Leaf removal and press fractioning for sparkling wine.

Belinda Kemp
Cool Climate Oenology & Viticulture Institute (CCOVI), Brock University, Ontario, Canada.
Background to leaf removal study

- Industry-led, long term study over five years that includes leaf removal
- Pinot noir for sparkling & red table wine on the same vineyard & Cabernet franc.
- Title: Adaptation and Innovation: An integrative research program to improve grapevine health, wine quality, competitiveness and sustainability of the Canadian wine grape industry.

Funded by Natural Sciences and Engineering Research Council of Canada (NSERC) CRD grant and Ontario Grape & Wine Research Inc (OGWRI).
What is your compositional target for sparkling wine grapes at harvest?

1. **Champagne**: 10/10 rule = 10g/L acidity (expressed as sulphuric acid) & 10% potential alcohol. *(Emma Rice, Hattingley Valley, UK).*

2. We are looking for ripe fruit flavours even if the acid is still high. Apple, lemon and grapefruit in the Chardonnay and raspberry, strawberry and cherry in the Pinots. *(Emma Rice, Hattingley Valley, UK).*

3. **Clean is king!** That said, when tasting the berries, I am looking for any green characters to have diminished and the acid to be firm. I am also not looking for any typical ripe flavour characteristics but more neutral. *(Emma Garner, Trius Winery, Niagara).*

**Remember**

Do NOT treat grapes in the vineyard or base wine in the same way you do a still white wine!
Method, timing & severity of leaf removal for sparkling wine, NOTL (clone 667)

Leaf removal treatments

- Control
  - No leaf removal
  - 80% mechanical in the fruiting zone
    - 80%MEC7PB
  - 80% manual in the fruiting zone
    - 80%MAN7PB

- 7 Days post bloom
  - 80% mechanical in the fruiting zone
    - 80%MEC30PB
  - 80% manual in the fruiting zone
    - 80%MAN30PB

- 30 days post bloom
  - 33% over the whole canopy
    - 33%BC
  - 50% in the fruiting zone
    - 50%V

- At bunch closure
  - 50% in the fruiting zone
    - 50%V

- At veraison
  - 100% in the fruiting zone
    - 100%V

Savard (2016)
Experimental vineyard design

- Niagara-on-the-Lake Vineyard, Four Mile Creek sub-appellation, Ontario.
- Clone 667/SO2 rootstock
- Vine spacing was 2.7m x 1.5m
- 25 vines per replicate per treatment
- 3 rows as replicates = 75 vines/treatment in a randomised block design
- A buffer zone of 5 vines before treatments began and grapes not picked from these vines
- Pendelbogen VSP system
- Soil type: Chinguacousy clay loam
- All harvested on same day
Leaf removal machines

- **80%MEC7PB leaf removal:** a Gregoire DX30 was used each year.
- **This model uses suction to remove leaves from the fruiting zone.**

- **80%MEC30PB leaf removal:** Collard P3000LZP Polyvalent was used each year.
- **This model uses pulsed air to blow the leaves from the fruiting zone.**
## Treatment dates

<table>
<thead>
<tr>
<th>Stage</th>
<th>Treatment</th>
<th>Date executed 2016</th>
<th>Date executed 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 day PB</td>
<td>80% Leaf removal mechanical</td>
<td>28-Jun</td>
<td>04-Jul</td>
</tr>
<tr>
<td>7 day PB</td>
<td>80% Leaf removal manual</td>
<td>28-Jun</td>
<td>04-Jul</td>
</tr>
<tr>
<td>30 day PB</td>
<td>80% Leaf removal mechanical</td>
<td>26-Jul</td>
<td>28-Jul</td>
</tr>
<tr>
<td>30 day PB</td>
<td>80% Leaf removal manual</td>
<td>26-Jul</td>
<td>28-Jul</td>
</tr>
<tr>
<td>Bunch Closure</td>
<td>33% of entire Canopy</td>
<td>21-Jul</td>
<td>25-Jul</td>
</tr>
<tr>
<td>Véraison</td>
<td>50% Leaf removal</td>
<td>17-Aug</td>
<td>23-Aug</td>
</tr>
<tr>
<td>Véraison</td>
<td>100% Leaf removal</td>
<td>17-Aug</td>
<td>23-Aug</td>
</tr>
</tbody>
</table>
Winemaking

