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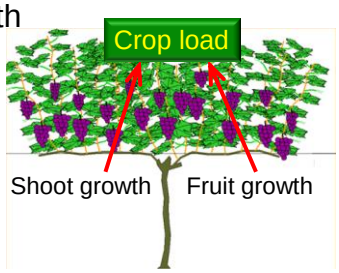
Vineyard Practices for Crop Yield and Quality

Markus Keller

Washington State University
Viticulture & Enology

Viticulture: The goals

- Growing grapes for profit
- Optimum light interception: “Sunlight into Wine”
- Balanced vines: Shoot versus fruit growth
- Open canopy: Ideal microclimate
- Optimum yield and fruit quality
- Low disease pressure
- Low spatial and temporal variation
- Vineyard access and mechanization
- Sustainability: Long-term view




A winemaker's dream?

Viticulture: The management toolbox

- Site/variety/clone match-making
- Planting density
- Trellis design & training system
- Pruning strategy
- Canopy management
- Water management
- Nutrient/floor/soil management

Vineyard design to harvest sunlight

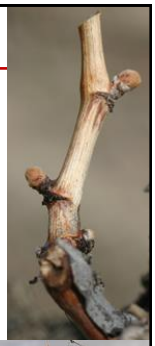
- Vineyard light interception depends on canopy size, shape, and orientation
- Increasing **row width**
  → Less light interception
- Increasing **canopy height**
  → More light interception

1:1!

- **Growth direction** impacts vigor
  → Upright shoots are more vigorous
  → Trellis design?
- **Shoot number** impacts vigor
  → More shoots are less vigorous
  → Pruning severity?

Vigor = Rate of shoot growth

Pruning established vines

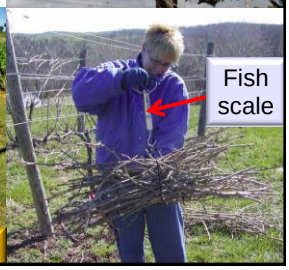


- Determines bud number and position
- Maintains vine size and shape
- Sets upper limit on yield potential

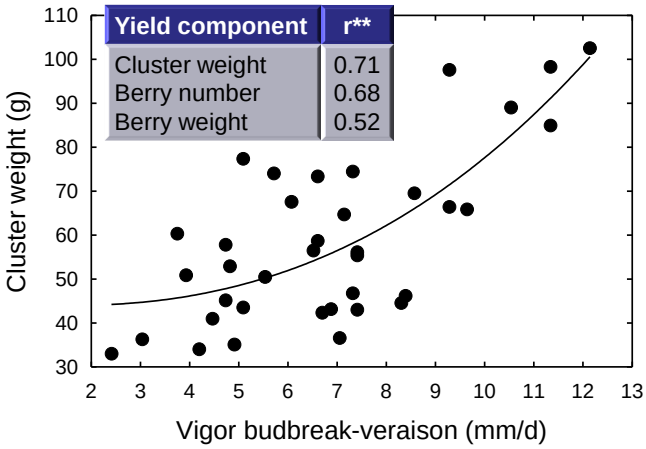
‘Golden Rules’ of winter pruning

1) 15 buds per lb of pruning weight (1 bud/oz)
   → Balance pruning
2) 5 shoots per ft of canopy
   → Canopy density

- Apply both rules simultaneously
  5 oz/ft → 5 buds/ft → 5 shoots/ft
- Pruning weight indicates vigor
- Divide canopy if pruning weight is higher than 10 oz/ft



Control vigor to control yield



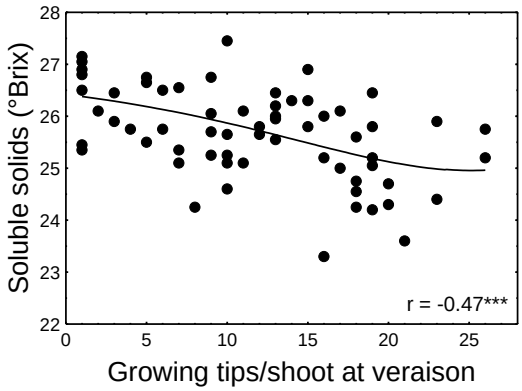
Yield component	r**
Cluster weight	0.71
Berry number	0.68
Berry weight	0.52

