Grape Entomology Update: Grapevine Leafroll and Grape Mealybugs

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OUTLINE

• Grape leafroll disease

• Survey of GLRaV and vectors in the Finger Lakes

• Role of Vectors in spread of grape leafroll

• Managing vectors to slow spread of GLRaV

• Conclusions and future directions
LEAFROLL DISEASE

- Ancient disease
- Complex disease with several viruses
- Limited host range
- Widespread distribution
- Vineyard spread by mealybugs and soft scale
- Detrimental impact on yield and fruit quality
# Leafroll: Historical Perspective

<table>
<thead>
<tr>
<th>Event</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>First description</td>
<td>1905</td>
</tr>
<tr>
<td>Graft transmission</td>
<td>1935</td>
</tr>
<tr>
<td>Virus recognition</td>
<td>1979</td>
</tr>
<tr>
<td>Vector transmission</td>
<td>1984</td>
</tr>
<tr>
<td>Lab diagnostic assays</td>
<td>1984</td>
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</table>
GRAPEVINE LEAFROLL-ASSOCIATED VIRUSES

- GLRaV-1: Mealybugs & soft scales
- GLRaV-2: No vector known
- GLRaV-3: Mealybugs & soft scales
- GLRaV-4: Mealybugs & soft scales
- GLRaV-7: No vector known
Pinot noir

GLRaV-3

Healthy

Dr. P. Gugerli, RAC, Changins, Switzerland
ECONOMIC ANALYSIS


- Cost impact in absence of response:
  - $9,384/ac (30% yield reduction, no quality penalty)
  - $16,013/ac (50% yield reduction and 10% penalty for poor quality)
OUTLINE

• Grape leafroll disease
• Survey of GLRaV and vectors in the Finger Lakes
• Role of Vectors in spread of grape leafroll
• Managing vectors to slow spread of GLRaV
• Conclusions and future directions
Finger Lakes Survey

- **Grapevine leafroll sampling locations**
- **Soft scale insect and mealy bug sampling locations**
LEAFROLL DISEASE IN FINGER LAKES

- Widespread distribution
  68%, 65 of 95 vineyard blocks surveyed

- High incidence (>20%)
  56%, 46 of 65 vineyard blocks surveyed

- Prevalence
  - GLRaV-3 (15%) >> GLRaV-1 (10%) > GLRaV-2 (3%) ~ mixed (4%)
Grape Mealybug
*Psuedococcus maritimus*

Cottony Maple Scale
*Pulvinaria innumerablilis*

Leucanium scale
*Parthenolecandum corni*
Mealybugs and soft scale wide spread, but at low levels
## Viruliferous Status of Vectors: Mealybugs + Soft Scales

(Fuchs et al. 2009b)

<table>
<thead>
<tr>
<th>N</th>
<th>None</th>
<th>LR1</th>
<th>LR3</th>
<th>LR1+LR3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>99</td>
<td>45</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>Incidence</td>
<td>45%</td>
<td>14%</td>
<td>21%</td>
<td>20%</td>
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</table>
GRAPE MEALYBUG *Pseudococcus maritimus*

<table>
<thead>
<tr>
<th>Month</th>
<th>ADULT</th>
<th>EGG</th>
<th>NYMPH</th>
<th>Overwintering stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>APR</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>MAY</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>JUN</td>
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<tr>
<td>JUL</td>
<td></td>
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<tr>
<td>AUG</td>
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</tr>
<tr>
<td>SEP</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OCT</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Overwintering stage
COTTONY MAPLE SCALE *Pulvinaria innumerabilis* & LEUCANIUM SCALE *Parthenolecanium corni*

<table>
<thead>
<tr>
<th>APR</th>
<th>MAY</th>
<th>JUN</th>
<th>JUL</th>
<th>AUG</th>
<th>SEP</th>
<th>OCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADULT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Overwintering stage</td>
</tr>
<tr>
<td>EGG</td>
<td></td>
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<tr>
<td>NYMPHS</td>
<td></td>
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<td></td>
<td>Overwintering stage</td>
<td></td>
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</tbody>
</table>

Overwintering stage
Grape Mealybug Observations and Phenology

*over-wintering crawlers were found throughout the early spring observations starting with the first observation on 4/29
Cottony Maple Scale Observations and Phenology

*large over-wintering immatures were found throughout the early spring on 2-year old canes
MEALYBUGS FOUND ON GRAPES IN CALIFORNIA

- Grape mealybug
  *Psuedococcus maritimus*

- Obscure mealybug
  *P. viburni*

- Longtailed mealybug
  *P. longispinus*

- Vine mealybug
  *Planococcus ficus*
OUTLINE

• Grape leafroll disease
• Survey of GLRaV and vectors in the Finger Lakes
• **Role of Vectors in spread of grape leafroll**
• Managing vectors to slow spread of GLRaV
• Conclusions and future directions
### Leafroll Virus Survey