1. Grape picking & pressing
2. Settling & clarification
3. 1st Fermentation
4. Malolactic fermentation (if required)
5. Blending base wines
6. Bottling & liqueur de Tirage (yeast, nutrients, riddling agent & sugar)
7. 2nd Fermentation & aging on lees
8. Riddling
9. Disgorging & dosage (wine & sugar)
10. Closure & packaging

Whole bunch pressed after grape chilling, to 1 bar
24hrs cold settling with enzymes & 1st fermentation at 16 °C (EC1118)
Bottled at Fielding Estate Winery, EC1118 for 2nd fermentation at 14 °C
12mths lees aging
Riddling/disgorging, no sugar added dosage, at Millesime
°Brix & titratable acidity (TA g/L) trend at harvest

<table>
<thead>
<tr>
<th>Year</th>
<th>Highest °Brix</th>
<th>Highest TA (g/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>80% MANUAL 7 &amp; 30PB</td>
<td>80% MECHANICAL30PB &amp; 33%BC</td>
</tr>
<tr>
<td>2016</td>
<td>No LR/C &amp; 100%V</td>
<td>No LR/C</td>
</tr>
<tr>
<td>2017</td>
<td>No LR/C &amp; 100%V</td>
<td>No LR/C &amp; 50%V</td>
</tr>
</tbody>
</table>
2015 pH & TA (g/L) base wines & similar in finished sparkling wine

Table a.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>TA (g/L)</th>
</tr>
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<tbody>
<tr>
<td>CONTROL</td>
<td>7.45</td>
</tr>
<tr>
<td>33MABC</td>
<td>7.65</td>
</tr>
<tr>
<td>80ME7PB</td>
<td>7.75</td>
</tr>
<tr>
<td>80MA7PB</td>
<td>7.85</td>
</tr>
<tr>
<td>80ME30PB</td>
<td>7.95</td>
</tr>
<tr>
<td>80MA30PB</td>
<td>8.05</td>
</tr>
<tr>
<td>50MAV</td>
<td>8.15</td>
</tr>
<tr>
<td>100MAV</td>
<td>8.25</td>
</tr>
</tbody>
</table>

Table b.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTROL</td>
<td>3.00</td>
</tr>
<tr>
<td>33MABC</td>
<td>3.04</td>
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<tr>
<td>80ME7PB</td>
<td>3.06</td>
</tr>
<tr>
<td>80MA7PB</td>
<td>3.08</td>
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<tr>
<td>80ME30PB</td>
<td>3.06</td>
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<tr>
<td>80MA30PB</td>
<td>3.04</td>
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<tr>
<td>50MAV</td>
<td>3.00</td>
</tr>
<tr>
<td>100MAV</td>
<td>3.00</td>
</tr>
</tbody>
</table>

TA (g/L) & pH of base wines in 2015 (Van de Meurwe 2015)

JUICE- Highest TA (g/L): 80% MECHANICAL30PB & 33%BC
Leaf removal treatments
Pinot noir juice & base wine (Clone 667)
(Savard 2015)
Phenolics (hydroxycinnamic acids) leaf removal Pinot noir base wines 2015

Effect of leaf removal treatment on the absorbance spectrum within the 250nm to 450nm range of base wines (Savard 2016).
2015 finished sparkling wines
(12mths on lees/12mths under cork)
Leaf removal treatments visual colour
(Bernard 2017)
Chemical analyses of leaf removal wines 2015 *(Bernard 2017)*

Residual sugar levels (g/L) 2015 sparkling LR wines

**Graph:**
- **Y-axis:** Residual sugar (g/L)
- **X-axis:** Leaf removal treatments
- **Legend:**
  - Yellow bar: Glucose (g/L)
  - Light grey bar: Fructose (g/L)
  - Brown bar: Total Sugar (g/L)

**Legend for treatments:**
- Control
- 33% MANBC
- 80% MEC7PB
- 80% MAN7PB
- 80% MEC30PB
- 80% MAN30PB
- 50% V
- 100% V

Note: The treatments are marked with letters (a, b, c, d, e, f) to indicate significant differences.
Ethanol in finished sparkling wine 2015 (Bernard 2017)

Total phenolics in finished sparkling wine 2015 (Bernard 2017)
Effect of leaf removal treatment on the absorbance spectrum within the 250nm to 450nm range of sparkling wines (Bernard 2017).
Caftaric Acid is formed when cafferic acid and tartaric acid undergo esterification.
## Other hydroxycinnamic acids