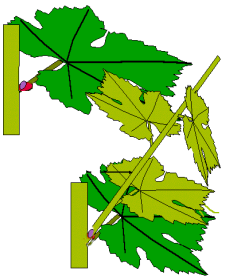
- Growth of shoots, flowers, berries may be coupled
- Vigorous shoots produce more and bigger berries

→ Increase shoot numbers to decrease cluster and berry size

Keller et al. (2015)

Control vigor to control quality





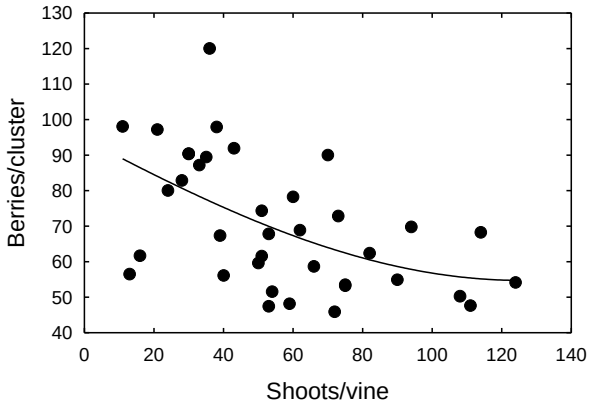
Growing shoot tips (vigorous shoots):

- Compete with berries for sugar supply
- Create shade that reduces fruit sun-exposure

→ Stop shoot growth before veraison

Keller et al. (2010)

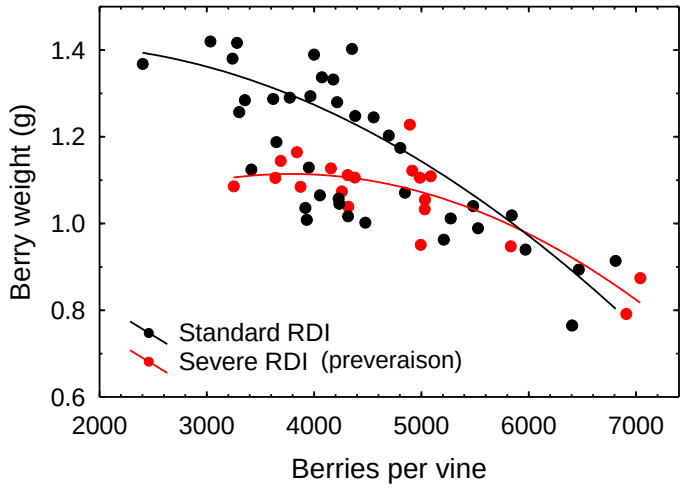
Pruning for loose clusters (& small berries)

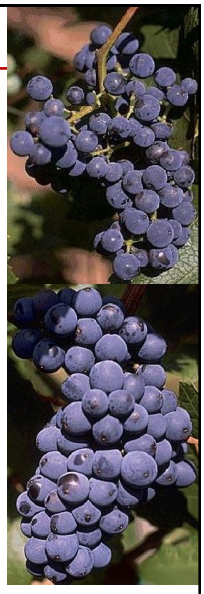


- Lower pruning severity → More buds
- More shoots/vine but lower vigor
- More clusters/vine
- More flowers/vine → Lower fruit set *and* smaller berries

Keller et al. (2015)

Keep in mind: Vines compensate





- Too little crop can lead to berry size compensation
- Prevention requires more severe preveraison water deficit

Keller et al. (2008)

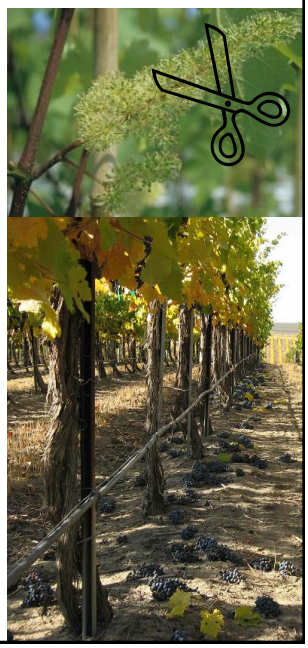
Cluster thinning to adjust crop load

Why?

