Grapevine Winter Injury
What Is It?

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Winter Injury

Where are we likely to find it?

- Low areas
- Areas near a bush
- Any dead air areas
- Higher elevations
- Wet spots (slower to acculate)

What Influences it - the weather?

- early winter cold
    - Dec. 02, 2002: -17C
- late winter cold
    - Mar. 17, 1993: -16C, Mar 02, 2003: -19C
- very rapid temperature drop
    - Dec. 24/25 1979: +3C to -25C in 8hrs
- protracted mid winter thaw (that's why the march cold caused so much damage)
    - Feb. 1993: >0C for whole month
- previous season drought/wet
    - July 2002: 20mm; July 1992: 160mm

*** If the soil is very wet and doesn't have time to dry out, vine goes into the winter in bad standing

What Influences it - vineyard management?

- whether your grape vine is hardy or not (eg. cabernets which are vigorous take longer to acclimate in the fall)
- wet spots in vineyard
- over cropping
- over fertilizing
- over pruning (over vigorous because too few buds are left on it)
- disease pressure
- drought stress
- ANY SEVERE STRESS

What influences it - the variety, clone rootstock?

- Mediterranean vinifera (related to table grapes, an exotic wine variety), northern vinifera, hybrids, labrusca, riparia and amurensis (the hardiest - -35°C, can loose it in the spring instead of the winter, buds will brake early)

- rootstocks vigour (high, low, phylloxera - extremely important)

What does it look like?

- failed buds and uneven budbreak
- unfruitful secondary and tertiary bud
- can failure, vine apoplexy
- trunk leakage and subsequent crown gall

*** Good bud break = 1) all 3 buds alive
2) most positions with primary buds
3) strong primary and good secondary, both fruitful
4) even shoot size and even distribution along canes (if all shoots are growing in the same direction on the same side of the shoot, that means they are all primary buds)

*** Bud damage = 1) primary dead, secondary and tertiary pushing
2) uneven shoot growth, many completely dead

*** Wood damage = 1) leakage after rehydration
2) dehydration cracks observed under field conditions

Vine Vigour Management Decisions

Understanding Photosynthesis and Carbohydrate Movement

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Cover Crops

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Fertilizer Timings

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Annual Life Cycle of Grapevine

Initiation of flower clusters for next summer

Reproductive period

Bloom Fruit set | Veraison | Maturation

Feb.	Mar-Apr	May	June	July	Aug	Sept-Oct.	Nov-Dec
		Bud Break			Active growth stops	wood matures	Leaf fall
Dormant period			most acitve growth			accum. of food reserves	

Vegetative growth period

- everything's going to get pushed back, the 2nd bud will break 6-7 days after the 1st
- if there is trunk damage, the carbohydrates can't get to the new buds, however, if less buds then there is more carbs./bud

Impact of Hedging

- eliminate the apical dominence
- lateral buds can then grow

Veraison

- the energy shifts and goes to the fruit and wood for the fall
- the temp. at which verasion happens is similar to all varieties, but it's the rate at which each variety processes it

After Harvest

- we don't really have post harvest period
- older, more shaded leaves will drop first

Direct Sunlight Interception by Leaves

First layer of leaves

- above light saturation

- Photosynthesis maximum

Second layer of leaves

- about 1/3 light saturation
- photosynthesis 25% of maximum

Third Layer of Leaves

- at compensation
- no net photosynthesis
- leaves are drained for CHO

*** if the leaf has insufficient light, then the bud has insufficient light and will not be fruitfull

Factors Affecting Vegetative Growth

• **Internal Factors**

- Cultivar, rootstock, vine size, hormonal balance

• **External Factors**

- Air temperature
- Soil temperature
- Light quality and quantity
- Photoperiod (sunlight hrs., production period)
- Precipitation
- Training system (the more vertical the trellis, the more vigorous the growth)

*** Temp. and sun have a little bit of effect on length of growth, however there are still signals that tell it to shut down

• **Actively growing grapevines seek sunlight**

a) Total vine growth (roots, shoots, leaves and crop) is regulated by sunlight, temperature, water and nutrients each season

b) Vines get large if basic elements above are not limited!

