New Initiatives in the Management of Grape Sour Rot

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So what?

- Wineries may reject grapes when the VA exceeds their acceptance limit of acetic acid (0.20 – 0.24 g/L)
- High VA indicates the presence of microbial contaminants that are not wanted in the winery
- $$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
- 20% of early varieties rejected at winery
- Multiple fungicide sprays applied
- Labour costs of several passes to drop rotted fruit
2009 Losses from Sour rot/ Elevated VA

- Crop insurance claims for vineyards
  - $1.5 M total
  - $750,000 excess rain
  - $250,000 hail
What’s causing it????
What’s causing it?

- 4 sets of 20 sour rotted berries
- Flamed to remove surface organisms

Plant, 2008
What’s causing it?

- Berries crushed, diluted juice plated onto PDA, GYC, YPD

- Plates incubated at 25°C for 48 hours
Sour Rot Severity Rating Scale

0 – no rot
1 – slight rot
2 – moderate rot
3 – severe rot

Plant, 2008
Test berries in plastic container after 8 days. The top 4 berries in each section were intact and the bottom 4 berries were wounded.
Severity of Rot with and without Wounding

Disease Severity (0-3)

Intact  Wounded

Plant, 2008
# Frequency of Isolation

<table>
<thead>
<tr>
<th>Organism</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanseniaspora uvarum</td>
<td>36</td>
</tr>
<tr>
<td>Candida zemplinina</td>
<td>4</td>
</tr>
<tr>
<td>Gluconobacter cerinus</td>
<td>49.5</td>
</tr>
<tr>
<td>Gluconobacter frateurii</td>
<td>0.3</td>
</tr>
</tbody>
</table>
Why does it happen?
Why does it happen?

• Tight clusters/Thin skins
  – Varieties Affected
    • Pinot noir, Pinot gris, Gamay, Chardonnay, Riesling, Gewurztraminer, Baco noir
Why does it happen?

Same amount of wax per berry at pea-size and maturity
2008 Weather – SOGGY & WARM!

Why does it happen?
Why does it happen?

- Diffuse powdery mildew infections
  - Slow-growing, sparse, non-sporulating
  - Usually associated with minute patches of dead epidermal cells
Protect fruit during peak period of susceptibility, and continue protection until ontogenic resistance is fully expressed 3-4 weeks postbloom.
Why does it happen?

• “It is known” clusters infected with bunch rot are more prone to sour rot
• But
  – Frequently found sour rot without bunch rot sporulation
  – Frequently found sour rot in areas of clusters (shoulders) where no berry squeeze occurred
  – Very weak correlation between severity of bunch rot and sour rot in 2008 with >1000 observations in 3 Niagara vineyards
Why does it happen?

- **Grape Berry Moth**
  - Bunch rot frequently associated with GBM injury
  - Probably similar relationship with sour rot organisms
Factors that Promote Sour Rot

- Vinegar flies attracted by volatile compounds released during berry degradation
- Vector sour-rot organisms
  - passive transport by adults
  - transmitted throughout cluster during larval stages
  - larvae carry sour rot organisms in their gut.
What can we do about it?
Sour Rot Management

- Reduce injury
- Reduce infection by pathogens
Reduce Injury

• Loosen grape clusters
  – Reduce berry squeeze
  – Thinner cuticle on berries in contact
Reduce Injury

• Loosen grape clusters
  – Gibberellic acid (GA)
    • GA + ammonium chloride at full bloom and 4 days later resulted in fewer berries/cluster & reduced splitting
    • Reduced fruitfulness following yr (esp Riesling)
  – Other compounds affecting cluster development
    • Product “X” @ 180 g a.i./ha applied at full bloom
Zabadal & Dittmer Cluster Compactness Scale
Effect of Product “X” on Riesling Cluster Compactness, 2008

Similar but less pronounced effects in P. noir
Effect of “Product X” on Riesling Sour Rot, 2008

Similar but less pronounced effects in P. noir
Reduce Injury

• Loosen grape clusters
  - Bloom basal leaf removal (Hed and Travis)
    • 3-4 leaves around clusters (Vignoles) manually removed at trace bloom
    • starves clusters for photosynthate and fewer flowers set fruit.
    • looser cluster with fewer berries
Reduce Injury

- Early leaf stripping may help reduce incidence of sour rot
  - Change berry skin and wax characteristics
  - Change cluster compactness