- Regulates crop load (fine-tuning)
  → Prevents overcropping
  → Adjusts crop to seasonal weather
- Accelerates ripening
  → May improve fruit composition

When?

- Early → Promotes shoot and berry growth
- Late → Greater effect on yield
- Bloom: Cut through flower clusters
  → May reduce cluster compactness
- Lag-phase/veraison → Quality control?
- Preharvest → Disease, disorder control



Less water means more control

- Less water → Low vigor → Open canopy → Less hedging
- Open canopy → High fruit sun-exposure → Less leaf removal
- Less water → Less weed growth → Less herbicide, tilling

When vines need a drink

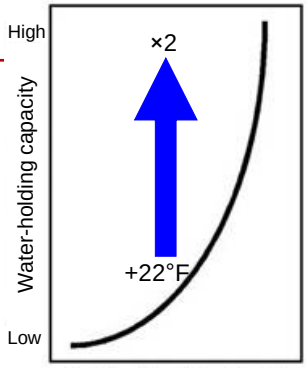
Drink in moderation:

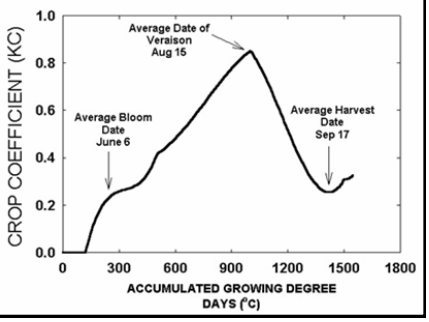
- Wine grapes need **12-20" water** per year (from rainfall + irrigation)

But drink frequently:

- Temperature drives water demand
- Budbreak – fruit set: 5 – 10%
- **Fruit set – veraison: 30 – 60%**
- Veraison – harvest: 10 – 30%
- Harvest – leaf fall: 5 – 25%

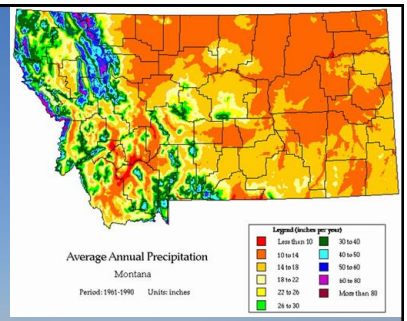
  (refill top 3 ft of soil for freeze and start-up insurance)