• **Growth increases with increasing leaf numbers**

a) Greater interception of sunlight but what about shading?

- balance is important

• **Vigour is inversely proportional to bud numbers**

a) How many is too many or enough?

• **Vigour is proportional to the angle of the cane with respect to the ground/horizon**

a) Complete upright gets the most sunlight in low competition and has greatest apical bud hormone influence

• **Flower production (fruit initiation) is inversely related to vegetative growth**

a) More flowers take more energy reserves from plant thus diverting CHO from vegetative to reproductive use

• **Cluster production decreases the intensity of vegetative growth (helps regulate the speed of growth)**

a) Clusters, flowering, fruit set and fruit sizing take energy and resources

• **Pruning wounds and squeezing or twisting canes can slow vegetative growth**

a) Restricting flow of nutrients and growth regulating hormones from one area to another can alter shoot growth and bud development

Factors Affecting Vegetative Growth Summary

a) Growth increases with increasing leaf numbers
b) Vigour is inversely proportional to bud numbers
c) Cane vigour is proportional to the angle of the cane with respect to the ground/horizon
d) Flower production (fruit initiation) is inversely related to vegetative growth
e) Cluster production decreases the intensity of vegetative growth
f) Pruning wounds and squeezing/twisting canes can slow vegetative growth

Vigour and Cold Injury

- **Dormant wood/bud samples in 2003 have revealed**
- Large diameter canes (>10mm or pencil size) have shown greater damage of primary buds
- Large bud cultivars have more primary and secondary bud injury
- **Dormant wood/bud samples in 2003 have revealed**
- Excessive growth and shading has more injury to buds
- Bull wood shoots showing more bud and cambial injury
- **Expectations in 2003 for growth**
- Reserves will be focused into fewer buds than optimum for balanced growth at many locations
- Trunk damage may be exhibited by aggressive shoot growth from base of vines or high numbers of "suckers" developing low on the vines
- Clumping or shoot congestion will predominate making canopy management important
- Bull wood shoots will be prevalent

Methods of Managing Vigour

- Use of cover crop
- Crop load management
- Water management
- Fertility management
- Canopy management

Cover Crops

- **Advantages**
- Prevent soil erosion
- Increase soil organic matter
- Reduce soil compaction
- Reduce vine vigour
- Harbour benefical insects
- etc.
- **Disadvantages**
- Increase water and nutrient requirements
- May delay maturity
- Serve as reservoir for pests
- etc.

Common Cover Crops Used

1) Annual rye
2) Perennial rye

3) Oilseed Radish
4) Fescues

Desired Characteristics of a Cover Crop

- Rapid establishment
- Dense cover
- Wear resistant (traffic)
- Low maintenance
- Winter hardy
- Drought tolerant
- Shade tolerant

Grasses for Cover Crop

			Tolerance	*To*		
Name	**Growth**	**EST rate**	**Water**	**Drought**	**Shade**	**Cold**
Perennail Ryegrass	Bunch	Fast	Good	Excellent	Fair	Poor
Tall Fescue	Bunch/ Spreading	Moderate	Excellent	Excellent	Fair	Good
Creeping Fescue	Bunch	Slow	Excellent	Excellent	Good	Good
Chewing Fescue	Bunch	Slow	Exellent	Excellent	Good	Good
Kentucky Bluegrass	Rhizomes	Moderate	Good	Excellent	Good	Good
Orchard grass	Bunch	Moderate	Good	Excellent	Good	Good
Bent Grass	Rhizomes	Moderate	Excellent	Excellent	Fair	Good

Cover Crop Summary

1) Can reduce vigour
2) May reduce TA and decrease Botrytis
3) Tillage increases soil degradation
4) May inhibit weed problems
5) Large numbers of candidate grasses
6) Mixtures superior to single species planting
7) Establish early in 2003 at high vigour potential sites

Crop Load Management (are you over cropped?)

