Harvesting and Handling of Grapes

Production
Domestic Production

- California produces 98% of table grapes grown in the U.S.
  - CA industry composed of ~550 farmers
  - 1st vineyard was planted by William Wolfskill in 1839

- 1/3 of the crop is exported to over 50 countries worldwide.
  - Top 5 exporting regions include: Canada, Mexico, China, Central America, Australia

- Per capita consumption in the U.S. is 8.4 lbs. per capita (2.5 lbs per capita, 1970).

Table Grape Cultivars & Maturity

- Summer Royal
- Fantasy Seedless
- Marroo Seedless
- Autumn Royal
- Flame Seedless
- Scarlett Royal
- Sweet Scarlet
- Crimson Seedless
- Red Globe
- Sugraone
- Princess
- Thompson Seedless
- Autumn King
### Table Grape Maturity

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Soluble Solids</th>
<th>Sugar Acid Ratio</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Thompson Seedless</em></td>
<td>17.0%</td>
<td>20:1</td>
<td>15%</td>
</tr>
<tr>
<td><strong>Thompson Seedless</strong></td>
<td>16.5%</td>
<td>20:1</td>
<td>15%</td>
</tr>
<tr>
<td>Flame Seedless/ Ruby Seedless</td>
<td>16.5%</td>
<td>20:1</td>
<td>No</td>
</tr>
<tr>
<td>Italia</td>
<td>16.5%</td>
<td>20:1</td>
<td>No</td>
</tr>
<tr>
<td>Superior Seedless/ Perlette</td>
<td>15.5%</td>
<td>20:1</td>
<td>14%</td>
</tr>
</tbody>
</table>

*Varieties grown north and west of the San Gorgonio Pass.*

**Varieties grown south and east of the San Gorgonio Pass**

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### Harvest Preparation

- Treat avenues to prevent dust
- Withhold irrigation
- Level soil
- Remove high cover crops
- Prune some long canes; remove some leaves
Harvesting

Workers pick grapes into pans in the vineyard. Defective berries are removed, and bunches with sour rot are avoided.

Trimming
Transport to roadside

Packing

• Field Packing
• Shed Packing
Providing “shade” during packing is very important

Potential considerations:
- Ambient Temperature: may be HOT
- Delay in getting to cooling facility
- Uneven lighting – detection of problems
Trimming & box filling
Harvest containers vary

Cleanliness is CRUCIAL
Palletizing and transport to cooler

Diversity in Package Types
0.2-1.5% water loss during picking and packing
Temperature/Time Dependent

Effect of sun exposure on grape temperature
Table grape stem condition after cooling delays (32°C/90°F, 80% RH) + 6 days (0°C/32°F, 80% RH)
Shed packing
Placement of SO$_2$ pad

Table Grape Containers

- TKV (wood end)
- EPS Foam
- Returnable Plastic (RPC)
- Corrugated
Consumer Packaging

Master Containers

Plain pack/EPS foam
Bagged/TKV
Wrapped/Corrugated
Forced air cooling
Bags slow cooling

Air speed and relative humidity affect grape weight loss
Table Grape Storage

- Pulp Temperature: -0.5 – 0°C
- Room Temperature: -1°C
- Relative Humidity = 95%
- Airflow: 20-40 cfm/ton during storage
- SO₂ fumigate weekly or use storage pads to control Gray Mold (*Botrytis cinerea*)

Gray mold caused by *Botrytis cinerea*
Gray mold (caused by *Botrytis cinerea*) on Table Grapes

Infection pathways (Elmer & Michailides 2004)

1. Conidial infection of the style and ovules
2. Conidial infection of the stamens and/or petals
3. Fruit infection via the pedicel *
4. Conidial accumulation within the developing bunch
5. Conidial infection of fruit
   
   *This happens when it rains* ….
6. Conidial accumulation on fruit and dispersal to insect or picking wounds
   
   *Most common under dry conditions*…
Three Main Problems

1. **Botrytis Decay**
2. **Bleaching**
3. **Hairline**

**Effect of storage temperature on decay development**

- **Thompson Seedless**
  - 3.9°C
  - 1.7°C
  - 0.5°C

- **Emperor**
  - 39°F
  - 35°F
  - 31°F

Days in Storage
Goals of fumigation

- Initial fumigation to control surface infection
- Weekly fumigation to control spread of latent Botrytis infection (nesting)

Dosage Considerations

For SO₂ measured as ppm-hour

CT = average SO₂ concentration (ppm) x fumigation time (hours)

A CT of 100 ppm-hours kills both spores and mycelia of *Botrytis cinera*
Initial Fumigation

• Prior Shed Packing
• After Packing
  – Injection into individual packages
  – During Forced Air Cooling (defrost afterwards)

Fumigation during cooling

• Efficient use of both cooling timing and SO₂ distribution throughout room
• Forced air ensure good penetration even to center boxes within pallet
• With good room design, should produce >80% penetration
• Measured as the room air CT product (conc x time)
Fumigation before packing

Injection into individual package as compared to fumigation prior to packing
Storage/Transit

- Room Fumigation (Passive)
  - Use higher air flows during initial fumigation
  - Good air circulation patterns necessary to insure good distribution

- Use of SO₂ pads – allows for slow release during storage or transit
  - Rate of gassing temperature dependent

Berry Bleaching from Sulfur dioxide

- Mostly red cultivars
- Sulfite harms flavor
High rates of SO\textsubscript{2} caused these early season ‘Thompson Seedless’ grapes to brown

SO\textsubscript{2} expressed as c x t product in a one hour fumigation. Grapes stored 10 days at room temperature before these pictures were taken.

