Grape Berry Ripening Issues

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What types of grapes are you growing?

• *V. vinifera*
• *V. labrusca* hybrids
• *V. aestivalis* hybrids
• French American hybrids
• Modern hybrids
• Muscadines
What is Maturity?

- **Physiological maturity**: seeds are capable of germinating (occurs immediately after veraison)
- **Industry definition**: ripeness at which a desired style of wine can be produced
  - Sparkling wine
  - White wine
  - Red wine
  - Dessert wine

From: L. Bisson, Practical Winery and Vineyard Journal, 2001
Consumer preference has been moving toward wines with "ripe" characteristics.

J. Alston et al. (JWE, 2011)
Masking

Fundamental Theorem of Wine Aroma (FTWA)

“Vegetal”, “Herbaceous”

Unripe aromas and ripe aromas mask each other

(and, excessive amounts of either is a problem)

“Fruity”, “Sweet”

Slide credit: Gavin Sacks
Berry Ripening

1. Berry softening
2. Sugar accumulation
3. Malic acid respiration
4. Accelerated berry growth
5. Color change
6. Increase in pH
7. Increase in amino acids
Sugars

- Glucose
- Fructose

Flavor development and sugar accumulation occur independently.

Not all cultivars accumulate sugar at the same rate and maximum concentration.

From: N. Dokoozlian, Grape Berry Growth and Development
Acids

- Tartaric acid
- Malic acid

Malic acid respiration is a function of temperature and time.

Potassium also plays a significant role in juice pH.

From: N. Dokoozlian, Grape Berry Growth and Development
Phenolics

- Anthocyanins
- Tannins
- Flavonols

The final concentration of skin and seed phenolics varies greatly by cultivar.

Tannins become less bitter and extractable with fruit maturation.
Aroma Compounds

The types and concentration of aroma compounds varies widely among cultivars.

- Norisoprenoids
- Monoterpenes
- Thiols
- Methylanthranilate
- Methoxypyrazines
- Green leaf volatiles

Most aroma compounds in wine are produced during fermentation from grape berry precursors.
Factors That Affect Ripening

- Cultivar
- Rootstock
- Nutrition
- Water status
- Temperature
- Sun exposure
- Disease
- Insects
- Crop load

From: Jackson and Lombard, 1993
Vineyard Variability

Vineyard variability leads to reduced quality

- **Between vines**: soil, vine age, frost damage, disease, pruning
- **Between clusters on the same vine**: cluster position, vine stress, disease, frost damage
- **Between berries on the same cluster**: sun exposure, shot berries, poor weather at bloom, micronutrient deficiency, disease, insect infestation
Cluster Shading

Consequences of severe cluster shading:

• larger berries
• higher pH (if interior leaves are heavily shaded)
• lower phenolics
• lower aromatics (e.g., monoterpenes, norisoprenoids)

Diffuse light and morning sun exposure are preferred in hot climates.
Dense canopy with poor exposure  
Excessive exposure (hot climate)
Sunburn is caused by overheating and oxidative stress.
Start by selecting an appropriate training system
Temperature

• Sun exposed berries may be up to 30°F warmer than ambient temperatures
• Anthocyanin production is thought to increase up to 86°F and be inhibited at 95°F in vinifera
• Extremely high temperatures can delay ripening
V. labrusca hybrids are prone to uneven ripening in hot climates.
• excessive fruit exposure can exacerbate the problem
Withholding Irrigation

- Mild to moderate water stress in first stage berry of development may be desirable (smaller berries)
- Must be able to monitor water status
- Severe stress can delay development and ripening
- Some cultivars (e.g., Syrah) are more prone to raisining than others
Visual Symptoms of drought stress

Actively growing

Not actively growing, not stressed

Stressed

Stressed
Too much water can result in excess vigor, delayed veraison, and slowed ripening.
Nutrition

Potential consequences of excess nitrogen:
• High vigor and shading
• Increased susceptibility to powdery mildew and botrytis
• Higher juice pH (increased K+)
• Lower phenolics
• Higher susceptibility to water stress

Potential consequences of nitrogen deficiency:
• Reduced bud fruitfulness and fruit set
• Reduced berry nitrogen
Any nutrient deficiency that is severe enough to reduce photosynthesis can have a negative impact on ripening
Fungal, bacterial, and viral diseases can impair a vine’s ability to ripen its fruit.

Leaf Roll Virus

Pierce’s Disease
Downy Mildew
Anthracnose
Powdery Mildew
Black Rot

Early season berry infection

Late season rachis infection
Severe insect pest damage can impair ripening

Severe leafhopper infestation

Grape leaf skeletonizer damage
Salt toxicity
Vine Balance

Crop load
- leaf area to fruit (10-15 cm² per gram of fruit)
- Pruning weight to yield (5-10 for vinifera)

Recommended crop load values assume healthy vines.
Vine Balance

- 3 to 5’ shoots
- at least 15 to 20 leaves per shoot
- 3 to 5 shoots per foot of canopy

Adjusting the crop:
- Pruning
- Cluster thinning
- Shoot thinning

Adjusting the canopy:
- Pruning
- Shoot thinning
- Leaf removal
- hedging
Severe overcropping can result in poor fruit quality and reduced vine size.
Undercropping can also lead to poor fruit quality.
Wine Quality and Cropload

Data pooled from cvs. Cabernet s. and Carignane

From: Dry 2004
Evolution of Methoxypyrazines (MPs) in Grapes

MPs are associated with:
- Cabernet Sauvignon
- Merlot
- Cabernet Franc
- Sauvignon Blanc
- Carmenere
- Some hybrid grapes
MPs and Crop Load Management

MPs were higher at lower croploads.

Chapman et al. (AJEV, 2004)
Basal Leaf Removal to Reduce MPs

Cabernet Franc at Harvest

Merlot at Harvest

Post-veraison leaf removal does not reduce MPs (data not shown)

Green Leaf Volatiles (GLV)

Produced by plant tissue in response to mechanical damage via enzymatic oxidation of polyunsaturated fatty acids

GLV compounds provide the aromas of
  - crushed leaves
  - fresh cut grass
  - crushed grape skins (esp. if unripe)

Grapes’ capacity to produce GLVs decreases with maturity.

Slide credit: Gavin Sacks
Summary of Ripening Problems and Solutions

- Cultivar selection/expectations
- Vineyard design and practices to minimize variability
- Proper pruning and management practices for vine balance
- Canopy management for cluster microclimate
- Proper irrigation and nutrition
- Disease and insect pest control
Questions?

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