<table>
<thead>
<tr>
<th>Site</th>
<th>Cult</th>
<th>GLRaV-1</th>
<th>GLRaV-3</th>
<th>increase</th>
<th>GLRaV-1</th>
<th>GLRaV-3</th>
<th>increase</th>
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<tr>
<td></td>
<td></td>
<td>06</td>
<td>07</td>
<td>08</td>
<td>increase</td>
<td>06</td>
<td>07</td>
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<tr>
<td>A</td>
<td>Cs</td>
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<td>0</td>
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<td>5%</td>
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<tr>
<td></td>
<td>Pn</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>Ch</td>
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<td>50%</td>
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<td>0</td>
</tr>
<tr>
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<tr>
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<td>25%</td>
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<tr>
<td></td>
<td>Cs</td>
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<td>0</td>
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<td>25%</td>
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<tr>
<td>C</td>
<td>Cf</td>
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<tr>
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<tr>
<td>F</td>
<td>Ch</td>
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<td>30%</td>
<td>40%</td>
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<tr>
<td></td>
<td>L</td>
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</tr>
<tr>
<td>G</td>
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<td>33%</td>
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<td>20%</td>
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<tr>
<td>H</td>
<td>L</td>
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<td>30%</td>
<td>50%</td>
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<td>10%</td>
<td>20%</td>
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<td>I</td>
<td>L</td>
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<td>No</td>
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<tr>
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<td>10%</td>
<td>No</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>L</td>
<td>R</td>
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<td>50%</td>
<td>75%</td>
<td>Yes</td>
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</tbody>
</table>
✧ Chardonnay with widespread grape leafroll
✧ Collect grape mealybugs, 23 vines, April – Nov, 2010 & 2011
✧ RT-PCR with appropriate primers
## Occurrence of GLRaV-1 & GLRaV-3 in grape mealybugs over time in Finger Lakes Chardonnay

<table>
<thead>
<tr>
<th>Month</th>
<th>Stage*</th>
<th>N</th>
<th>No Virus</th>
<th>LRI</th>
<th>LR3</th>
<th>LR1+3</th>
<th>Positive/Te (%)</th>
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<tbody>
<tr>
<td>April</td>
<td>Cr</td>
<td>26</td>
<td>6</td>
<td>19</td>
<td>0</td>
<td>1</td>
<td>20/26 77</td>
</tr>
<tr>
<td>May</td>
<td>Im</td>
<td>26</td>
<td>1</td>
<td>0</td>
<td>14</td>
<td>11</td>
<td>25/26 96</td>
</tr>
<tr>
<td>June</td>
<td>Im&amp;Ad</td>
<td>30</td>
<td>5</td>
<td>2</td>
<td>4</td>
<td>19</td>
<td>25/30 83</td>
</tr>
<tr>
<td>July</td>
<td>Cr</td>
<td>34</td>
<td>6</td>
<td>1</td>
<td>6</td>
<td>21</td>
<td>28/34 82</td>
</tr>
<tr>
<td>August</td>
<td>Im&amp;Ad</td>
<td>32</td>
<td>3</td>
<td>3</td>
<td>16</td>
<td>10</td>
<td>29/32 91</td>
</tr>
<tr>
<td>Sept.</td>
<td>Cr</td>
<td>12</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0/12 0</td>
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<tr>
<td>Nov.</td>
<td>Cr</td>
<td>15</td>
<td>14</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1/15 7</td>
</tr>
</tbody>
</table>

*Cr = crawler, Im = immature, Ad = Adult
Greenhouse transmission study, 24 hr acquisition period: 40% infected vines after 3 months
OUTLINE

• Grape leafroll disease
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EXPERIMENTAL PLAN

• Vineyard characteristics
  - moderate GLRaV levels but increasing
  - moderate vector populations

• Treatments (2011 & 2012)
  - Spirotetramat [Movento] (Yes or No)

• Experimental design
  - plot size: 12 vines X 4 rows = 48 vines per replicate
  - six replicates per treatment

• Assessments (2011 & 2012)
  - mealybug counts (August)
  - vine by vine GLRaV assessment with DAS-ELISA
New Vines with GLRaV Infection, Fall 2012

Mean Vines Newly Infected ± SE

Control

Movento

P < 0.02

Insecticide treatment
New Vines with GLRaV Infection, Fall 2013

\[ P = 0.14, NS \]
CONCLUSIONS

1. Movento (systemic) effective in controlling mealybugs

2. Achieved modest decrease of spread of GLRaV

3. Reduction in spread does not persist

4. Movento is slow acting

5. May need fast-acting control of crawlers (especially early-season) + systemic
MANAGEMENT CONSIDERATIONS

• No cure for leafroll-infected vines in a vineyard
• No resistance
• Tolerance
• Planting material from virus-tested, clean stocks
• Approach tailored to the virus(es)/vector(s)
MANAGEMENT CONSIDERATIONS

• Cultural approaches
  – Harvest selectively
  – Adjust crop load
  – Rogue if incidence <25% (± 2 vines)
  – Remove if incidence >25%
  – Sanitation

• Insecticides for managing leafroll?
MANY INSECTICIDES LABELED FOR MEALYBUGS

• **Movento** [spirotetramat]
  - systemic, must apply on green leaf material
  - requires penetrant (e.g. LI 700)
  - very effective, but takes time
  - does not require precise timing of application

