Subtropical Frost and Freeze Hazards
Frost Hazards

- Ranks with pest control, nutrition, and irrigation.
- May be most limiting factor
  - 1962-63 entire Northern Hemi.
  - Texas from 10 M boxes in 1961 to 740,000 boxes in 1964.
Damage Continues

• Frost and Freeze losses in winter of 1983-84. Loss of 100,000 Ha.
• Brazil seldom has loss from frosts and freezes.
• Mediterranean area protected by Alps (Oriented east - west).
• Rockies are North - South.
Frost or Freeze?

- **Frost** - Wind is light to none (Radiation)
- **Freeze** - Wind over 10 mph (advective).
- Since damage occurs by ice formation - term freeze hardiness fits what happens in fruit.
Freeze Avoidance (Supercooling)

- *Citrus* species supercool threshold:
  - Fruit -5°C
  - Mature leaves -7°C
  - Stems -8.9°C
  - Non-acclimated <-2°C
  - Flower -4.3°C
Intercellular Ice Formation

- Citrus tolerates some ice formation between cells.
  - Watersoaking at -3°C may not cause leaf abscission.
Freeze Acclimation

- Function of
  - Soil temperature
  - Tissue temperature
  - Daylength
    - Better under long days
    - Increased metabolites
Maximum Acclimation

- Daytime temps/ 20 to 25° C
- Night-time air & soil temp/ 12° C for 2 weeks or more.
- Causes quiescence (not dormancy).
- Loss of hardiness > 12.5° C.
Biochemical Changes

- Sugar content increases with acclimation.
- Lowers freezing point and acts as a cryoprotectant for cell membranes.
- Critical are minimum temp. and duration below minimum.
Passive Protection Methods

• Site selection
  – Weather Records
  – Avoid low places (Frosts)
  – Wind breaks N & NW (Freezes)
    ◦ Trees
    ◦ Shade cloth.
More Passive Methods

• Clean cultivated, packed soil absorbs more net radiation from sun, thus more radiant energy at night than sod covered or newly cultivated orchard floor.
• Orangeries- since Roman times.
• Today near Sorrento, Italy.
Still More Passive Methods

• Japanese grow citrus in greenhouses
  – Frost protection
  – Hastens fruit maturity

• Taiwanese grow peaches under cover. (prevents frost & leaf curl)
Active Methods - University Return Stack Heating

- Protection against both frosts and freezes.
  - Initial $40 \times 48 = $1920/A
  - Annual operating 5 gal diesel $0.65 \times 48 \times 4 \text{ nights} +$50 labor = $674
  - Total = $2594/A first year
Return Stack Specifications

- Best of oil heaters
- One hole setting uses 0.3 gph
- Three hole setting uses 1 gph
- 30,000 BTU / hr (20 - 70% radiant)
- Energy directed horizontally
- Rain in stack - blow over
Other Heaters

- Large Cone - slightly more radiant energy less blow over
- Short Stack Heater - Smoke
- Open Pots - Don’t even think about it.
Pressurized Oil Systems

- Diesel delivered though underground plastic tubes
- Efficient
- Must keep nozzles cool
- Problems - high pressure oil, filter clogging
## Propane Heaters

### Vapor Pressure of Propane

<table>
<thead>
<tr>
<th>Temperature</th>
<th>PSI</th>
</tr>
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<tbody>
<tr>
<td>70°F</td>
<td>109</td>
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<tr>
<td>32°F</td>
<td>54</td>
</tr>
<tr>
<td>-44°F</td>
<td>0</td>
</tr>
<tr>
<td>130°F</td>
<td>257</td>
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</tbody>
</table>

- **30,000 gal tank / 60 acre orchard**
Solid Fuel Blocks

- Once cost effective - but not now
- Four blocks under grapefruit canopy raised temp 13° F
- Unique for LGRV
  - Fewer frosts / season
  - Store under trees all year
Wind Machines

- Only for frosts
- Most effective in hill and valley topography - California
- Mixes inversion layers (upper warmer air with lower colder air)
- Increase temp 0.5 to 1.5° C
- One machine / 5 to 8 acres
Irrigation - Frost Protection

- Provides Sensible Heat
  - Warm water source
- Heat of Fusion
- Only for frosts
  - Evaporative cooling removes 7.5 times as much energy from irrigated area than provided by Heat of Fusion.
Overhead Irrigation

• Heavy foliage accumulates ice which breaks limbs.
• Works better on strawberries and blueberries.
• Primarily used on citrus nurseries.
Microsprinklers

• At ground level elevates 1 to 2°C to lower canopy
• No help for fruit and upper canopy
• Elevated about 1 m give some protection of scaffold limbs - quicker re-establishment.
Elevated Microsprinklers

• Excellent results 12.5 gph / tree
• Hardie Microsprinkler III
• Protected peach buds when air temp dropped to 18° F (-8° C)
Microsprinkler Limitations

• One 5HP pump for 5 A
  – Same pump irrigates 20 A
• LRGV Irrigation Districts - water not available on demand.
Insulators and Tree Wraps

- Soil banks effective
  - Expensive but saves trunk.
  - Remove in spring.
- Polyurethane foam wrap banded with metal strapping.
- Plastic bag of water between wrap and trunk???
THE END