Citrus Degreening

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What is degreening?
The process of exposing “green” citrus fruit with low levels of ethylene to enhance coloration
Chlorophylls
Photosynthetic carotenoids
Thylakoids
Chloroplast

NON-Photosynthetic carotenoids
Chromoplast

Success is dependent on:

• Initial Peel color
• Temperature
• Duration of exposure

From I. Eaks

Coloration stops when C$_2$H$_4$ is stopped

From K. Inoue, UCD
Preharvest Factors Affecting Degreening

- Fruit Maturity, Tree Vigor, and Climatic Effects
- Cultural Practices

- Immature fruit may be poorly colored
- Fruit from trees that are vigorously flushing are more difficult to degreen
- Natural color break needs to have been initiated
  7 - 13 C (45 – 55 F) night temperatures
- For best color development in CA valencia orange need
  (Young and Erickson, 1961)
  20C (68F) day; 7C (45F) night; 12C (54 F) soil
Preharvest Factors Affecting Degreening
Cultural Practices

- Rootstock
  Affects tree vigor and may therefore affect color break

- Spray Programs
  Summer oil insecticide sprays may delay color break
  Gibberellin application

- Fertilization Practices
  High Nitrogen which increases tree vigor, thereby affecting color break

Grierson and Newhall (1960)

The Degreening Atmosphere

- Ethylene
- Temperature
- Humidity
- Air Circulation
- Ventilation and Atmospheric Composition
**The Degreening Atmosphere - Ethylene**

- Results in the destruction of chlorophyll and the development of carotenoids
- Will stimulate respiration; with low ethylene levels effect is transitory
- May stimulate volatile production
  - Greater stimulation in green vs yellow lemons (Norman and Craft, 1968)
- May enhance decay especially stem end rots as well as anthracnose
- Hastens button senescence
- Literature for the most part indicates that it is unnecessary to exceed 5 ppm, lower concentrations may be equally effective depending on cultivar

*Button discoloration following degreening*
Anthracnose (tear staining)

The Degreening Atmosphere - Humidity

- Low R.H. may result in soft fruit and loss of size
- Very low humidity may inhibit process
- Low R. H. may accentuate physical blemishes and increase stem end rind breakdown
- Best results with 90-95%
Blemishes are enhanced
May not be evident initially but only after packing and storage

The Degreening Atmosphere - Temperature

- De-greening temperature varies with growing region
  29C in FL vs. 20-21C in CA

- High temperatures inhibit carotenoid pigments (>30C; 86F)
The Degreening Atmosphere –
*Air Circulation*

Good air circulation is required

- to equalize conditions of temperature, humidity, ethylene through entire room
- to uniformly deliver ethylene to every fruit
- to remove unwanted products such as carbon dioxide and volatiles (?) from room

The Degreening Atmosphere –
*Atmospheric Composition*

High carbon dioxide can inhibit ethylene

*Threshold values of CO₂ inhibitory effect is unclear*

- 1% - FL orange and grapefruit degreening rooms (Grierson and Newhall, 1960)
- 2.5%, Shamouti oranges; 5%, lemons (Cohen, 1973) in controlled environment

Oxygen concentration may have some influence; reports are confusing
Other Factors Affecting Degreening

*Packinghouse Treatments*

- **Bin Drenching**
- **Washing**
  *Increases time for degreening?*
- **Waxing**
  *Inhibits*
- **Color Sorting**
  *Increases efficacy of treatment*

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**Ethylene Degreening**

*What do we degreen?*

- Early season navel oranges
- Re-greened valencia oranges
- Lemons
- Mandarins
**Degreening**
- early season navels
- late season valencias

1 - 5 ppm ethylene
68 - 70 F; 90 - 95% RH
<1% CO₂

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**Degreening of Mandarins**

Mainly early season satsumas harvested before the onset of cool temperatures
Harvest

Bin Drench

Packinghouse

Degreening

TBZ/SBC/Cl₂

1 to 5 days

Fungicide application

Source: J. Smilanick

Blue Mold
P. italicum

Green Mold
P. digitatum

Penicillium sp.

Caused by wounding during harvesting and handling

Sporulation - direct loss and necessitates repacking

Source: Arpaia, Mary Lu "Citrus Degreening" (c) 2015 Postharvest Technology Center, UC Davis
**Lemon Degreening**

*Desert lemons harvested in August – October*

*Coastal lemons on a more limited basis*

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**Pre - DeGreening**

- Grading, sorting and culling before soak tank
- Soak tank (1 to 4 min residence)
- Imazalil or Thiabendazole
- Fungicides in Storage WAX
- Water rinse
- Water Brushing
- Dryer
- Color sorting
- Storage (Coastal Lemons) or Degreening/Packing (Desert Lemons)

Source: J. Smilanick
Ethylene Degreening
Recommended Conditions

- **Ethylene:** 1-5 ppm
- **Temperature:**
  - 20-21°C (68-70°F) in CA
  - 28-29°C (82-84°F) in FL
- **Humidity:** 90-95%
- **Ventilation:** 1 air exchange/hour
- **Carbon Dioxide:** reports varies, <1%

Thank you for your attention
Other resource information on degreening

FRESH CITRUS FRUIT 2nd Edition
Florida Science Source, 2006
http://www.ultimatecitrus.com/fssource

Recommendations for Degreening Florida Fresh Citrus
Ritenour et al. 2008
University of Florida Circular 1170
http://postharvest.ifas.ufl.edu.