Frost Protection & Recovery in Vineyards
2009 Review
Spring Frost

- **What**: Damage to vines vegetative growth
- **When**
- **Where**
- **Why**
Cold Damage to Vines

- Winter kill
  - \(-10^\circ\text{F} \text{ (-12}\degree\text{C})\)

- Spring frost
  - \(-31^\circ\text{F} \text{ – ½ hour}\)
  - \(-26^\circ\text{ - 28}\degree\text{F}\)
Bud Damage Winter vs Spring
Budbreak and Frost

- March 15 – average
- May 1 – frost possibility until
- Prune late
- Double prune
- Variety & Site selection
General History of Spring Frost

- 2008 Statewide Scattered outside of Lodi
- 2007 Winter Injury
- 2006 Minor Frost (Just before Budbreak)
- 2001 Frost April 1-3 East SJ Co & North Delta
- 1999 Frost April 10 East SJ Co
- 1997 Frost April 5 Scattered East
- 1996 Minor Frost March 26 Scattered
- 1991 Winter Kill
- 1984 Minor Frost (one night)
- 1983 Slight Frost South County
- 1972 Major Frost
- 1968 Frost
Frost Damage

- What
- When
- Where
  - Inversions vs Arctic air mass
  - Low Areas
  - Obstruction of air flow
- Why
Contributing Factors Frost

- Soil texture
- Slope & Aspect (drainage)
- Stage of Vine Growth
- Carbohydrate Status
- Variety
- Relative Humidity & Dew Point
- Weather Pattern up to Frost
Topography and Drainage
Dew Point

&

Relative Humidity
Frost Damage

- Ice Nucleation
- Ice nucleating bacteria
- Ice Crystals
- Cell Rupture
- Cold Temperatures
Being Prepared – What to Do?

Active Frost Protection

versus

Passive
Control Strategies

- **Passive**
  - To reduce or prevent potential damage
  - Less costly

- **Active**
  - To prevent immediate damage
  - More costly
Active Protection

- Sprinklers or Misters
- Wind Machines
- Orchard Tunnels
- Heat
- Bactericides – CuSO$_4$, Cu(OH)$_2$, etc.
- Biological
Wind Machine
Semi-Portable Machines
Overhead Sprinkler Irrigation
Water Supply Needed

- Radiation Frost 50 to 55 gpm/acre
  - 0.11 to 0.15 acre inches per hour

- Advective Frost 100 + gpm/acre
  - 0.25 acre inches per hour

- Period of Protection $\frac{1}{2}$ to 6 hours or more
Radiation vs. Advective Frost

- Relative humidity; dew point
- Wind, clouds or fog
- Soil texture
- Slope & aspect (drainage)
- Stage of vine growth
- Variety
Examples of Technology

- Sprinklers - $1500/acre – water supplies
- Wind Machines - $20,000/10 acres – radiation
- Orchard Tunnel - $10,000/10 acres – radiation
- Helicopters - $200/hr ? – Acres
- Other
Comparative per Acre Costs

- **Wind Machines**
  - $2,000
  - $25.79
  - 10 acres; effective

- **Sprinklers**
  - $1,500
  - $4.58
  - limited application

- **Helicopter**
  - $40.00/hr
  - Effective but, expensive and limited
Alternative Controls

- **Chemicals** copper based; bactericides
  - No evidence of Effect

- **Micro Mist/Foggers**
  - No consistent evidence

- **Biological**
  - Yes, but not available
  - Not 100% effective
Passive Control Strategies

- Passive
  - Site selection
  - Soil & ground cover
  - Irrigation Pre-Frost
  - Delay growth
Pre-Frost Irrigation
Increased Protection
Limitation of Drip Irrigation
Soil & Ground Cover

- Soil’s Capacity & Conductivity
- Dry & Cultivated
- Uncultivated & Bare
- Dry & Mowed
- Wet & Mowed
<table>
<thead>
<tr>
<th>Ground Preparation for Frost Control</th>
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<tbody>
<tr>
<td>Warmest</td>
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<tr>
<td>WET, FIRM, BARE GROUND</td>
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<td>DRY, FIRM, BARE GROUND</td>
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<tr>
<td>SHREADED COVER CROP</td>
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<td>FRESH DISCED</td>
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<td>LOW COVER CROP</td>
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<td>HIGH COVER CROP</td>
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<td>Coldest</td>
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Cover Crop Benefits vs Costs
Living Dangerously
Weather Records and Monitoring

- History of Site
- Area temperature and weather data
- Thermometer Stations placed
- Weather Stations or Data loggers (low cost)
- Frost alarms
- NOAA web site  www.wrh.noaa.gov
Frost Recovery Strategy

What to do after the damage is done.
2008 Surprise

Cabernet Sauvignon
Spring Frosts

- 1933  Late April
- 1961  April 19 and 20
- 1964  April 24
- 1972  March 26, 27, and 28
- 1983  April 13
- 1984  April 20
- 1997  April 5
- 1999  April 9
- 2001  April 8
- 2008  April 15, 20 and 24
## Lodi District Weather Stations 2008

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<thead>
<tr>
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<th>April 7</th>
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Avg April Minimum 48° F
Sauvignon blanc

Chardonnay
Pinot gris

Chardonnay
Grenache
Merlot
Frost Damage Mitigation

- Trimming Damaged Tissue
- Shoot Thinning
- Cluster Thinning
- Removing All Shoots or Repruning

Benefits < Costs 1933, 1967, 1972

- Adjust Management for Lower Crop
Doing Something vs Nothing

- Shoot Removal                  Winkler, 1933
- Repruning vs Trimming          Antcliff, 1957
- Self Recovery                  Lider, 1965
- Shoot Removal                  Kasimatis & Kissler, 1972
Kasimatis & Kissler Trials

- Tokay, Carignane, Zinfandel, Chenin blanc, and Grenache
- Seven Sites
- Shoot Removal of all shoots, damaged shoots only, and a control with no adjustment
- Shoot removal done 3 days after frost*

*1972 Frost March 26, 27, & 28
# Harvest Yield

**1972**

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<th>Strategy</th>
<th>Total</th>
<th>Primary</th>
<th>Secondary</th>
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Yield lbs per vine

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<tr>
<th>Measurement</th>
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<th>Range</th>
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<tr>
<td>Brix</td>
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<td>T.A.</td>
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<td>(0.3-0.7 g/L)</td>
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<td>pH</td>
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Canopy/Crop Load Strategies

- Cluster Thinning: No
- Shoot Thin Damaged shoots if half or more of shoots killed to clusters and beyond: Maybe
- Shoot Thin if only shoot tips damaged: No
- Remove all shoots and start again: No
- Cut back to long spurs if cane pruned: Maybe
- Do nothing, but irrigate*: Yes (9/10)

*and normal pest control
Summary

- Irrigation normal or slightly more initially
- No extra nitrogen; less depending on crop
- Continue Pest Management, especially powdery mildew
- No cluster thinning
- No shoot thinning for most varieties and sites
- Cane pruned vines may benefit from re-pruning
- Some fruit buds developing for 2009 may be damaged, but many factors determine ultimate fruitfulness for next year.
SGT Bryan Verdegaal
2/10\(^{th}\) AHB 10\(^{th}\) Mountain Division
Camp Speicher Tikrit, Iraq