The fundamentals of fruit zone leaf removal

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Overview

**Why** remove fruit zone leaves?

**When** should leaves be removed?

**To what extent** should leaves be removed?

**How** should leaves be removed?

Climate perspective; refinement for specific situations
Why manage fruit zones?

Fruit zone management is a tool…

To manage:

Fungal diseases (rots)

Fruit composition
  Primary
  Secondary

Crop yield
Radiation is a “tool” to manage rot
Bunch rot management

- The threat of bunch rot is ever-present in humid regions

- As we try to attain balanced chemistry...
  ....sugars increase, acids decline, and skin softens create the “perfect storm” for rot.

  .... the hurricane systems don’t help...
OR…. to minimize late season rots

• Pick everything in late August / early September:
  - 17-18 Brix
  - 3.2 pH
  - 12 g/L acidity

  - And make sparkling wines
  - And/or rosé
# Canopy microclimate differences as a function of canopy density.

(Smart and Robinson 1991)

<table>
<thead>
<tr>
<th>Microclimate characteristic</th>
<th>Interior region of a sparse canopy</th>
<th>Interior region of a dense canopy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sunlight</strong></td>
<td>Most leaves and fruit receive some direct sunlight at some point during the day</td>
<td>Most leaves and fruit are in the shade for the day</td>
</tr>
<tr>
<td><strong>Temperature</strong></td>
<td>Fruit and leaves are warmed by sunlight and may be cooler than air temperature at night</td>
<td>Most leaves and fruit are at approximately ambient temperature, both day and night</td>
</tr>
<tr>
<td>Humidity</td>
<td>Leaves and fruit experience ambient humidity values</td>
<td>Humidity can build up slightly within the canopy</td>
</tr>
<tr>
<td>Wind speed</td>
<td>Leaves and fruit are exposed to ambient wind speed values</td>
<td>Wind speeds are reduced within the canopy</td>
</tr>
<tr>
<td>Evaporative potential</td>
<td>Evaporation rates are similar to ambient values</td>
<td>Evaporation rates are reduced within the canopy</td>
</tr>
</tbody>
</table>
Radiation is a “tool” to manage fruit composition and target wine styles.
Fruit composition management

• In general, exposed fruit:
  
  o Has greater varietal character
    • Increased “good” aromatics
      o Norisoprenoids
      o Thiols
      o Terpenes
    • Decreased “bad” aromatics
      o Methoxypyrazines

  o Greater Brix: acidity ratios

  o Greater phenolics and anthocyanins (reds)
Primary and secondary grape metabolites in grapevines – an ecophysiological perspective

- Aromatics
- Phenolics
- Acids
- Sugars
- Indirect
- Direct

![Diagram showing sunlight, indirect and direct pathways to sugars, aromatics, phenolics, and acids.](image-url)
What’s that smell: An introduction to varietal aroma

Russell Moss
Summary

- The following increases most varietal aromas with a few exceptions:
  - Water stress
  - Higher juice YANs
  - Adequate vine nutrition
  - Botrytis
  - Drying of fruit
  - Heat
  - Sunlight

What’s that smell: An introduction to varietal aroma

Russell Moss, EWE 2017
When should leaves be removed?

• Like pest management…

• …canopy management is most effective when implemented in a timely fashion
In an ideal world...
Fruit zone leaf removal

• When?
How many leaves to remove?

- No simple answer

- Time is limited
  - Especially over large acreages

- Typically, removal of an average of 2-3 leaves per shoot will create a fruit zone with 1 to 2 LLN
  - (Reynolds and Wolf 2008)
Labor and time – “con” of leaf removal
How to remove leaves?

• **By hand**
  - Highly laborious
  - Low upfront cost
  - Precise

• **Mechanical**
  - Less laborious
  - Timely
  - High upfront cost
  - Savings over time...
  - Topography-dependent
"Air pulse mechanization"
"Cutting mechanization"

Mark Hoffmann
Bird netting – “con” of leaf removal
Harvest efficiency – “pro" of leaf removal
But… what about sunburn?

Sunburn is a “risk” in exposed fruit…

**BUT**… rot is a risk in shaded fruit….

More “extreme” in whites than reds

Less occurrence when leaves are removed very close to fruit set relative to near bunch closure

Sunburn may be more intense in drought conditions

Sunburn may be more intense in high-wire than in low-wire systems
Does vintage matter?... of course... but good luck predicting how the vintage will go...

