Impact of Crop Load and Training Systems on Marquette in Michigan: Summary of 2012-2016 activities at MSU

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The Northern Grapes Project is funded by the USDA’s Specialty Crops Research Initiative Program of the National Institute for Food and Agriculture, Project #2011-51181-30850
Acknowledgments

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- Tim Martinson and Chrislyn Particka

- NE1020 Project; Cultivar evaluation across US Southwest Michigan Research and Extension Center (Dave Francis and Tom Zabadal)
- Horticulture Teaching and Research Center (Bill Chase and Tom Fernandez)

Bob Utter
Summary of Activities at MSU from 2012 to 2016

• Experimental activity
• 3 locations: Southwest Michigan Research and Extension Center (SWMREC) Benton Harbor, Horticulture Teaching and Research Center (East Lansing) and Flying Otter Vineyard and Winery (Adrian)
• Experiments on:
  • Trellis systems
  • Crop load
  • Canopy management
Outline

• Marquette in Michigan
  – The role of cold hardy CVs in expanding the MI grape and wine industry

• Working on trellis systems and crop load: Why?
  – High sugar and high acids, looking for a balance to produce high quality wines; coupling fruit technological maturity parameters

• 2012: impact of spring frost on yield and fruit quality
  – Early ripe good for cool climate, but early bud-burst subjected to spring frost

• 2012-2016: the role of (a) trellis system and (b) yield per vine and (c) canopy management on fruit technological maturity at harvest and wine sensory components
Marquette in Michigan
The role of cold hardy CVs in expanding the MI grape and wine industry

<table>
<thead>
<tr>
<th>Variety Category</th>
<th>2015</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Acres</td>
<td>%</td>
</tr>
<tr>
<td>Concord</td>
<td>8,030</td>
<td>59</td>
</tr>
<tr>
<td>Niagara</td>
<td>2,830</td>
<td>21</td>
</tr>
<tr>
<td>Hybrids</td>
<td>760</td>
<td>6</td>
</tr>
<tr>
<td>Viniferas</td>
<td>2,040</td>
<td>15</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13,660</strong></td>
<td></td>
</tr>
</tbody>
</table>

- The 2014 USDA report 27 acres of Marquette in MI.
- Marquette was recently planted in MI, accounting for 40% of the new hybrid acreage.

5th Appellation
Established in 2016:
“Tip of the Mitt”

http://www.michiganwines.com

Data from USDA 2015 Fruit Inventory Report

Training Systems Trial

High Wire Cordon (HWC)

Geneva Double Curtain (GDC)

Moving Trellis (MT)

Spring of 2012
Impact on Marquette vines

Growing Degree Days (base 50F)

27-Feb  12-Mar  26-Mar  09-Apr  23-Apr  07-May

BUD BURST 3/28/2012

Temperature (F)

Days

Relative budburst time in Michigan
How the Vines Responded to the Frost

Primary

Secondary

After the frost

45°

90°

CPS

CSS
Impact of Frost: CPS vs CSS

No differences between training systems

No differences in berry growth; CSS recovered the late start (≈ 10d)
Difference in fruit chemistry only in the early phase of the ripening process
# Yield Components and Fruit Quality

<table>
<thead>
<tr>
<th>Trellis System</th>
<th>Yield (Kg/vine)</th>
<th>Number of clusters</th>
<th>Cluster weight (g)</th>
<th>Berries per cluster</th>
<th>Pruning weights (kg)</th>
<th>Ravaz Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>HWC</td>
<td>3.30</td>
<td>67</td>
<td>62.9</td>
<td>60</td>
<td>0.93</td>
<td>3.5</td>
</tr>
<tr>
<td>GDC</td>
<td>3.20</td>
<td>69</td>
<td>53.4</td>
<td>54</td>
<td>1.02</td>
<td>3.8</td>
</tr>
<tr>
<td>MT</td>
<td>3.53</td>
<td>75</td>
<td>58.0</td>
<td>62</td>
<td>1.12</td>
<td>3.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Trellis System</th>
<th>TSS (°Brix)</th>
<th>pH</th>
<th>TA (g/L)</th>
<th>Phenolics (a.u./g)</th>
<th>Anthocyanin (mol/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HWC</td>
<td>19.5 b</td>
<td>3.4</td>
<td>9.2</td>
<td>0.90 b</td>
<td>0.91</td>
</tr>
<tr>
<td>GDC</td>
<td>21.4 a</td>
<td>3.3</td>
<td>9.4</td>
<td>1.05 a</td>
<td>0.92</td>
</tr>
<tr>
<td>MT</td>
<td>19.7 b</td>
<td>3.4</td>
<td>9.8</td>
<td>0.96 b</td>
<td>1.01</td>
</tr>
</tbody>
</table>

