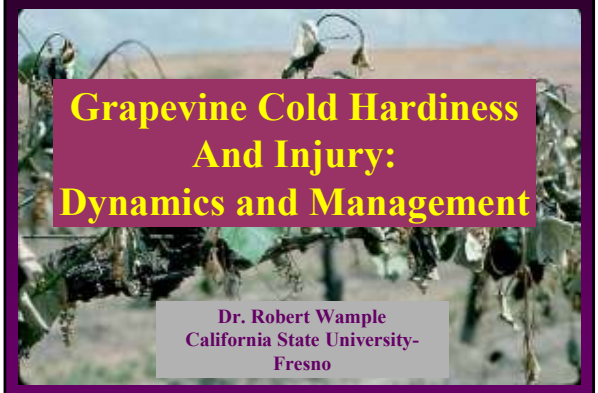

Grapevine Cold Hardiness And Injury: Dynamics and Management

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Low Temperature Tolerance Vs Avoidance

- Tolerance
  - Supercooling
- Avoidance (?)(Permanent crops)
  - Delayed budbreak (Spring Frost)
  - Early dormancy (Fall Frost)

Grapevine Cold Hardiness

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 (20-30yards;9-11F)(2-20yards: 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/gal)water.
      - Heat of fusion = approx. 335 KJ/L (1.4 BTU/gal)water.
    - **Helicopters**

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

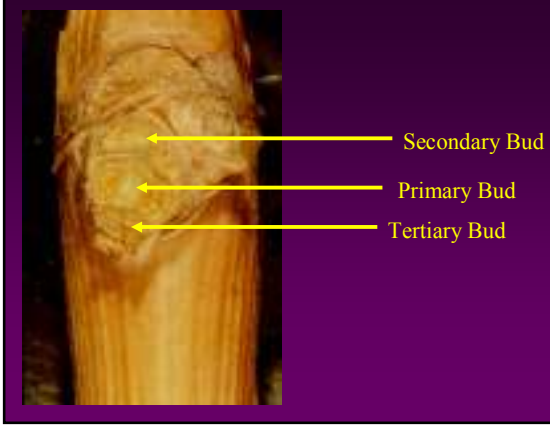
- *The higher starting temperatures are necessary to avoid the problem of initial "evaporative dip" when using sprinklers caused by the lower vapor pressure (relative humidity).*