- Reduce powdery mildew
- Reduced Botrytis bunch rot
Before Bloom Leaf Removal
After Bloom Leaf Removal
Effect of Bloom Treatments on Riesling Cluster Compactness, 2009

The diagram shows the effect of various bloom treatments on Zabadal rating. The treatments include Prod X 45g, Prod X 90g, Prod X 180g, GA 5 ppm, GA 10 ppm, GA 20 ppm, GA 5 ppm 2X, GA 10 ppm 2X, Stimplex 2.8L, Stimplex 3.5L, Stimplex 5L, bloom leaf, and check. The Zabadal rating ranges from 0.0 to 3.0, with Prod X 180g showing the highest effect and Prod X 45g showing the lowest effect. The diagram indicates that Prod X 180g and Prod X 90g have a significant effect on cluster compactness compared to the other treatments.
Effect of Bloom Treatments on Incidence of Sour Rot, Riesling, 2009

No treatment with VA > 0.2 g/L
Effect of Leaf Removal on Sour Rot, Riesling & Pinot noir 2009

- Leaves removed by hand at
  - Pea-size berry
  - Veraison
- Product X @ 180 g a.i./ha + pea-size berry leaf removal
- GA 5 ppm 2X + pea-size berry leaf removal
Untreated
No leaf removal
Veraison

Leaf removal at bloom
Veraison

Pea-sized berry
Leaf removal
Effects of Leaf Removal Timing on Cluster Weight, Riesling, 2009

![Bar graph showing the 10-cluster weight (kg) at different stages: Check (red), Bloom (yellow), Pea-size (green), and Veraison (purple). The graph indicates that the highest cluster weight is at Bloom, followed by Check, Pea-size, and Veraison.]
Effects of Leaf Removal Timing on Cluster Weight, Pinot noir, 2009

![Bar chart showing the effects of leaf removal timing on cluster weight. The chart compares different stages: Check, Bloom, Pea-size, and Veraison. The y-axis represents 10-cluster weight (kg) ranging from 0 to 2.5. The x-axis lists the stages: Check, Bloom, Pea-size, Veraison. The Check stage has the highest cluster weight, followed by Pea-size and Veraison, with Bloom having the lowest weight.]
Effects of Leaf Removal Timing on Brix, Pinot noir, 2009

![Bar chart showing soluble solids (Brix) for different stages: Check, Bloom, Pea-size, Veraison.](chart.png)
Effects of Leaf Removal Timing on Brix, Riesling, 2009

![Bar chart showing the effects of leaf removal timing on Brix for Riesling in 2009. The chart displays four stages: Check, Bloom, Pea-size, and Veraison. The y-axis represents Soluble Solids (Brix) ranging from 17.5 to 20. The x-axis represents the timing of leaf removal. The Check stage has the highest Brix value, followed by Bloom, Pea-size, and Veraison, which has the lowest Brix value.]
Effects of Leaf Removal Timing & Ca on Incidence of Sour Rot, Riesling, 2009

Very little sour rot in P. noir; no differences among treatments
Reduce Mechanical Injury

• Suggestions for Cherry Cracking
  – Physical removal of water from fruit surface
    • Helicopters, air blast sprayers
  – Osmoticum sprays
    • Mineral salts (CaCl2) applied prior to or during rain
    • Reduce absorption of water across skin
  – Protectants
    • Raingard? (non-ionic surfactant)
Reduce Mechanical Injury

• Suggestions for Cherry Cracking cont’d
  – Surfactants, copper, plant hormones
    • Mixed results
  – Calcium
    • Strengthen cell walls?
    • Timing between fruit set and veraison
Sour Rot Trial 1, 2008, cv. Riesling

• Riesling sprayed at cluster close, veraison, 2 wk post-veraison
  - Oligosol Ca @ 10 L/ha
  - Acadian Kelp 1 kg/1000 L
  - Standard: Scala/Elevate/Scala
Sour Rot Trial 1, 2008, cv. Riesling

Disease Severity

- Check
- Standard
- Calcium
- Kelp

Botrytis

Sour rot
Sour Rot Trial 2, 2008, cv. Riesling

- Riesling & Pinot noir
- Oligosol Ca
  - 10 L/ha at pea-size berry
  - 10 L/ha at pea-size berry + veraison
  - 10 L/ha at veraison
Sour Rot Trial 2, 2008, cv. Riesling