+10% at the time of harvest

+15% at the time of harvest
Conclusions 2012

• 2012 frost events similarly impacted the 3 training systems
• No differences in canopy growth and size (data not shown)
• Basic fruit chemistry of CPS and CSS was similar for all the training systems. Differences only due to late phenological stages at the beginning of fruit ripening.
• Yield per vine was similar between the training systems
• With 80% primary bud kill vines yielded about 2 T/acre
• Experimental wines made from CPS had more color, alcohol, acidity, astringency and body when compared with CSS wines (basic fruit chemistry at harvest different only for pH and TA)
Summary of the Work

Experimental Activity in 2013-2016

• Experimental activities focused on:
  – Comparing training system
  – Modifying crop load
  – Canopy management strategies

• The objectives: study interaction between (a) canopy growth and yield levels (crop-load), (b) cluster exposure and (c) fruit technological maturity at harvest.
Comparing High Wire Cordon (HWC) Geneva Double Curtain (GDC) and Moving Trellis (MT)

<table>
<thead>
<tr>
<th>Trellis</th>
<th>Kg per vine</th>
<th>T/acre</th>
<th>Brix</th>
<th>pH</th>
<th>TA</th>
<th>Harvest Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDC</td>
<td>3.1a</td>
<td>6.3 a</td>
<td>24.8</td>
<td>3.5</td>
<td>7.0</td>
<td>Aug 30 to Sept 29</td>
</tr>
<tr>
<td>HWC</td>
<td>2.7 a</td>
<td>5.4 a</td>
<td>23.9</td>
<td>3.4</td>
<td>6.5</td>
<td></td>
</tr>
<tr>
<td>MT</td>
<td>2.1 b</td>
<td>4.0 b</td>
<td>23.0</td>
<td>3.7</td>
<td>6.6</td>
<td></td>
</tr>
</tbody>
</table>

- 2014 no significant data (Polar Vortex)
- The 3 training systems achieved optimal fruit quality at harvest
- Harvest date varied by a month between the experimental years
- MT produced less fruit without increasing fruit quality
- GDC and HWC performed similarly
# Crop Load Experiments with HWC

![image of grapes](image1.png)

The yield per vine for different treatments is as follows:

- **High**
  - Cluster/vine: 264.0 a
  - Cluster weight (g): 52.6
  - Berries/cluster: 44.2
  - Berry weight (g): 1.19
  - Pruning Weight (kg): 1.85 b

- **Medium**
  - Cluster/vine: 184.8 b
  - Cluster weight (g): 49.6
  - Berries/cluster: 42.0
  - Berry weight (g): 1.18
  - Pruning Weight (kg): 1.97 b

- **Low**
  - Cluster/vine: 114.3 c
  - Cluster weight (g): 50.2
  - Berries/cluster: 42.9
  - Berry weight (g): 1.17
  - Pruning Weight (kg): 2.41 a

![image of grapes](image2.png)
Yield Components and Fruit Chemistry

SWMREC: Southwest Michigan Research and Extension Center (Benton Harbor)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>TSS (°Brix)</th>
<th>pH</th>
<th>TA (g/L)</th>
<th>Phenolics (mg/L)</th>
<th>Anthocyanin (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>22.4 b</td>
<td>3.6 b</td>
<td>6.70</td>
<td>1264 b</td>
<td>916 c</td>
</tr>
<tr>
<td>Medium</td>
<td>22.9 b</td>
<td>3.6 ab</td>
<td>6.93</td>
<td>1594 a</td>
<td>985 b</td>
</tr>
<tr>
<td>Low</td>
<td>25.8 a</td>
<td>3.8 a</td>
<td>6.78</td>
<td>1668 a</td>
<td>1024 a</td>
</tr>
</tbody>
</table>