- **Generate proper wood to fruit ratio**

- 5-10:1 ratio of fruit to pruning wood weight

- **Cluster thinning well after fruit set**

- to not thin as much, thin early

- **Keep all fruit possible and thin later rather than pre or immediate post bloom**

- thin for balance and if plant is in stress
*** shorter internodes = better maturity and change of survival of the bud

Water Management
- Use irrigation to manage stress not enhance growth
- Controlled irrigation if used at all
- No irrigation after fruit set phase
- Use cover crop to handle excess irrigation

Subsoiling
- Use as a technique for managing soil
- Use in late season to assist in water management and correction of hardpans
- No closer than 50 cm (18 inches) to base of trunk area

*** The younger the vineyard, the more important it seems to be

Fertilizer Selection
- What is really needed? (what is already available in the soil?)
- Rate at which element is available
- Ability to evenly distribute the material
- Compatibility

Timing of Applications
- 2003 - more than 20% injury - No nitrogen prior to bloom (look at it as a post bloom application)
- 2003 - more than 80% injury - No nitrogen at all
- Only apply enough N and other elements to meet crop load removal
- Only treat recognizable deficiencies - cocktails just in case avoided
- 2003 - adjust P and K levels to match anticipated crop load (reduce amounts by expectation of reduced below normal yields at your site)
- Only apply enough to meet crop load removal
- Only treat recognizable deficiencies - cocktails just in case avoided

Summary of Suggestions
- Reduce fertilizer use - timing and amounts must match actual growth rates and crop load!
- Be prudent with irrigation (too much too soon can lead to problems in fruit maturity)
- Maintain good pest control
- Retrain trunks and shoots to optimize sunlight interception (fruitfulness for 2004)
- Keep extra buds to regulate growth and only remove if reducing normal shoot growth

Disease Management after the BIG CHILL

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Disease Management

• **Phomopsis**

- Shoots that were severely infected last year probably more prone to winter damage
- Infections on leaves, shoots, rachises on basal 5 internodes
- Can't tell whether primary shoots will die off because of trunk damage
- Don't scrimp on early fungicides if there is a history of phomopsis in the vineyard

*** Disease control for this year will affect the bud viability for next year

Powdery Mildew and Downy Mildew

- Severly infected shoots have reduced bud viability
- Primary infections by powdery
  - 3-5 leaves
- Primary infections by downy
  - 10 cm shoots
- Critical to maintain fungicide protection during this period to reduce the amount of disease later in the season

*** If you control the powdery mildew on the leaves, you can control it on the wood

- Important to maintain good control throughout the season regardless of crop load
- Maintain healthy leaves for carbo source to maintain above and below-ground tissues
- Optimize bud fruitfulness
- Retain healthy shoots for next year's canes

Crown Gall

• **Agrobacterium vitis**

- Infects only grapevine

• **Symptoms**

- Galls
  - Frequently found at graft union
  - Sometimes on canes & stems, especially on cold-damaged vines
- Poor shoot growth above galls
- Delayed ripening of fruit
- More prone to winter kill
- Adventitious root growth above gall
- Vines may be infected but **not show galls for 3-5 years**
- Galls develop sooner if vines are physically damaged or winter damaged

• **Sources of inoculum**

- Infected nursery stock
- Infected debris from previous grape plantings (2-5 years)

- Can be moved from infected grapevine to healthy grapevine
- Wild grape isolates non-tumorigenic
• **Infection occurs at sites of plant injuries**
- Freeze damage
- Cultivator nicks
- Pruning/suckering wounds

Crown Gall
• *A. vitis* overwinters mainly in root system
• Under moist conditions in spring, root pressure causes sap to sweep bacterial cells from roots upwards
• *A. vitis* cells are attracted to wounded cells
• Certain phenolics and other compounds released by wounded cells induce virulence genes of *A. vitis*
• Genetic material from *A. vitis* incorporated into chromosomes of grape cell
• **Galls**
- Initially smooth, frequently near edges of old galls
- Becomes rough, dark, brittle and cracked
- No growth rings
- Dead galls may flake off vine
- May be confused with callus tissue
• **Sources of inoculum**
- In galls and systemically infected vines
- In roots for up to 2 yrs, no longer than 5 yrs
• **Control**
- No chemical treatment
- Reduce freeze injury
- Avoid injury of crowns and roots during cultivation
- Train multiple trunks
· Renewals each year to replace trunks killed by cold or crown gall
· Does not eliminate pathogen but ensures a crop and manage disease at a tolerable level
- No late season Nitrogen (it effects the overwintering of the vine)
· Softer wood is not as a winter hardy

