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2:30 pm – 3:45 pm

Red Wine: Color and Tannin Development and Management

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Managing Phenolics in the Vineyard

Phenolics for red wine

- **Hydroxycinnamates → Volatile phenols**
  - Tartrate esters in pulp and skin
  - Accumulate early, then often decline

- **Flavonols → Copigments**
  - Glycosides in skin
  - Accumulate throughout berry development

- **Flavan-3-ols → Tannins**
  - Monomers in skin and seed
  - Accumulate only before veraison

- **Tannins**
  - Oligo- and polymers in skin, seed, stem
  - Accumulate only before veraison
  - May continue to polymerize during ripening

- **Anthocyanins → Polymeric pigments**
  - Glycosides in skin (+pulp in teinturier cvs.)
  - Accumulate only during ripening (>9 Brix)
A winemaker’s dream

- Loose clusters
- Small berries
  - High skin/juice (sometimes)
  - High seed/juice
- Uniform composition

Temperature and water limit berry size

- Cool spring temperatures → Small flowers → Small berries
- Water deficit before veraison → Small berries
- Berry size is determined early → It is difficult to manipulate berry weight after veraison

Keller et al. (2010)
Keller (2015)
Diluting fruit quality – really?

More water **before** veraison increases berry size.

More water **after** veraison decreases berry shrinkage.

Water deficit: It’s not just about berry size

- Water deficit → Small berries, low vigor
  → Open canopy, restricted shoot growth
  → High cluster sun-exposure
  → High light and high temperature
- Exposed berries are warm berries

Keller et al. (2016)
Deficit irrigation: A tool for wine quality

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

→ Dehydration does not make fruit more mature  
  Casassa et al. (2015)

Sun exposure: Light or heat?

- **Visible light** (>5% full sun) stimulates anthocyanins, hydroxycinnamates, slightly skin tannins
- **UV light** strongly stimulates flavonols
- **Temperature** optimum is 68-95°F for anthocyanins but <68°F for flavonols; both are inhibited/degraded above 95°F (tissue temperature!)
- Heat, low light shift anthocyanin profile towards malvidin
- Higher preveraison temperatures increase tannins
- Unclear temperature effect on hydroxycinnamates
- Sun-exposed berries: 6-8x flavonols, 2-4x flavan-3-ols (mono-, oligo-, polymers) than shaded berries

  Sun exposure: Light or heat?  
  Sun-exposed berries: 6-8x flavonols, 2-4x flavan-3-ols (mono-, oligo-, polymers) than shaded berries  
  +25°F  
  Kolb et al. (2003)  
  Spayd et al. (2002)
**Sun exposure: How much is too much?**

- Leaf removal: Do it early! Be careful on west/south side!
  - Prebloom → Reduces cluster compactness, overcropping
  - 2-4 weeks after fruit set → Enhances sun exposure
- **Bad recipe:** Too much, too late (veraison or later) → Sunburn

**Nitrogen: Moderation is a virtue**

- More N → Higher yield, more lateral growth, denser canopy
- Growing shoot tips compete with fruit → Delayed ripening
- N suppresses secondary metabolism (phenolics)
- **Bad recipe:** Apply N fertilizer, then hedge away excess growth

Nitrogen: Interaction with light

Light drives anthocyanin accumulation, but N modulates it

Keller & Hrazdina (1998)

Summary: Vineyard practices for phenolics

- Vintage variation in phenolics as high as cultivar variation → Cultural practices can only fine-tune what nature imposes
- Unclear effect of crop load (Overcropping delays ripening but is often coupled with shade effect)
- Low vigor increases anthocyanins, skin tannins
- Sun exposure increases flavonols, anthocyanins, skin tannins, but decreases tannin extractability (Mostly due to more light – beware of excessive temperature!)
- Water deficit increases anthocyanins, skin tannins (Mostly due to lower vigor, greater fruit exposure, and smaller berries)
- Nitrogen (but not P or K) deficit increases all phenolics (Due to lower vigor, greater fruit exposure, and stimulation of phenolics production: nitrate suppresses “phenolics genes”)