- Impact on TSS (Brix) of +10/20% with a reduction of yield of -40/50%
- Minimal impact on pH at Acidity
- Reduction on phenolic compound in high cropping level (-25%)
- Impact of cropping levels on color compounds
Increasing Color Compounds and Sugar Accumulation

• Canopy management
  – Leaf removal pre-veraison
  – Cluster exposure 100%

• Time of harvest
  – Targeting 24 Brix in all the cropping treatments
Improving Cluster Microclimate

Environmental parameters

Photosynthetic Active Radiation (PAR)

Temperature
Cluster Exposure at Pre-Veraison

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Cluster exposure</th>
<th>Brix</th>
<th>pH</th>
<th>TA</th>
<th>Anthocyanin (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>No</td>
<td>21.9 c</td>
<td>3.5</td>
<td>6.9 a</td>
<td>797 b</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>23.8 b</td>
<td>3.4</td>
<td>6.5 b</td>
<td>1045 a</td>
</tr>
<tr>
<td>Medium</td>
<td>No</td>
<td>23.6 b</td>
<td>3.3</td>
<td>6.8 a</td>
<td>916 b</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>24.3 ab</td>
<td>3.4</td>
<td>6.3 b</td>
<td>1200 a</td>
</tr>
<tr>
<td>Low</td>
<td>No</td>
<td>23.7 b</td>
<td>3.4</td>
<td>6.8 a</td>
<td>1024 a</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>25.5 a</td>
<td>3.5</td>
<td>5.5 b</td>
<td>1222 a</td>
</tr>
</tbody>
</table>

- Clear trend of cluster exposure in improving sugar accumulation
- Clear trend of cluster exposure in reducing acidity accumulation
- Clear trend of cluster exposure in improving color compounds: high crop load with leaf removal has the same concentration of anthocyanins of medium and low cropping levels without cluster exposure
Managing Harvest Date (2015)
Targeting 24 Brix
### Managing Harvest Date (2015)  
**Targeting 24 Brix**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Harvest Date</th>
<th>Yield (T/acre)</th>
<th>TSS (°Brix)</th>
<th>pH</th>
<th>TA (g/L)</th>
<th>Phenolics (mg/L)</th>
<th>Anthocyanin (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Sept 29</td>
<td>10.2 a</td>
<td>23.9</td>
<td>3.6</td>
<td>7.0</td>
<td>1718</td>
<td>1385</td>
</tr>
<tr>
<td>Medium</td>
<td>Sept 24</td>
<td>8.5 b</td>
<td>24.6</td>
<td>3.6</td>
<td>6.9</td>
<td>1777</td>
<td>1141</td>
</tr>
<tr>
<td>Low</td>
<td>Sept 17</td>
<td>5.3 c</td>
<td>24.8</td>
<td>3.5</td>
<td>6.7</td>
<td>1837</td>
<td>1322</td>
</tr>
</tbody>
</table>

- Difference of about 2 weeks between Low and Medium cropping levels harvest date
- All the treatments reached 24 Brix in 2015
- No differences in other fruit technological maturity parameters
Potential Problems For future Research

Sustainability

Cold Hardiness

$r^2 = 0.94$
Conclusions: What We Learn in Michigan

• Marquette is very prone to frost
  – Great production on secondary, no difference in basic fruit quality from CPS and CSS

• Marquette ripens the fruit very early for MI standards
  – End of August / Early September: at least 20-40 days before our signature red vinifera CVs (Pinot Noir and Cabernet Franc)

• Marquette is resilient to cropping levels
  – Yield per vine barely impacted basic fruit chemistry fruit technological maturity at harvest
  – Canopy management improved fruit technological maturity at harvest
  – Harvest time is pivotal to reach desired fruit maturity
Questions?