Low rainfall permits deficit irrigation

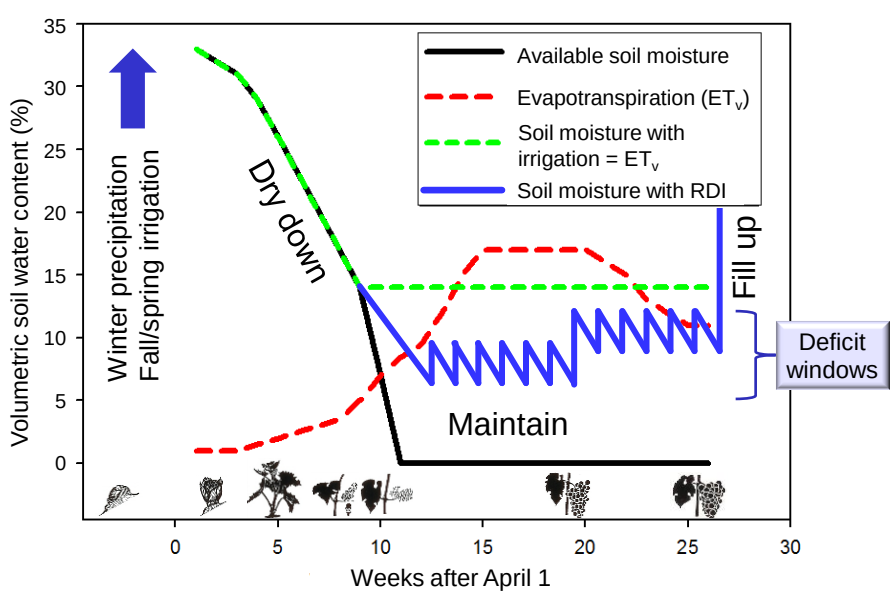
RDI = Regulated Deficit Irrigation



RDI: The basics

- Controlled seasonal water deficit
- Apply less water than vineyard evaporates
- Goals: Limit growth, maximize quality
- Results in soil water deficit over time
  - → Applied after fruit set
  - → Results in plant water deficit
  - → Reduces shoot growth and canopy density
  - → Reduces berry size and yield

RDI: Coming to a vineyard near you?



ET_v = Vineyard evapotranspiration = Water evaporation from plants and soil

RDI: A word on irrigation scheduling

- **<u>Weather-based</u>:** Use evapotranspiration from weather station
  - ➢ **ET_v** = Vineyard ET
  - ➢ **ET_o** = Reference ET (grass, alfalfa)
  - ➢ **K_c** = Crop coefficient (0 – 0.9 → Canopy)

  $ET_v = ET_o \times K_c$

  → Easy to interpret and decide, site-specific

- **<u>Soil-based</u>:** Measure soil moisture
  - ➢ Soil moisture sensors (various principles and manufacturers)

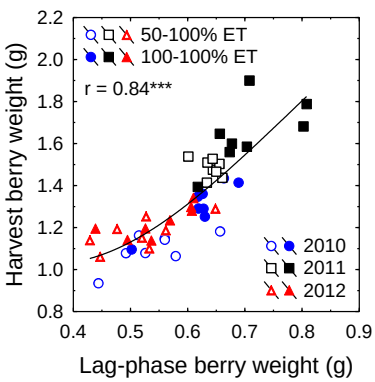
  → Expensive, easy to interpret and decide, soil-specific

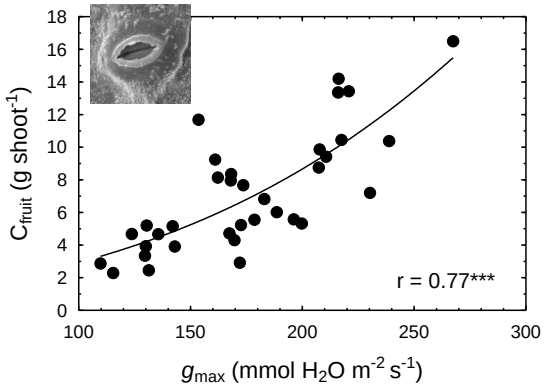
- **<u>Plant-based</u>:** Measure vine water status
  - ➢ Pressure bomb, porometer, sap flow sensors

  → Skill, experience, expensive, hard to interpret and decide

- All methods: **Decide on target deficit level and timing**
- Varietal differences!