Eutypa die-back
- Shortened internodes most apparent early season
- Wood canker associated with pruning wounds
- Wedge-shaped necrotic sapwood

Controlling vines to maximize winter hardiness

Don't push
- Only a little nitrogen but don't starve them.
- Good potash fertilization early in the season
  - maximize fruit development, but control the quantity
  - shading and excess vigour can cause an excess of potash in the juice which will result in high pH, unastable wine
- Keep them growing but don't over do the water
- Water at critical times - pre-bloom to veraison - so the vines are healthy
- Cut off water after veraison to harden up and ripen the vines and fruit

Balance crop and vine size
- Little vines carry a little crop, but big vines can carry a big crop
- A big vine needs a big trellis to display all leaves to the sun - then it can fully ripen a big crop
- Make sure the vine is in balance - enough leaves for the crop and/or enough crop for the vigour - Winkler's postulates
- Excess crop reduces vigour/vine size - excess vine size reduces crop
- Balanced pruning until vines are mature

Know the vigour potential of the site
- Do not pre-fertilize
- Adjust pH before planting
- Assist organic matter before planting
- Do tissue/petiole analyses before making detailed fertilizer programmes
- Keep young vines clean of weeds and clean of diseases

Trellising ????
- As many answers as there are vineyard managers
- Tailor the trellis to the potential vigour
  - A good site with good drainage and good potential vigour - put in enough wires and posts long enough (wide enough) for Scott Henry or perhaps Geneva Double Curtain
  - A weak site (heavy soil, shallow soil, dry site) - put vines close together and make a small trellis close to the ground - fan or low cordon
- Make sure the vine that grows is utilized - don't spend the summer doing summer pruning - build a trellis to use the leaves and display them properly.

Note: Many table grapes are hardier than European wine grapes. Varieties such as Fredonia, Sovereign Coronation (black seedless) Concord and Niagara will need little or no protection. Vanessa (red seedless) will need some protection, either high hilling or burying the lower wire. Himrod (white seedless) will need protection, probably burying the bottom wire or more.

TRAINING SYSTEMS FOR GRAPES

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Several things have to be decided before settling on a training system for a vineyard. The site, the potential vigour, the end use and economics all have to be addressed.

The Site

Is this an area where winter injury is chronic and must be managed properly for a profitable vineyard? Training systems with many options for renewal parts might be appropriate. Training systems with a minimum amount of permanent wood might also be appropriate.

Are there physical problems with the site that might dictate trellis type - i.e. high wind, steep slopes, very rocky soil? Post size may be a consideration and/or the effects of wind pressure.

The Potential Vigour

What is the natural soil drainage like and will this affect the potential vigour of the site? Grapes planted on coarse, well drained soils will have far greater vigour than those planted on heavy clays or other poorly drained soils. Trying to fit a big vine on a small trellis means a lot of summer pruning. Fighting vigour is generally counterproductive and retrofitting an existing trellis to accommodate another design can be expensive. On the other hand, a vineyard where the trellis is not full is wasting space.

The End Use

Is the targeted quality for the vineyard narrowly defined or is it based on a minimum standard? Some training systems lend themselves to very careful crop control and therefore are easier to manipulate the end quality. Other are definitely for bulk production with minimal crop control and timing is used to reach the processor minimum standard.

Economics

Where grapes are paid by a minimum standard, the incentive is for quantity and simplicity. Grapes at the low end of the pay scale are usually grown on sturdy, simple trellises that require minimal pruning or other hand input. High value varieties are often grown on more complex systems with a much higher hand input.

The Decision

The training system adopted for a vineyard may be more a choice of tradition than one of rationale. However, it is easier to plan for a site with some vineyard history than for a new area where environmental factors and vigour potential are just educated guesses.