• **Assail** [acetamiprid]
  - contact and ingestion (not systemic)
  - medium effectiveness
  - timing important (target crawlers)
INSECTICIDES LABELED FOR MEALYBUGS

- **Danitol** [fenpropathrin]
  - contact insecticide, good residual
  - timing important (target crawlers)
  - medium effectiveness mid-season (mealybugs concealed)

- **Baythroid** [beta-cyfluthrin]
  - contact insecticide, good residual
  - timing important (target crawlers)

- **Leverage** [immidaclonoprid + beta-cyfluthrin]
  - contact plus ingestion, good residual
  - timing important (target crawlers)
INSECTICIDES LABELED FOR MEALYBUGS

- **Lorsban Advanced [chlorpyriphos]**  
  - contact, good residual  
  - timing is prior to late budbreak  
  - target overwintered crawlers  
  - should be effective?

- **Admire Pro [imidacloprid]**  
  - ingestion, some contact, foliar  
  - timing important [target crawlers]

- **Actara [thiamethoxam]**  
  - ingestion, some contact, foliar  
  - timing important [target crawlers]
INSECTICIDES LABELED FOR MEALYBUGS

- Platinum [thiamethoxam]
  - ingestion, some contact, systemic through drip
  - timing probably less important [targets feeding stages]

- Dormant oil
  - contact activity, little residual
  - timing is prior to late budbreak
  - marginal effectiveness, may work better on soft scale
SUMMARY

• Disease & vectors wide-spread in Finger Lakes
• Vectors at low densities
• Vectors infected with GLRa Viruses
• Vectors contribute to within vineyard spread in minority of vineyards
• Few crawlers in fall become viruliferous
• Infection of overwintered crawlers occurred, high rates by budbreak
• Spread by overwintered crawlers may be high
SUMMARY

• Systemic insecticide may reduce spread

• Contact insecticide, with good residual, prior to budbreak, may reduce spread

• Combining rogueing with insecticides?

• Use of virus tested, clean planting material most critical
Acknowledgements

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Steve Hesler, Pat Marsella-Herrick, Bill Wilsey, Rosemary Cox, Yen Mei Cheung

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Collaborators
Marc Fuchs, Tim Martinson, Harvey Hoch, Miguel Gomez

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NY Wine & Grape Foundation
USDA Viticultural Consortium
NYSDAM Specialty Crop Block Gran Kaplan
European fruit leucanium Observations and Phenology

- Red line: Aurora Accum. DD (base 50; Jan 1)
- Blue line: On Site Accum. DD (base 50; May 1)

*Large over-wintering immatures were found throughout the early spring on 2-year old canes.

**Graph details:**
- x-axis: Date
- y-axis: Accumulated DD (base 50)
- Key dates:
  - 5/22/09: 1st eggs observed (271 DD)
  - 6/12/09: 1st Generation Crawlers (593 DD)

**Image inset:**
- Close-up image of fruit leucanium on a branch.
Life-history notes:
- Competent vector of GLRaV
- Invasive to many regions, but not in eastern US
- Adapted to warmer climates
- Multiple generations
- Will feed on roots
# DISTINGUISHING GRAPE AND VINE MEALYBUGS

## Table I: Distinguishing characteristics of grape, obscure and vine mealybugs.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Grape <em>Pseudococcus maritimus</em></th>
<th>Obscure <em>Pseudococcus viburni</em></th>
<th>Vine <em>Planococcus ficus</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Body shape</td>
<td>Rectangular</td>
<td>Rectangular</td>
<td>Oval</td>
</tr>
<tr>
<td>Filaments surrounding body</td>
<td>Thin, non-uniform</td>
<td>Thin, non-uniform</td>
<td>Thick, uniform</td>
</tr>
<tr>
<td>Filaments posterior end</td>
<td>Thin, long</td>
<td>Thin, long</td>
<td>Thick, short</td>
</tr>
<tr>
<td>Defensive fluid</td>
<td>Reddish, orange</td>
<td>Clear</td>
<td>Clear</td>
</tr>
<tr>
<td>Diapause (dormant period)</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Generations</td>
<td>2</td>
<td>2 to 3</td>
<td>4 to 7</td>
</tr>
<tr>
<td>Synchronized generations?</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Stages overlap throughout year?</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Overwinters under the bark primarily in:</td>
<td>Upper trunk, cordons, spurs</td>
<td>Trunk, cordons, spurs</td>
<td>Graft union, pruning wounds on trunk, base of spurs. (roots in light soils)</td>
</tr>
<tr>
<td>In summer lays eggs</td>
<td>Under bark on old wood, bunches</td>
<td>Under bark on old wood, bunches</td>
<td>Under bark on old wood, bunches, throughout the canopy above the fruit zone</td>
</tr>
<tr>
<td>Honeydew production</td>
<td>Moderate</td>
<td>Moderate to high</td>
<td>High</td>
</tr>
</tbody>
</table>

From L. Varela, R. Smith, M. Battany, and W. Bentley (2006) *Practical Winery & Vineyard Magazine*