Control water to control berry size

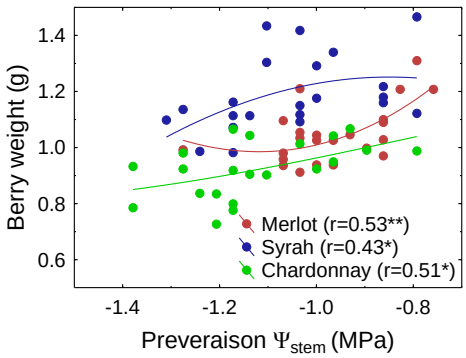




- Water deficit decreases growth and photosynthesis
- Water deficit <u>before</u> veraison → Small berries
- Water deficit <u>after</u> veraison → Less sugar, berry shriveling
- It is difficult to manipulate berry weight after veraison

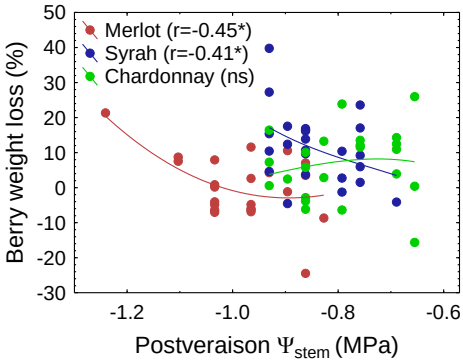
Keller (2015); Keller et al. (2016)

Irrigation dilutes fruit quality – really?

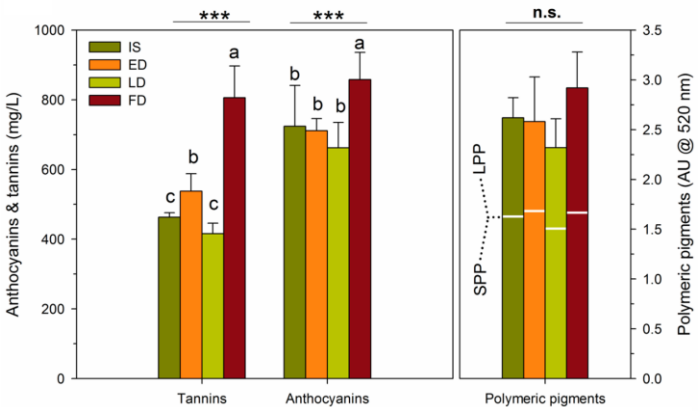


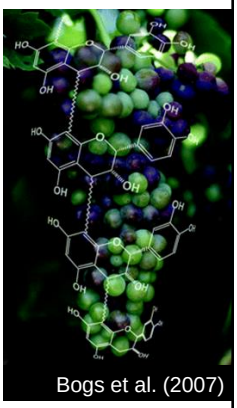
More water **before** veraison increases berry size

More water **after** veraison decreases berry shrinkage



RDI: Tool to manipulate wine style




Bogs et al. (2007)

- Full-season deficit (35% ET_v) → More anthocyanins, tannins → More LPP
- Preveraison deficit → Intermediate tannins
- Postveraison deficit → No gain over industry standard (70% ET_v)

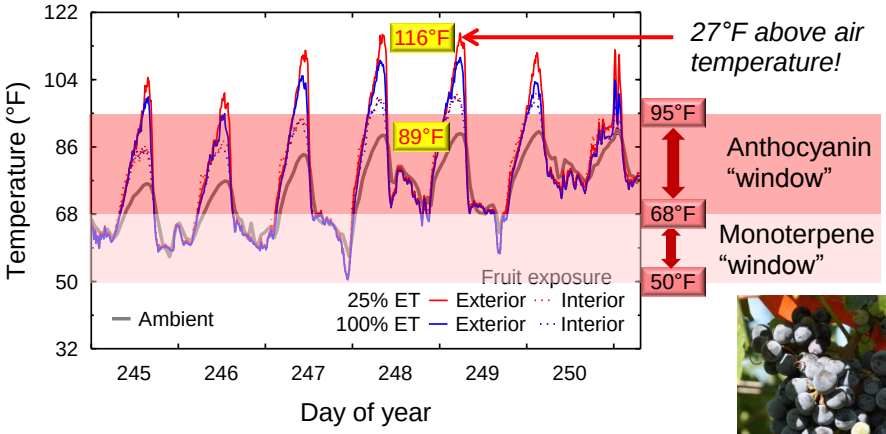
→ Dehydration does not make fruit more mature

Casassa et al. (2015)

Water deficit: Some is good – more is better?