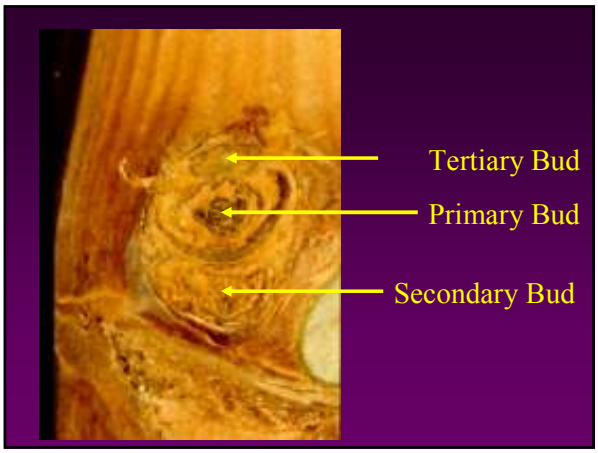
Low Temperature Injury

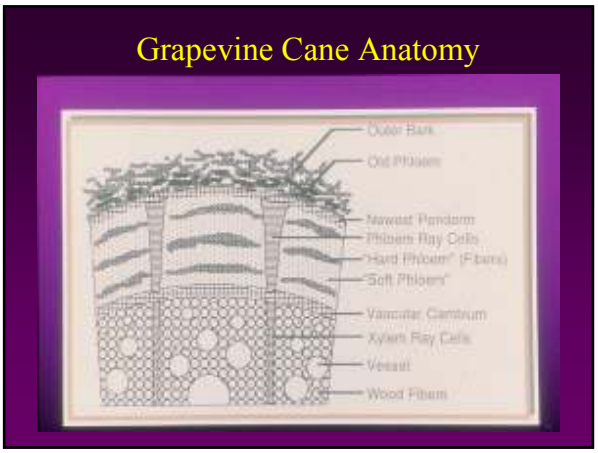
Vegetative & Flower Tissue

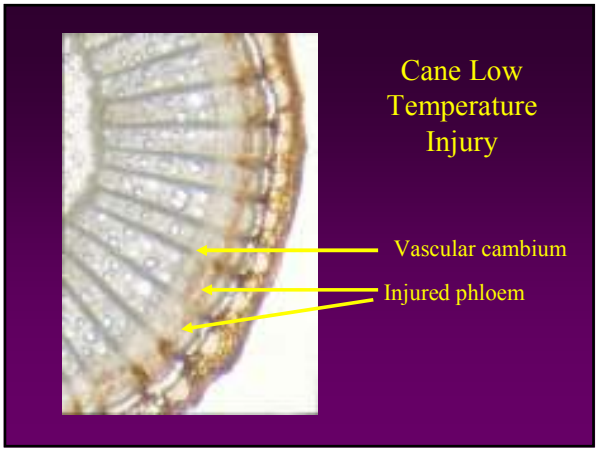
Low Temperature Injury

Dormant Tissue




Tertiary Bud
Primary Bud
Secondary Bud


Grapevine Cane Anatomy


Cane Low Temperature Injury
Vascular cambium
Injured phloem

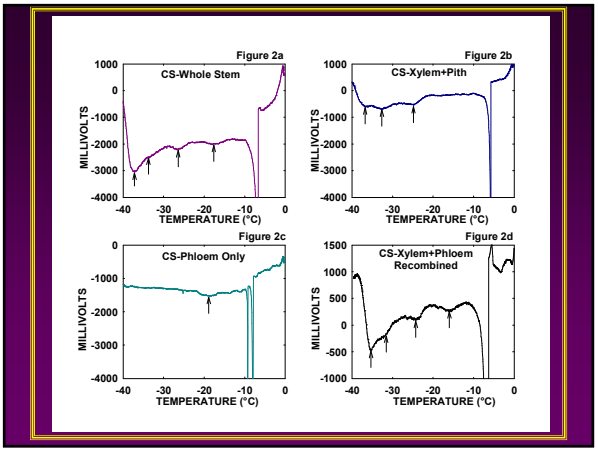
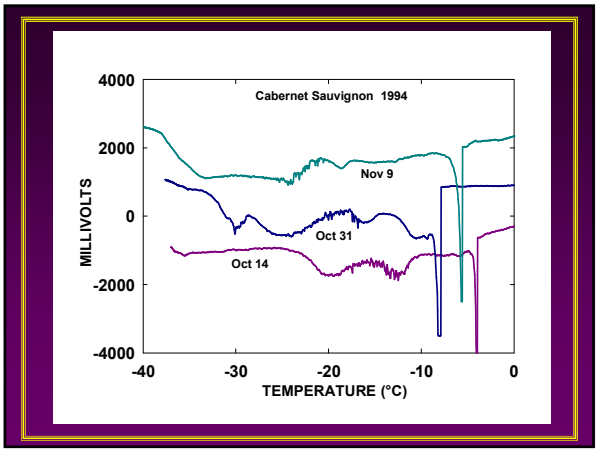
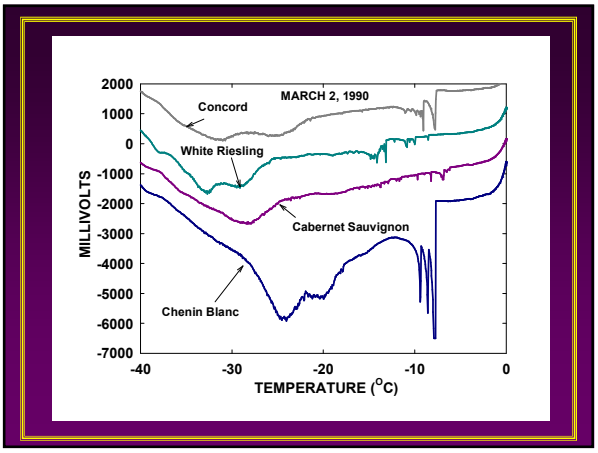
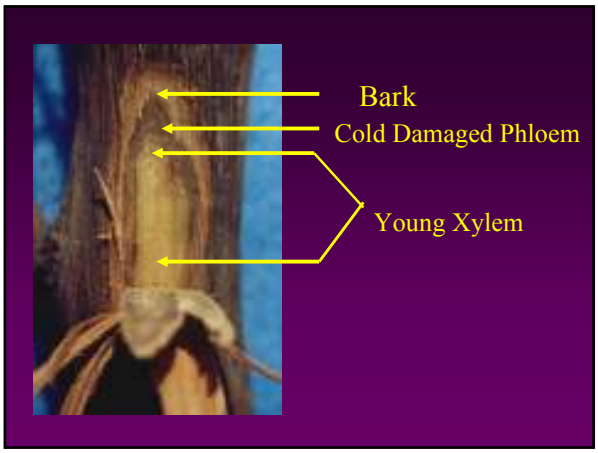
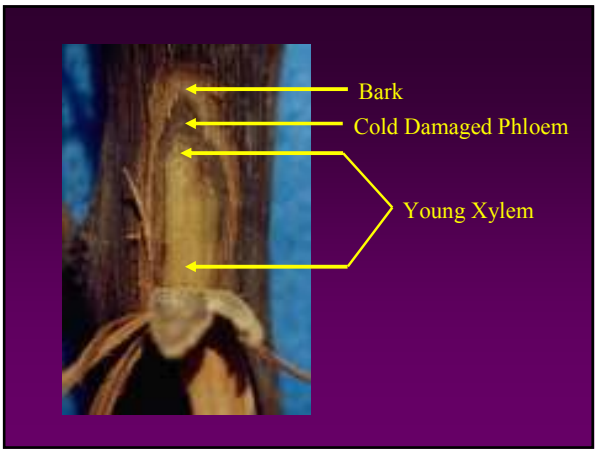