### Highest & lowest

<table>
<thead>
<tr>
<th>Compound</th>
<th>Highest</th>
<th>Lowest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caffeic acid</td>
<td>80%Man&lt;sup&gt;7PB&lt;/sup&gt; (6 mg/L)</td>
<td>33%ManBC (4 mg/L)</td>
</tr>
<tr>
<td>P-coumaric acid</td>
<td>80%Man&lt;sup&gt;7PB&lt;/sup&gt; (2 mg/L)</td>
<td>50%V (0.8 mg/L)</td>
</tr>
<tr>
<td>Coutaric acid</td>
<td>80%Mech&lt;sup&gt;7PB&lt;/sup&gt; (2 mg/L)</td>
<td>33%ManBC (0.9 mg/L)</td>
</tr>
<tr>
<td>Ethyl caffeic acid</td>
<td>80%Mech&lt;sup&gt;7PB&lt;/sup&gt; (5.6 mg/L)</td>
<td>33%ManBC (2.3 mg/L)</td>
</tr>
<tr>
<td>Ethyl ρ-Coumaric acid</td>
<td>80%Mech&lt;sup&gt;7PB&lt;/sup&gt; (0.9 mg/L)</td>
<td>50%V &amp; 100%V (0.5 mg/L)</td>
</tr>
</tbody>
</table>
Sensory analysis
Leaf removal wines 2015 *(Bernard 2017)*

Biplot (axes F1 and F2: 52.58 %)

- 80%MAN30PB
- 80%MEC7PB
- 33%MANBC
- 100%V
- 80%MAN7PB
- 50%V
- Bitter
- Yeasty
- Tropical fruit
- Peach
- Pear
- Pineapple
- Black liquorice
- Grainy
- Savoury
- Sour
- Floral
- Lemon
- Lime
- Citrus
- Vegetal
- Red fruit
- Mineral
- Apple
- NO LR

F1 (34.38 %)
F2 (18.20 %)
Further research and considerations

**Further research**
- Disgorging 2016 in April, bottling 2017 in April & disgorging it in April 2018.
- Full data collection and analysis of sparkling wine from 2016 & 2017

**Further considerations**
- Carry over effects i.e. yield
- LR according to style aim?
- Financial implications for vineyards
- Manual/machine requirements ($)
- Mixed LR treatments - i.e. early + at véraison, early machine with low %LR + manual later
- Assess impact longer lees aging & longer post disgorging time
NOW TO press fractioning considerations

Considerations
✓ Wine style *(fruity, lees aging/barrel, non-vintage blend or vintage)*
✓ Press type *(traditional 4000kg or pneumatic press)*
✓ Press size
✓ Press cycles
✓ Pressure level used per fraction
✓ Grape variety
✓ Health of grapes
✓ Mechanical or manual harvesting
✓ SO₂ addition level at press
✓ Initial grape ripeness
✓ Whole bunch pressing
✓ Grape temperature at picking & pressing
Bit of history of press fractions

• A book published in Reims in 1718 attributed to the priest Jean Godinot lays the foundation for press fractioning of Pinot noir juices from practical observations!
• He described the colour and grape juice quality during the pressing cycle of whole bunches.
• He noted more delicate wines from the 1\textsuperscript{st} & 2\textsuperscript{nd} squeezes! Squeezes 4-7 = coarse, stained and sold at lower prices!

BUT WHAT ABOUT AGING ABILITY, FOAM HEIGHT & STABILITY!

COLOUR – FRESHNESS – QUALITY – VARIETY
Making white sparkling wine from red grapes

- Cool grape temp
- Whole bunch pressing
- Gentle, gradual increase in pressure
- Low juice extraction
- Press fractioning

Champagne pressing (based on 4000kg grapes)

- Cuvee = 20.5hL (541 gallons)
- Tailles = 5hL (1\textsuperscript{st} taille -3hL + 2\textsuperscript{nd} taille 2hL)/132 gallons
- 3\textsuperscript{rd} taille 1-2hL distillation
Press fractions

CLONE 115 (Dijon clone)
Optimising press fractions (Clone 115)

Press fractioning options

- Without press fraction separation
  - All press fraction juice combined to produce one, low quality sparkling wine