- No water deficit (100% ET_v):
  → Vigor, weeds, powdery mildew
- Whole-season 25% ET_v (-56% water):
  → Loss of vine capacity and productivity
  → Not sustainable
- Preveraison 25-35% ET_v (-31% water):
  → Maintains vine capacity and productivity
  → Small berries, high fruit sun-exposure
- Preveraison water deficit is <u>more</u> important than postveraison deficit
- Apply rather severe water deficit from fruit set to veraison, then increase water supply if needed during ripening

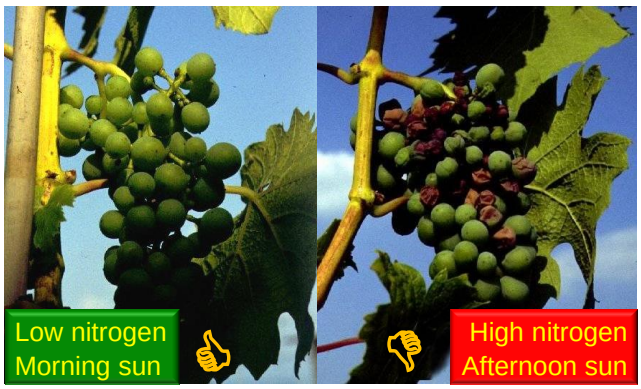
Water deficit: It's not just about berry size



- Water deficit → Small berries, low vigor
  → Open canopy, restricted shoot growth
  → More sun-exposed clusters
  → High light and high temperature
- Exposed berries are <u>warm</u> berries

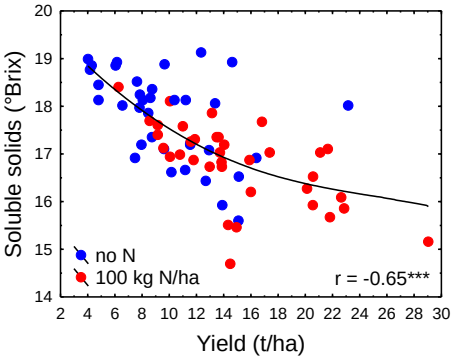
Keller et al. (2016)

Sun exposure: How much is too much?



- ***Do*:** Remove leaves early, and mostly on east/north side
  - ✓Prebloom → Lower yield, loose clusters, thicker berry skin
  - ✓2-3 weeks after fruit set → Higher cluster sun-exposure
- ***Don't*:** Too much, too late (veraison or later) → Sunburn
  - ✓White grapes: Overexposure → Bitter/astringent phenolics

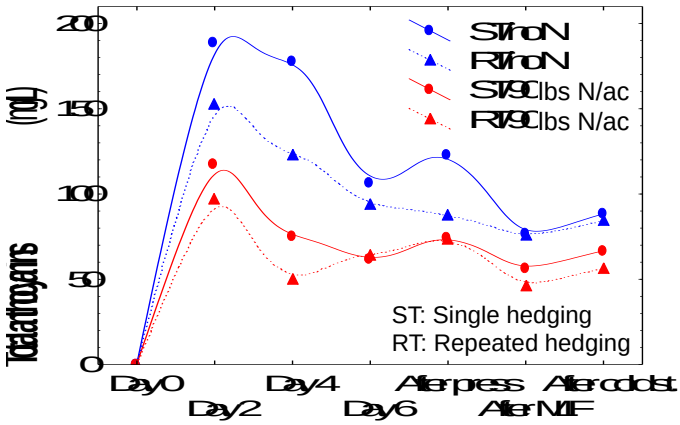
Nitrogen: Moderation is a virtue



- More N → Higher yield, higher vigor, denser canopy → Delayed ripening
- More N → More malate and K^+ → Often higher pH
- More N → More aroma precursors (volatile thiols)
- ***Do*:** Apply moderate rates of N (2-6 lbs/ton of fruit)

Keller et al. (2001, 2010)