The chart illustrates disease severity for Botrytis and Sour rot across different treatments:
- **Check**
- **Ca pea size**
- **Ca veraison**
- **Ca 2X**

The y-axis represents disease severity, ranging from 0 to 8, while the x-axis categorizes treatments as Botrytis and Sour rot.
Effect of Leaf Removal on Sour Rot, Riesling & Pinot noir 2009

- 2 Stopit (CaCl) + pea-size berry leaf removal
- 4 Stopit (CaCl) + pea-size berry leaf removal
Sour Rot Management

• Potassium Metabisulphite?
  – Used as anti-oxidant and anti-microbial (vs microbes) in vinification (40-60 g/tonne)
  – Rengasamy & Poole (NZ):
    • 5 kg per 1000 L water
    • Botrytis-infected berries dry out
  – Wicks (Australia):
    • 3-4 g/L KMS killed Botrytis spores & inhibited growth of germ tubes
    • If 4 g/L applied w/i 48 hr of infection, inhibits sporulation from infected berries
    • Little effect on sporulation after that
Sour Rot Management

• Potassium Metabisulphite (KMS)
  – Concerns:
    • Does it work?
    • How does it work? (anti-oxidant/anti-microbial/both?)
    • Excess sulphites & SO$_2$ in wine?
    • Worker/equipment exposure
Effect of Vineyard Treatments on VA, 2008

- Riesling with history of sour rot
  - Removed all clusters with more than 25% sour rot
  - Sprayed day 1
  - Collected 25 clusters per plot
  - Determined VA for each sampling date
Effect of Vineyard Treatments on VA, 2008

All treatments significantly reduced VA. Milstop and KMS reduced it more than other treatments.
## Timing of Sour Rot Spray, 2009

<table>
<thead>
<tr>
<th></th>
<th>Sep 3</th>
<th>Sep 17</th>
<th>Oct 1</th>
<th>Oct 8</th>
<th>Oct 17</th>
<th>Oct 25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Veraison</td>
<td>i</td>
<td>i</td>
<td>i</td>
<td>i</td>
<td>i</td>
<td>i</td>
</tr>
</tbody>
</table>
Post-Veraison Treatments, 2009

- 2 apps@ 2-wk intervals, then 4 @ 1-wk intervals (6 apps)
  - KMS @ 5 kg/1000 L
  - KMS @ 10 kg/1000 L
  - KMS @ 2.5 kg/1000 L
  - Milstop (K\textsubscript{2}CO\textsubscript{3})
  - Milstop + KMS
  - Oxidate (H\textsubscript{2}O\textsubscript{2})

- 2 wk intervals (5 apps)
  - Actinovate (*Streptomyces lydicus*)
  - Blight Ban A506 (*Pseudomonas fluorescens*)
  - Purshade (CaCO\textsubscript{3})

- Veraison, 2 wk post veraison, 4 wk post veraison (3 apps)
  - Vermicompost
  - Switch (cyprodonil + fludioxonil)
  - Stopit (CaCl)

- Untreated check
Average Daily Temperature and Precipitation, 2008 and 2009

![Graph showing average daily temperature and precipitation comparison between 2008 and 2009. The x-axis represents the months of May to October, and the y-axis represents temperature in °C and precipitation in mm. The graph compares the average daily temperature and precipitation for each month with blue bars indicating 2008 and green bars indicating 2009. The temperatures are higher in 2008 compared to 2009, especially in July and August. The precipitation is lower in 2009 compared to 2008, with June having the highest precipitation in both years.]
Average Daily Temperature and Precipitation, September 2008 and 2009
Effects of Temperature, Rain, Brix on Sour Rot Development, 2009
Effects of Post-Veraison Treatments on Berry Microflora

• Sampled fruit before and 24 hr after treatment with
  - KMS 5 kg/1000 L
  - Oxidate
  - Actinovate
  - Blight Ban
  - Milstop
  - Milstop + KMS
  - Vermicompost
Effect of Post-veraison Treatments on Yeasts, 2009

![Graph showing the mean % change for different treatments over 1 and 2 days.](image)

- Untreated
- KMS
- Oxidate
- Actinovate
- Blight Ban
- Milstop
- Milstop + KMS
- Vermicompost
Effects of KMS on Vinification

