Vineyard Management for Quality Wine

Andy Allen
Viticulture and Enology Program
Arkansas Tech University - Ozark
Final wine quality is derived to a large degree from grape composition.

Grape composition is influenced by:

- Climate
- Cultivar
- Site characteristics
- Cultural practices
Quality wine is only made from grapes with good potential for wine quality, managed in such a way as to maximize their components that contribute to wine quality potential.
Vineyard management practices for quality wine grapes

• Focus on:
  – Vine balance
  – Canopy management
  – Crop load management
  – Vine nutrition
Balanced Vines

Balance has been achieved between vegetative growth and fruiting when a sustainable yield of high quality fruit is obtained each season.
The Balancing Act

Fruit production
(Carbohydrates utilized)

Vegetative growth
(Carbohydrates produced)
Indicators of Balance

• Pruning weight per foot of canopy:
  – 0.2 to 0.4 lbs

• Yield to pruning weight ratio (Ravaz Index):
  – Vinifera: 5-10
  – Native and hybrid: largely undetermined but considered to be higher

• Leaf area to fruit weight ratio:
  – 3 to 8 ft²/lb
Factors Affecting Balance

- Cultivar, Rootstock
- Disease and Insect mgt
- Pruning
- Crop load
- Irrigation
- Fertilization
- Climate
- Vine spacing
- Trellising
- Soil
- Weed control

Vine Balance
Major Vineyard Management Factors

• Trellising
• Spacing
• Pruning
• Crop adjustment
Trellising and Spacing

The vine must not only have enough leaf area, the leaves must be properly displayed to achieve maximum photosynthetic production.
Spacing

• Row spacing
  – Has greater effect on yields per acre
  – Should be far enough apart to prevent row-to-row shading

• Vine spacing
  – Far enough apart to allow vine to express vigor
  – Shoot density
Balanced Pruning

• Resulted from research on Concord in Michigan by Partridge and in New York by Shaulis

• Goal is to balance fruit production of the vine with vegetative growth (cane growth and maturation)

• Patridge proposed using pruning weights of live cane tissue from year one to predict upper limit of vine’s capacity to produce and ripen crop in year two
Balanced Pruning

- Estimate vine size and then prune the vine
- Weigh one year old cane prunings using a small spring scale
- Apply the weight obtained to a pruning formula to determine the number of nodes to retain per vine
- Upper limit to node number?
Canopy management

• Cultural practices which modify the canopy density to improve vine microclimate:
  • Trellis choice
  • Vine/row spacing
  • Fertilization/irrigation practices
  • Vine health maintenance
  • Physical manipulation of canopy components*
Canopy management practices

• Shoot thinning
  – Should be done when shoots are 2”-6” in length
  – Remove shoots from “non-count” positions
  – Improves canopy density
    • Reduces shoot density, leaf layer number
    • Increases proportion of canopy gaps, exterior leaves
  – Reduces crop load
Canopy management practices

• Shoot positioning
  – Goal is to re-orient shoots into position appropriate for trellis/training system
  – Should be done when shoots are long enough to remain in place after positioning but before tendrils attach to neighboring shoots
  – May require more than one pass through vineyard
  – Improves environment around fruiting/renewal zone
  – Has benefits for other vineyard management tasks
Canopy management practices

• Leaf removal
  – Should be done between fruit set and pea-size
  – Remove 2-6 leaves per shoot in the fruiting zone
  – Improves canopy microclimate by reducing leaf layer number
  – Possibly the most beneficial canopy management practice
    • Can improve fruit composition and color
    • Can reduce bunch rots
Benefits of canopy management

• Improving the canopy microclimate to permit more light and air penetration into fruiting zone
  • Reduces disease pressure
  • Improves spray penetration
  • Allows more efficient photosynthesis
• Improves fruit composition
  • Improves color
  • Reduces levels of methoxypyrazines
  • Improves development of flavor and aroma compounds
  • Improves sugar and acid composition

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<th>Treatment</th>
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Light environment effects on grape quality

- Good exposure of bunches to light increases terpenoids, phenolics, and color pigments
- Good exposure can decrease levels of methoxypyrazines
- Excessive heat can reduce color, phenolics and volatile aromatics
Cluster exposure effects

• Cluster exposure of Traminette
  – Exposed (E), Light Shade (LS), Moderate Shade (MS), Heavy Shade (HS)
  – Leaf layer numbers 0, 1, 2, >3
  – E, LS and MS had higher Brix, lower pH and lower TA and HS
  – As shading decreased, PVT and total monoterpenes increased with E having ~30% higher concentration than HS
Cluster exposure effects

- Cluster exposure of Golden Muscat
  - Exposed (58% - leaf removal) and Shaded (48% - shoot positioned)
  - Shaded clusters were darker than exposed
  - Exposed clusters had higher TSS (~2 °Brix)
  - Exposed clusters had phenolic content (350 mg/L vs 270 mg/L)
  - Shaded clusters had higher pH and K+ content
  - Shaded clusters had higher FVT than exposed
  - Exposed clusters had higher PVT than shaded
  - Wines from exposed clusters were less acidic, had higher phenolics (24g/L) and greater PVT than shaded

Cluster exposure effects

• Cluster exposure of Shiraz
  – Shaded (5%), Moderate Exposure (10-40%), High Exposure (40-80%)
  – Shading reduced Brix, delayed ripening by 7 days compared with MET and HET
  – Shading reduced total anthocyanins compared to MET and HET
  – Total skin phenolics were higher in HET than MET and in MET than in ST
  – Skin tannins in ST were 30-40% lower than HET, tannins in HET were 10-20% higher than MET
  – ST wines were rated lower for mouthfeel and fruit flavor

Effect of one- and two-sided leaf removal on composition of Cynthiana juice and wine in three seasons in Arkansas.