Nitrogen: How to mess up wine color

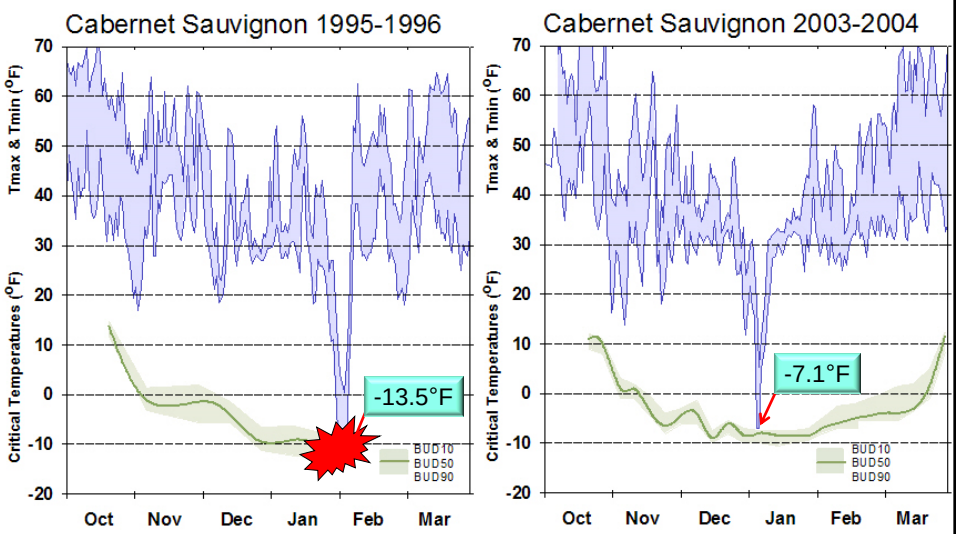


- More N → Slower secondary metabolism → Less color…
- More N → More disease pressure (powdery mildew, bunch rot)
- ***Don't*:** Apply excess N, then hedge away excess growth

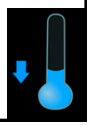
Keller et al. (1999, 2001, 2003)

Cold damage: Faces of injury

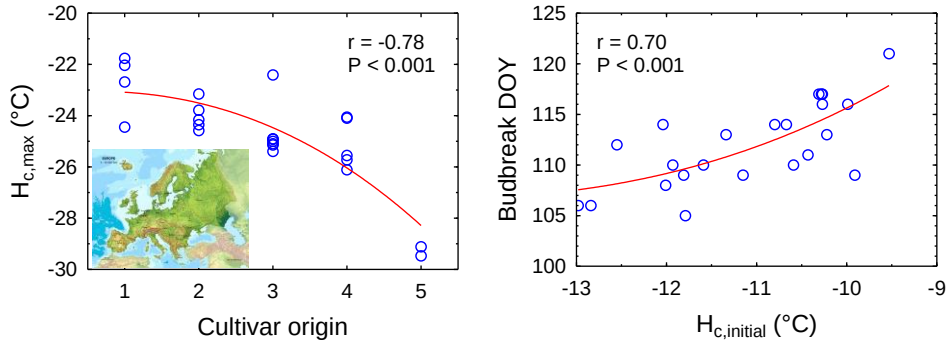
Cold damage: The freak event challenge



- Vines acclimate in late fall, deacclimate in spring
- Current hardiness and budbreak time determine survival