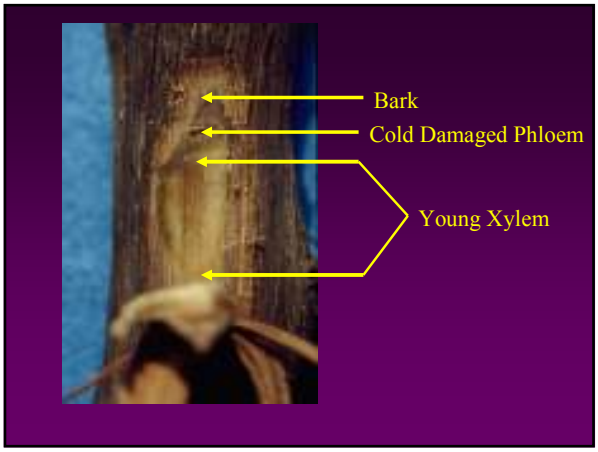
Figure 2a
CS-Whole Stem
Figure 2b
CS-Xylem+Pith
Figure 2c
CS-Phloem Only
Figure 2d
CS-Xylem+Phloem Recombined
MILLIVOLTS
TEMPERATURE (°C)


Cabernet Sauvignon 1994
Nov 9
Oct 31
Oct 14
MILLIVOLTS
TEMPERATURE (°C)


MARCH 2, 1990
Concord
White Riesling
Cabernet Sauvignon
Chenin Blanc
MILLIVOLTS
TEMPERATURE (°C)

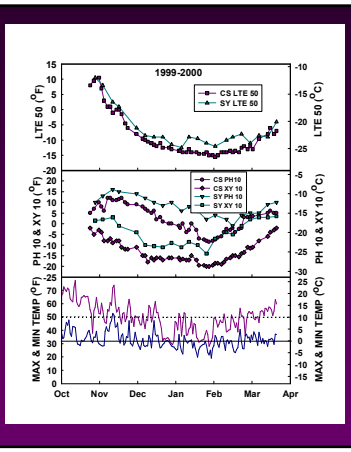






Factors Contributing to Dynamic Changes in Grapevine Cold Hardiness

- 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.