• Treatments: 2 wk, 1 wk, 3 d, 1 d preharvest at 5 kg/1000L (5000 ppm) (2.4 kg KMS/ha)
• Each plot consisted of all rot-free fruit on 4 to 6 Riesling vines
• If no sulfur dioxide dissipated, then the expected concentration of SO$_2$ in the juice would be 197 mg/L (based on a crop level of 4 t/acre)
Effects of KMS on Vinification

• Fermentations were sampled every other day for cell count and °Brix until the fermentations went to dryness
Effects of KMS on Fermentation

Fermentation slower in untreated control compared to KMS
Effects of KMS on Fermentation

No effect on yeast growth
## Effects of KMS on Fermentation

### Table 3. Wine parameters.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>pH</th>
<th>Titratable acidity (g/L tartaric acid)</th>
<th>Residual Sugar (g/L)</th>
<th>Ethanol (% v/v)</th>
<th>Total YAN (mg N/L)</th>
<th>Free SO2 (mg/L)</th>
<th>Total SO2 (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>2.86 ± 0.04</td>
<td>9.7 ± 0.2a</td>
<td>1.1 ± 0.5</td>
<td>11.2 ± 0.3</td>
<td>6.1 ± 3.0</td>
<td>1.6 ± 0.6</td>
<td>3.0 ± 0.8</td>
</tr>
<tr>
<td>2 weeks</td>
<td>2.87 ± 0.07</td>
<td>8.9 ± 0.5b</td>
<td>1.2 ± 0.5</td>
<td>11.3 ± 0.3</td>
<td>7.4 ± 1.5</td>
<td>1.7 ± 0.4</td>
<td>3.2 ± 0.8</td>
</tr>
<tr>
<td>1 week</td>
<td>2.82 ± 0.07</td>
<td>8.8 ± 0.3b</td>
<td>1.3 ± 0.7</td>
<td>11.1 ± 0.2</td>
<td>7.6 ± 2.2</td>
<td>1.8 ± 0.9</td>
<td>2.9 ± 0.9</td>
</tr>
<tr>
<td>3 days</td>
<td>2.81 ± 0.06</td>
<td>8.9 ± 0.3b</td>
<td>1.6 ± 0.6</td>
<td>10.7 ± 0.4</td>
<td>7.3 ± 0.6</td>
<td>1.7 ± 0.5</td>
<td>2.9 ± 0.8</td>
</tr>
<tr>
<td>1 day</td>
<td>2.86 ± 0.11</td>
<td>8.8 ± 0.3b</td>
<td>1.6 ± 1.1</td>
<td>11.0 ± 0.6</td>
<td>8.6 ± 2.9</td>
<td>1.8 ± 0.7</td>
<td>3.0 ± 0.8</td>
</tr>
</tbody>
</table>

Mean values followed by letters are significantly different by LSD (p<0.05).

Very low levels of SO₂

Nsd in TA, residual sugar, ethanol
Effects of KMS on Fermentation

- KMS vineyard sprays did not adversely affect the yeast’s ability to carry out the fermentation.
- Sulfur dioxide sprayed in the vineyard is not detectable in juice processed from grapes only 1 day after KMS spray application.
- Effects on storability of wine????
Factors that affect sour rot: Canopy management

- Improved spray penetration
- Faster drying
- Increased wax deposition
- Higher phenolic compounds in skins
Future Research

• Repeat cluster loosening treatments
  – Assess return fruitfulness
• Effects of temperature, wetness duration, Brix, cuticle/skin characteristics on infection
• Timing of treatments
• New post-veraison treatments
• Effects of treatments on organisms causing sour rot
• Interactions among causal organisms + Botrytis, powdery mildew
• Effects of treatments on cuticle and skin characteristics
Acknowledgements

• Ontario Grape and Wine Research Inc.
• Niagara Peninsula Fruit and Vegetable Growers Association
• Vincor Canada
• Schenck Greenhouses and Farms Ltd.
• Niagara Vintage Harvesters
Acknowledgements

- Dr. Debra Inglis
- Lisa Dowling
- Rhiannon Plant
- Cristina Huber
- Kathryn Hoshkiw-Tombs
- Dr. Ai-Lin Beh
- Shiri Sauday
- Paula Haag & Dr. Peter Sholberg, AAFC Summerland
- Dr. Keith Seifert, AAFC
Acknowledgements

• BASF Canada
• N.M. Bartlett
• Biosafe Systems
• Forterra Inc.
• NORAC Concepts Inc.
• Plant Products
• Bioworks Inc.