‘Norton’ Grapevine is Resistant to Grapevine Vein Clearing Virus

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Virus Resistance in Grapevines

- Identification of resistance genes to viruses in *Vitis* rarely reported
- Resistance to viruses highly desirable trait
GVCV

- DNA virus endemic to our area
- Vein-clearing, stunted vine, death of infected vine
- Deformed berries
Native grapevines host the virus ≈ 10% (19/186)

Discovered A. *cordata* as viral reservoir ≈ 34% (142/413)

Found grape aphids (A. *illinoisensis*) are a vector
GVCV

- Native grapevines
  - V. cinerea
  - V. vulpina
  - V. rupestris
  - V. palmata

- Cultivated grapevines
  - Chardonel
  - Vidal blanc
  - Cabernet Sauvignon
  - Traminette
  - Chardonnay
  - Valvin Muscat
What about Norton?
The Wonders of Norton

Resistant to:
- Downy mildew
- Powdery mildew
- Bunch rot
Norton and GVCV
<table>
<thead>
<tr>
<th>Survey of GVCV in Foundation Vineyard</th>
<th>Chardonel</th>
<th>Vidal Blanc</th>
<th>Norton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>19%</td>
<td>30%</td>
<td>0</td>
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Norton scion on GVCV-infected Chardonel

GVCV-infected Chardonel on Norton
GVCV-specific 442 bp and 835 bp fragments by PCR.
The 16S rRNA-specific 105 bp fragment baseline for DNA quality.
RNA for a DNA virus?

- Required part of GVCV replication cycle
- Part of plant defense against viruses
Next-generation technology that determines sequence and quantity of all RNA present in plant sample

We used RNAseq to determine presence of GVCV
RNAseq scions and rootstocks

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<tr>
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<th>GV x CS</th>
<th>N x GV</th>
<th>GV x N</th>
</tr>
</thead>
<tbody>
<tr>
<td>GVCV genome</td>
<td>100% assembled from small RNAs in GVCV-infected Chardonel scion and Cabernet Sauvignon</td>
<td>not assembled from Norton scion. GVCV genome 100% assembled from GVCV-infected Chardonel</td>
<td>100% assembled from GVCV-infected Chardonel scion. GVCV genome not assembled from Norton</td>
</tr>
</tbody>
</table>
Norton as parent

Norton sauvignon

Cabernet sauvignon

Resistant progeny?

Quality wine grapes?
Norton as parent

- 2006- Planted 100 crosses of Norton and Cabernet Sauvignon
Norton as parent

- 2019-Pathogen resistance experiments on progeny
Norton as a parent

- Over 200 grafts of progeny and GVCV-infected Chardonel
- Surviving vines assayed
- 61 progeny susceptible to GVCV via graft transmission
- 20 resistant
PCR assay of Norton progeny grafted with GVCV infected Chardonel

GVCV-specific 442 bp and 835 bp fragments by PCR
The 16S rRNA-specific 105 bp fragment baseline for DNA quality
CN; Cabernet Sauvignon mother crossed with Norton
Management of viruses

Prevention

- Virus free planting stock
- Limit vectors
- Control inoculum sources
Management of viruses

Resistance to grapevine viruses

Photo: Wendy McFadden, (OMAFRA)
Norton  
Vignoles  
Chambourcin  
Chardonel  
Vidal Blanc  
Traminette  
Cayuga White  
Vivant  
Orion  
NC-6
Conclusion

- Norton is resistant to GVCV
- Evidence via field studies, grafting, PCR and RNAseq
- Preliminary progeny evaluation shows resistance likely a heritable trait from Norton
Future research

- Investigate whether Norton is resistant or tolerant to other important grapevine viruses
Future research

- Explore breeding to confer virus resistance to progeny
- Discern mechanism(s) of Norton’s resistance
THANK YOU!