e.g., CO_2 and possibly peel oil vapor)
  - **1% CO_2 can about stop degreening**
- Ventilation also results in more uniform temperature throughout the room
- Result in faster and more uniform color development within the load
- Continuous ventilation is often better than periodically opening the room
- Excessive ventilation wastes ethylene and (when used) heating

Potential Problems

- Poor air circulation = uneven temperature distribution and local buildups of CO_2 in the room
  - **Both = uneven color development**

What Inhibits Color Development?

- Warm weather
  - **particularly warm nights**
  - **Regreening in the Spring**
- Factors that promote vigorous growth
  - **high rainfall**
  - **high nutrient levels (esp. N & K)**
- Field oil sprays
- Peel oil (e.g., from brushing)
- Some scale insects (e.g., chaff & purple scale)

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Thank you!

Question?