

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 $> 12.5^{\circ}$ 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 x $\$0.65 \times 48 \times 4$ 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 through underground plastic tubes
- Efficient
- Must keep nozzles cool
- Problems - high pressure oil, filter clogging

Propane Heaters

Vapor Pressure of propane

- Temperature PSI
 - 70° F 109
 - 32° F 54
 - - 44° F 0
 - 130°F 257
- 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)
- Rieger, Mark and S. C. Myers. 1990. HortScience 25:632-635.

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