Grapevine Cold Hardiness and Injury: Dynamics and Management

Dr. Robert Wample
California State University-Fresno

Low Temperature Tolerance Vs Avoidance

- Tolerance
  - Supercooling

- Avoidance (Permanant crops)
  - Delayed budbreak (Spring Frost)
  - Early dormancy (Fall Frost)

Critical vs Minimum temperature
The temperature at which tissue damage will occur vs predicted or observed minimum temperature

Dynamic nature of critical temperatures
Management may influence critical temperature

Factors Associated With Changes In Grapevine Cold Hardiness

- Carbohydrates
  - Starch to sugar conversions
  - Specific sugars associated with molecular stability

- Lipid saturation and membrane stability

- Intracellular water content

- Increase in total nitrogen and protein nitrogen

Types of Frosts/Freezes (R. Evans; AJEV)

- Radiation.
  - Most common
    - Large, dry air mass; no clouds; little wind;
    - Clear sky = -4F; tissue temp. 2-4F below air temp.
    - Thermal inversion (20-30 yard: 9-11F; 2-20 yards: 3-6F).
    - Rate of heat loss rapid down to near “dew point.”
      - Heat of condensation = approx. 2500 KJ/L (10 BTU/gal water).
      - Heat of fusion = approx. 335 KJ/L (1.4 BTU/gal water).

- Advective
  - Strong, cold winds (below critical temp.)
  - Rapid heat loss

General Cold Protection (R. Evans; AJEV)

- Passive (low cost)
  - Site selection (slope, aspect, air drainage [11-14F colder in low spots])
  - Variety (Chardonnay vs Cabernet Sauvignon)
  - Cultural practices (irrigation- pre- & post-harvest, pruning, crop load, fertilizer, cover crop, soil, chemical sprays – midwinter vs delayed bud break)
  - Large bodies of water
General Cold Protection
(R. Evans; AJEV)

- **Active**
  - Calculated heat loss: 1.2 million BTU/ac/h
    - Oil heaters: 3.1 million BTU/ac/h (@ 50 gal #2 diesel/ac/h; ca. 45 heaters/ac)
  - Propane heaters: 4.4 million BTU/ac/h (@ 50 gal LP/ac/h; ca. 65 heaters/ac)
  - Wind Machine: dependent upon strength of inversion (ca. 50% of the difference; 10-11 ac/machine)
  - Sprinkler system: 3.1 million BTU/ac/h (@ 0.12 inches of water applied/h)
    - Heat of condensation = approx. 2500 KJ/L (10 BTU/galwater).
    - Heat of fusion = approx. 335 KJ/L (1.4 BTU/galwater).

- **Helicopters**

---

**Low Temperature Injury**

Vegetative & Flower Tissue

---

**Low Temperature Injury**

Dormant Tissue

---

**General Cold Protection**
(R. Evans; AJEV)

- **Wet bulb temperature**
  - Starting temperature
  - >26F 34F
  - 24-25F 35F
  - 22-23F 36F
  - 20-21F 37F
  - 17-19F 38F
  - 15-16F 39F

- The higher starting temperatures are necessary to avoid the problem of initial “evaporative dip” when using sprinklers caused by the lower vapor pressure (relative humidity).
Secondary Bud
Primary Bud
Tertiary Bud

Grapevine Cane Anatomy

Cane Low Temperature Injury

Vascular cambium
Injured phloem

Figure 2a
Figure 2b
Figure 2c
Figure 2d

Cabernet Sauvignon 1994
Nov 9
Oct 31
Oct 14

Concord
March 2, 1990

Cabernet Sauvignon
White Riesling
Chenin Blanc
Factors Contributing to Dynamic Changes in Grapevine Cold Hardiness

- Photoperiod
  - Day length (increasing or decreasing)
- Temperature
- Species / Cultivar
- Water / irrigation
- Cropload
- Nutrition
- Harvest date
- Rootstock
Cold Hardiness Management

- Physiological State of the vine
  - Variety specific
  - Influenced by: water, nutrition, crop load, pruning date, harvest date, rootstock, temperature
  - Which of these can we control?
  - Cost of Management
    - Factor controlled
    - Critical temperature

Low Temperature Injury Management

- Extent of damage
  - Influenced by:
    - Minimum temperature and critical temperature
    - Duration of minimum temperature
    - Meteorological / climatic (meso and micro) conditions

Low Temperature Injury Management

- Tissue / Organs Damaged
  - Vegetative shoots
  - Buds
  - Canes
  - Trunks (crown gall)
  - Roots
- Ability to evaluate damage
  - Visual symptoms
  - Acreage

THANK YOU.