- With press fraction separation
  - First fraction (F1): Quality base wine, more blending options, aging
  - Second fraction (F2): 2nd label, more blending options, could be used in dosage, lower quality than F1
  - Third fraction (F3): 2nd label, more blending options, could be used in dosage, lower quality than F2
  - Fourth fraction (F4): Sell to local distillery for distillation $$$
Experimental winemaking method

- Pinot noir - Clone 115
- Whole bunch pressed
- Wine taken from tap before hitting the tray - middle of each cycle
- No enzymes added
- 30 ppm SO2
- Winemaking in triplicate - no MLF
- Chemical analysis of juice & wine pH, TA (g/L), Brix, free & total SO2, ethanol, Nitrogen, turbidity, glucose, fructose, residual sugar, malic acid, heat stability, tartrate stability, total phenolics, conductivity & potassium.
- EC118 both fermentations
- *Tirage* same for all fractions (calculated on residual sugar & target of 24 g/L for 2nd fermentation)
## Press fraction juice composition

### Press fraction juice analysis

<table>
<thead>
<tr>
<th>Press Fraction</th>
<th>Brix</th>
<th>TA (g/L)</th>
<th>pH</th>
<th>Total YAN (mg N/L)</th>
<th>Malic acid (g/L)</th>
<th>Turbidity (NTU)</th>
<th>Acetic acid (g/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PF1</td>
<td>18.5</td>
<td>8.3</td>
<td>3.12</td>
<td>153</td>
<td>3.9</td>
<td>267</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>PF2</td>
<td>18</td>
<td>7.5</td>
<td>3.19</td>
<td>154</td>
<td>3.6</td>
<td>297</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>PF3</td>
<td>18</td>
<td>6.3</td>
<td>3.39</td>
<td>160</td>
<td>3.4</td>
<td>261</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

Significance: NS < 0.0001 0.0001 < 0.0001 < 0.0001 < 0.0001 NS
Press fraction juice and wine composition

(Analysis at every stage of winemaking but pre-fermentation and pre-bottling data presented today)

Press fraction base wine analysis (prior to bottling)

<table>
<thead>
<tr>
<th>Press fraction</th>
<th>Alcohol (% v/v)</th>
<th>TA (g/L)</th>
<th>pH</th>
<th>Residual sugar (mg/L)</th>
<th>Malic acid (g/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PF1</td>
<td>10.6</td>
<td>7.7</td>
<td>2.9</td>
<td>0.12</td>
<td>3</td>
</tr>
<tr>
<td>PF2</td>
<td>10.6</td>
<td>6.8</td>
<td>3.1</td>
<td>0.12</td>
<td>3</td>
</tr>
<tr>
<td>PF3</td>
<td>10.7</td>
<td>6.0</td>
<td>3.4</td>
<td>0.23</td>
<td>3</td>
</tr>
<tr>
<td>Significance</td>
<td>NS</td>
<td>&lt; 0.0001</td>
<td>&lt; 0.0001</td>
<td>&lt; 0.0001</td>
<td>NS</td>
</tr>
</tbody>
</table>
Visual effect (9 months lees aging)
PRESS FRACTIONING:
Sparkling wine research at CCOVI

Accelerated oxidation analysis of base wines (2014).
The absorbance at 420nm was measured over the course of 30 days.
Phenolic compounds in press fractions (Pinot noir clone 115)

Press fraction 1:
Sparkling wine with highest acidity, lowest pH, light colour and highest foam stability

Press fraction 2:
Sparkling wine with medium acidity, medium pH and medium colour

Press fraction 3:
Sparkling wine with lowest acidity, highest pH and darkest colour

Taille musts produce intensely aromatic wines – fruitier in youth than those made from the cuvee but far less age-worthy.

Grape must colour change during pressing

South of England, Chardonnay – 09/2010

Kemp et al. 2012
Projected revenue generated by alternative press fractioning and tier system decisions, shown in comparison to the estimated revenue generated by the current scheme.
Press fraction composition & considerations

• Aging ability
• Oxidation ability
• Calcium (tartrate potential)
• Potassium (K)/conductivity
• Quality potential

COMPOSITIONAL IMPACT ON FOAM QUALITY
• Proteins
• Polysaccharides during pressing
• Tartaric acid
• Phenolic compounds
Acknowledgements

Leaf removal project

• **Researchers:** Jim Willwerth, Mary Jasinski, Paul Van Merwe, Kyung-Hee Kim, Charles Bernard, Stephanie Bilek, Judah Campbell, Debbie Inglis

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References

Thank you for your attention. Any questions?