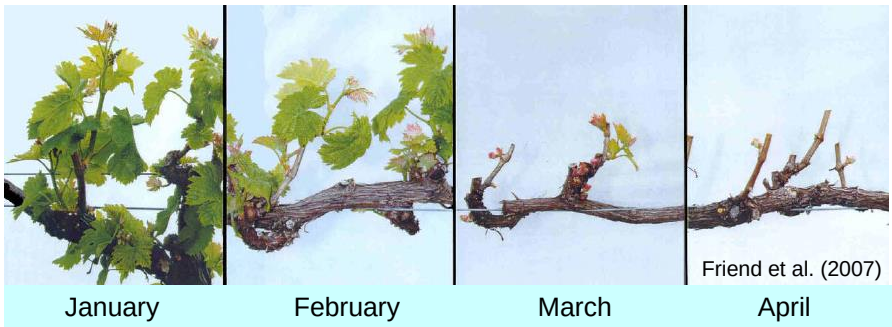
Cold hardiness: Varieties are not alike



- WSU cold hardiness (H_c) model for 23 grape varieties
- wine.wsu.edu; weather.wsu.edu, with weather forecast
- Northern/inland varieties tend to be more winter-hardy than southern/coastal varieties
- Winter-hardy varieties tend to have earlier budbreak → Hardy varieties are more vulnerable to spring frost

Ferguson et al. (2014)

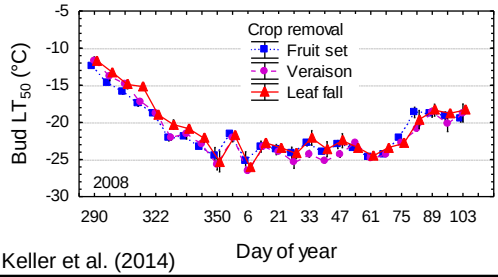
Mitigation: Dealing with early budbreak



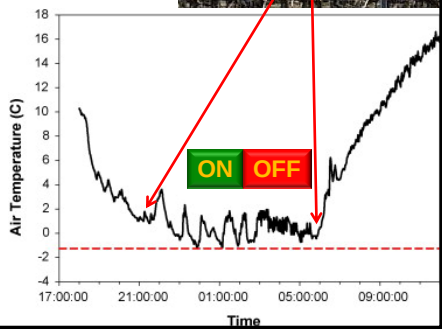
- Late pruning → Late budbreak → Vines compensate ≤3 weeks
- Cane versus spur pruning
  Budbreak near tip of cane inhibits budbreak near base, but not in spurs
- Mechanical prepruning (winter), then manual pruning (March-April) → Delay budbreak

Mitigation: Damage control

- Thermal inversions: +18°F at 65 ft above ground
- **Wind machine:** Mixing air to raise temperature → +2-6°F at 100 ft distance
- Temperature gradient collapses at wind speeds >3.5 miles/hour → Mixing useless
- **Beware:** Hardiness varies by site, temperature history, cultural practices, air drainage…
- **But:** No influence of harvest date (hang time…) or cluster thinning

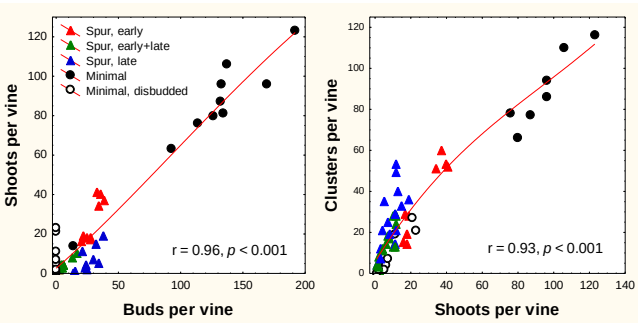


Keller et al. (2014)



When disaster strikes: Pruning adaptation

- Assess damage → Increase bud numbers to compensate for lost yield potential while maintaining fruit quality
- **Minimal pruning:** Maximize bud numbers if >75% bud injury
- **Kicker canes:** Renew cordon by pruning to 3-4 short canes; remove existing spurs, train canes to old cordon
- Avoid water stress to prevent canopy collapse



http://wine.wsu.edu/extension/weather

Keller and Mills (2007)

Pushing the 'reset' button

-18.5°F on 5 and 6 January, 2004

photos courtesy of G. Grove

Pushing the ‘reset’ button

October 2005: **5 tons/acre**

photos courtesy of G. Grove

It’s in the book

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2015

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Amazon

mkeller@wsu.edu