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**Damaged berries and SO\textsubscript{2} residues**

- SO\textsubscript{2} highly soluble in water
- Damaged berries will accumulate higher residues
- Good grading in field and during packing is very important
- Minimizing damage during handling
Berry bleaching from sulfur dioxide

Redglobe control

Redglobe SO₂ fumigated

Berry bleaching from sulfur dioxide
**SO$_2$ residues**

<table>
<thead>
<tr>
<th>DAMAGE</th>
<th>THOMPSON SEEDLESS</th>
<th>FLAME SEEDLESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTACT</td>
<td>2.3</td>
<td>2.2</td>
</tr>
<tr>
<td>LOOSE CAPSTEM</td>
<td>2.8</td>
<td>3.2</td>
</tr>
<tr>
<td>BRUISED</td>
<td>6.6</td>
<td>3.3</td>
</tr>
<tr>
<td>BOTRYTIS INFECTED</td>
<td>10.8</td>
<td>17.9</td>
</tr>
<tr>
<td>SPLIT OR CRUSHED</td>
<td>23.6</td>
<td>18.5</td>
</tr>
</tbody>
</table>

**SO$_2$ activity on *Botrytis cinera* mycelium**

![Graph showing SO$_2$ activity on Botrytis cinera mycelium](image)
Monitoring SO₂ Concentration

**Sulfur dioxide fumigation controls gray mold – is an alternative needed?**

- Sulfur dioxide is not allowed on ‘organic’ grapes
- Sulfur dioxide can harm berry appearance and flavor
- Regulatory issues with transportation and storage, worker safety, residue limits in grapes, and its discharge to air

- Fenhexamid (Elevate) within 24 hours of harvest

*Smilanick et al.*
Kiwifruit Handling

Kiwifruit are native to the Yangtze River Valley of Northern China.

Missionaries brought seeds from China to New Zealand.

Italy, China, New Zealand, Chile, South Africa.
The ‘Hayward’ variety is still the #1 cultivar

Hort16-A
Yellow Flesh
USA Kiwifruit

- 97% grown in California
- Kiwifruit ranks 67 out of over 300 commodities
- 25% of crop exported
  - Mexico
  - Canada
  - Korea

Determining minimum maturity
Starch

Kiwifruit

<table>
<thead>
<tr>
<th>Harvest</th>
<th>Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mature</td>
<td>Ripe</td>
</tr>
<tr>
<td>Starch</td>
<td></td>
</tr>
<tr>
<td>Sugars</td>
<td></td>
</tr>
<tr>
<td>SSC = 6.5%</td>
<td>SSC = 15%</td>
</tr>
</tbody>
</table>
How to assure Consumer Quality

- Minimum Maturity (6.2% SSC)
- Maximum Maturity (<14 pounds)
- Consumer Quality (>12.5% RSSC)
- Fruit Handler Quality (>15.1% DW)
Consumer Acceptance (‘in-store’)

15.1-16.1 % DW

Wait… I’m not “READY TO EAT” yet!!
- Hard
- Starchy
- Sour
- Odorless
- 6.5 - 7.0% HSSC
- 13.5 - 14% RSSC
- 17% DW

EAT ME… I’m “READY TO EAT”!!
- Soft, Juicy
- No starch
- Sweet,
- Aromatic
- Tasty
- 13.5 - 14.0% RSSC
- 17% DW

Kiwifruit ripening

Storage 4-12 months
Preconditioning (4-21 days)

Mature (Harvest)
- Low Consumer Acceptance

Ripe (Consumption)
- High Consumer Acceptance
Kiwifruit Harvesting & Packaging

[Images of kiwifruit harvesting and packaging]

[Images of workers in a kiwifruit orchard]
Holding or Curing

48 hour curing (59°F, 95% R.H., 2 m/s, ethylene free)
Packinghouse Operations

Bin Dumping

Cleaning → Brushing → Sepal Removal
Postharvest Diseases

*Botrytis cinerea*  *Penicillium expansum*

**Postharvest Fungicides:**
- Fenhexamid (Elevate)
- Fludioxonil (Scholar)
Sorting

Sizing
Tray packing
Box liner

Volume Filled
The type of kiwifruit container with box liners does not interfere with the ethylene application.
Forced Air Cooling

Cooling down to ~36°F

Air versus CA Storage

Temperature Management (32°F, 90% R.H.)
Storage Potential

Pericarp translucency
or
Internal breakdown

Fruit of lower maturity
more prone to this problem

Softening in air storage:

• Ethylene – accelerates softening
• Temperature – 0C
• Speed of cooling – should be < 24 hours
• Fruit maturity – more mature: more sensitive
Temperature and Ethylene influences softening

Duration of exposure influences softening
**Controlled Atmosphere Success Depends Upon:**

- Ethylene exclusion
- Temperature – 0°C
- Rapid establishment - < 1 week
- Continual monitoring to maintain optimum O₂ and CO₂ levels

**Ethylene in CA storage also detrimental**
Ethylene duration in CA storage (2% O₂, 5% CO₂)

Internal Breakdown No Problem White Core Inclusions
Thanks for your attention

Thanks to J. Thompson, D. Luvisi, J. Smilanick, A. Kader, C. Crisosto, A. Woolf for sharing parts of this presentation