In sunnier/drier vintages in humid climates...

Leaf removal typically offers less relative “benefits”

Exposed and shaded have similar quality and rot (Smith et al. 2018; Frioni et al. 2019)

<table>
<thead>
<tr>
<th></th>
<th>Harvest date</th>
<th>Harvest Brix</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010 (unnecessary) vs. 2011 (necessary)</td>
<td>September 9</td>
<td>26.0</td>
</tr>
<tr>
<td>2018 (necessary) vs. 2019 (unnecessary)</td>
<td>October 19</td>
<td>22.0</td>
</tr>
</tbody>
</table>
But... I thought anthocyanins can be reduced in highly exposed fruit...

We always must consider **WHERE** we are growing grapes....

Ambient radiation in N/S-oriented rows; Winchester VA, 2015
In north/south VSP; Winchester VA
Why is “leaf removal only on the morning / east canopy sides” a common recommendation?

<table>
<thead>
<tr>
<th>Canopy side</th>
<th>Hrs ≥ 30 °C</th>
<th>Hrs ≥ 35 °C</th>
<th>Total berry anthoc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>EAST</td>
<td>158</td>
<td>30</td>
<td>0.94</td>
</tr>
<tr>
<td>WEST</td>
<td>142</td>
<td>29</td>
<td>0.95</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Canopy side</th>
<th>Hrs ≥ 30 °C</th>
<th>Hrs ≥ 35 °C</th>
<th>Total skin anthoc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>EAST</td>
<td>159</td>
<td>37</td>
<td>119 a</td>
</tr>
<tr>
<td>WEST</td>
<td>166</td>
<td>89</td>
<td>76 b</td>
</tr>
</tbody>
</table>
Refine – improve something by making small changes; make more subtle and accurate

• Eastern and western US climates are very different…

• Why would we assume same management practices?

• Pesticide analogy
  ○ NC vineyard manager

https://earthobservatory.nasa.gov/global-maps/MODAL2_M_CLD_FR/CERES_NETFLUX_M
You must ask yourself...

- Where do I grow grapes?

- Do I value rot management over *risking* sunburn?
  - Sunburn *risk* can be offset by timing

- Do I value the data collected by university specialists?
  - Particularly related to grape and wine quality

- Do I have labor to implement in a timely fashion?
  - If not, should I:
    - Prioritize in some cultivars over others?
    - Consider mechanical means?

PennState Extension
Should leaf removal be a priority in all cultivars?

- **Whites vs. reds**
  - Fruit exposure optimizes rot management more so in whites
    - Petit Manseng, Merlot

- **Hybrids vs. vinifera**
  - Fruit exposure optimizes rot management more so in *vinifera*

- **Prioritize based on:**
  - Rot tolerance
  - Bud break and growth stage
Prioritizing / refining leaf removal efforts

<table>
<thead>
<tr>
<th>Leaf removal priority</th>
<th>Species</th>
<th>Berry color</th>
<th>Cluster morphology</th>
<th>Rot tolerance</th>
<th>Grape skin</th>
<th>Training system</th>
<th>Fruit zone architecture</th>
<th>Climate</th>
<th>Price premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>American</td>
<td>Loose</td>
<td>High</td>
<td>Thick</td>
<td>High Wire</td>
<td>Multi-dimensional; spacious</td>
<td>Dry, arid</td>
<td>Lower cost</td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>Hybrid</td>
<td>Red</td>
<td>Normal</td>
<td>Medium</td>
<td></td>
<td></td>
<td>Humid, subtropical</td>
<td>Higher cost</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>Vinifera</td>
<td>White</td>
<td>Compact</td>
<td>Low</td>
<td>Thin</td>
<td>VSP</td>
<td>Humid, continental</td>
<td>Higher cost</td>
<td></td>
</tr>
</tbody>
</table>
Take home

• **In a humid climate**
  - Fruit zone management is a tool to manage rots and fruit composition
  - The risk of sunburn may be offset by the ability to manage fruit composition and bunch rot
    - Assume cloudy and rainy weather

• **Be realistic about labor and budget**
  - Prioritize leaf removal accordingly based on cultivar, labor, and winemaking goals
Thank you

- Michela and PSU Wine and Grape Team
- PA industry stakeholders
- Best wishes for a great (rest of) the vintage!