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<tr>
<th>Year and treatment</th>
<th>Soluble solids (%)</th>
<th>pH</th>
<th>Titratable acidity</th>
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Leaf removal and methoxypyrazines

• No removal; removal of leaves 1,3,5; removal of leaves 1-5 at 10, 40, 60 DAA

• Cabernet Franc
  – Early (10, 40 DAA) leaf removal reduced IBMP by up to 88% (2007) and 60% (2008)
  – 10 DAA increased Brix in 2007
  – Almost all treatments reduced TA in both years
  – pH was not affected by leaf removal treatments

• Merlot
  – All leaf removal treatments significantly reduced IBMP 37-52%
  – Leaf removal treatments had no effect on Brix, pH or TA

Crop load management

• Removal of shoots and clusters to achieve yield that is in balance with the vegetative growth of the vine
Effects of Overcropping (Excessive Crop Load)

- Delayed maturity
- Decreased growth
- Loss of vine size
- Increased risk for winter injury
- Reduced subsequent yields
- Reduced fruit quality
- Reduced profitability

Winkler. 1954. AJEV 5:4-12
The 3 steps of crop load management

- Balanced pruning
- Shoot thinning
- Cluster thinning
Shoot thinning - hybrids

- Effects from research have been variable and cultivar specific
  - Cultivar              Yield (t/a)  Ravaz Index
  - Aurore               8 to 5.5     13.6 to 8
  - Chancellor           11.8 to 6.9  15.8 to 9
  - Villard Noir         10.7 to 7.1  16.5 to 11.2
- No appreciable effect on Brix, pH or TA
Shoot thinning - *vinifera*

- More effective on *vinifera* fruit and wine composition
- Minor reduction in yield

- **Pinot Noir**
  - Increased TA and Brix in berries and must

- **Cabernet Franc**
  - Increased Brix and color intensity in berries
  - Reduced TA in musts
  - Higher color intensity, phenolics and anthocyanins in wine
Effects of canopy management practices on yield and fruit composition of Chambourcin grapevines trained to a high-wire single curtain trellis.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield Per Acre (tons)</th>
<th>Average Cluster Number</th>
<th>Average Cluster Wt (g)</th>
<th>Average Berry Wt (g)</th>
<th>Average Berries/Cluster</th>
<th>Soluble Solids (%)</th>
<th>pH</th>
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Vine nutrition

• Many nutrients are required by vines for healthy vine growth and proper function
• Imbalances of certain nutrients can have serious consequences for wine quality
• Nutrient status and requirement should be established by regular monitoring
  – Observation
  – Soil testing
  – Petiole testing
Nitrogen (N)

- Required by grapevines in largest amount of all nutrients
- Taken up or utilized as either nitrate ($\text{NO}_3^-$) or ammonium ($\text{NH}_4^+$)
- Used in amino acids, proteins, nucleic acids, chlorophyll, enzymes
- Mobile in plants
- Vine nitrogen status
  - Excess levels can cause excess vigor, delay ripening, decrease berry quality
  - Deficiencies can reduce growth, crop, berry quality and aroma precursors
Nitrogen fertilization of Riesling

• 3-yr study in WA State on site with low-fertility
• Fertilization rates of 0, 50, 100, 200 lbs/acre
• As N rate increased:
  – Pruning wt increased up to 100 lb rate
  – Yield increased with 50 lb, no significant difference from 50 to 200 lbs
  – Ripening and harvest was delayed from 6-16 days with increasing rate of N
  – Total N, amino acids increased as N did
  – Increasing N reduced free monoterpenes, increased many bound monoterpenes
  – Decreased some higher alcohols
  – Increased concentrations of most esters
Potassium (K)

- Used in large quantities; in grapevines is 2\textsuperscript{nd} most required element
- Used as regulator of biochemical processes in plants including: CHO production, protein synthesis, solute and sugar transport, stomatal regulation
- Taken up as K\textsuperscript{+} ion
- Vine potassium status
  - Deficiencies can result in lower sugar levels
  - Excesses can potentially lead to high juice/wine pH levels
Excess potassium

• Morris, et al. 1987
  – 3 year study
  – 5 winegrape varieties (Ge, Se, CS, deC, Cyn)
  – Fertilized with 6 lbs $K_2SO_4$ per vine
  – Significantly higher must pH (3.6 – 3.8) in all except Gewürztraminer

• Morris, et al. 1983
  – 3 high rates of $K^+$ to applied weekly to Concord vines
  – Juice processed and analyzed either fresh or after 3-day cold storage
  – In both cases juice pH was significantly increased
  – High pH led to juices of less desirable color
Conclusions: Vineyard management and grape quality

- Wine grape quality development is improved by practices that improve:
  - Vine health and nutrition
  - Leaf area:fruit ratio
  - Leaf and fruit exposure to light
- Research results on many aspects of vineyard management vary, especially according to region and grape variety, indicating need for regional and varietal specific investigations