Grapevine Leafroll Disease: Management Strategies

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Rodrigo P.P. Almeida & Kent M. Daane
Worldwide, leafroll disease is most significant grapevine viral disease

Spread documented by Golino & Weber (*California Agriculture*, 2008)
The pathogens: grapevine leafroll-associated viruses

GLRaV-1
GLRaV-2
GLRaV-3
GLRaV-4
GLRaV-5
GLRaV-6
GLRaV-7
GLRaV-9
GLRaV-10
GLRaV-11
The pathogens: Grapevine leafroll-associated viruses

The map shows the distribution of GLRaV-1, GLRaV-2, GLRaV-3, GLRaV-4, GLRaV-5, and GLRaV-9 across different regions of California. Pie charts are used to represent the proportion of vineyard blocks sampled per region. The map indicates that 5-10 vineyard blocks were sampled per region.
Species level breakdown reveals GLRaV-3 is the dominant species spreading in Napa Valley.

- Of the 216 plants tested, 75% were positive for one of the GLRaVs.
- 12% Mixed – remaining GLRaVs all occur in mixed infections with 3.
Diversity within GLRaV-3: variant level breakdown (n=468)
What is the significance of diversity within GLRaV-3? Might not be any biological significance-TBD; Primers target specific regions of virus RNA for detection; GLRaV-3e, -3f were not detectable with currently available primer sets
The vectors: vineyard mealybugs
Which mealybug species do you have?

Grape mealybug (native to North America)

Obscure mealybug (South America)

Long-tailed mealybug (Australia)

Vine mealybug (Mediterranean)

Gill’s mealybug (native – southeastern US)
GLRaV-1 Vector in California
European fruit lecanium scale
Is phylloxera a potential vector?
Related to aphids, have piercing-sucking mouthparts
Glasshouse and Field surveys
Conclusion: phylloxera can acquire GLRaV, but do not transmit to new plant
Mealybugs are the vector of concern

Vine mealybug (Mediterranean)

Gill’s mealybug (native – southeastern US)

Grape mealybug (native to North America)

Obscure mealybug (South America)

Long-tailed mealybug (Australia)
No specificity is evident in GLRaV transmission
Key transmission information:

**Acquisition:** 1 hr *(max efficiency at 24 h.)*

**Inoculation:** 1 hr *(max efficiency at 24 h.)*

Tsai, Almeida et al. *Phytopath.* 2008
Key transmission information:

Mealybug lost infectivity 4 d after acquisition (when transferred to non-host of LR-3)

Tsai, Almeida et al. Phytopath. (2008)
Sforza et al.
1st instar mealybugs were more efficient vectors of GLRaV-3 than adults.

<table>
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<th></th>
<th>1st instar</th>
<th>Adult</th>
<th>p</th>
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<td>16/25</td>
<td>0/25</td>
<td>&lt;0.01</td>
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<tr>
<td>LR109</td>
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What are the critical management strategies?
1. Plant material: Get it tested to know what is planted (source of inoculum)
1. Plant material: Know what you are planting (rootstock and scion) and plant certified material.
2. Know your vector and its life cycle

Grape mealybug (native to North America)

Obscure mealybug (South America)

Long-tailed mealybug (Australia)

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Vector life cycle: When are crawlers (dispersal stage) present in the vineyard?

- Lecanium scale
- Cottony vine scale
- Grape mealybug
- Obscure mealybug
- Vine mealybug

The life cycle graph shows the presence of crawlers for each species over the months from January to January. For example, Lecanium scale is present from April to June, while Obscure mealybug is present from May to October.
Vector life cycle: How many mealybug generations per year?

VMB has more generations per year & more eggs per female

Daane, Walton, Daugherty, submitted J Econ Entomol, based on temperature cabinet studies, field validation in some areas.
3. Work strategically: proximity can be a factor

Source block  →  Clean block

Plant certified material
3. Work strategically: proximity can be a factor
4. Work strategically: remove (minimize) inoculum
Minimize source of inoculum: Rogue or pull block

Keep disease from establishing: Rogue symptomatic vines

Plant certified material
Why is it important to maintain low disease incidence?
Logistic growth model—keep disease incidence low

slow growth

Moderate to rapid growth

slow growth
2009: 8.1% GMB, 44.6% GLD; 2010: 19% GMB, 43.2% LRD

2009: 1.6% GMB, 10% GLD; 2010: 6.8% GMB, 10.2% LRD

2009: 0% GMB, 0.1% GLD; 2010: 0.2% GMB, 2.2% GLD
Movement of GLRaV from a point infestation

MB movement
Source block

Minimize source of inoculum

Minimize the number of infective MB leaving the block

Clean block

Keep disease from establishing

Kill incoming infective MB “immediately” (life history)
Spray Volume: 100 GPA; Air-blast Sprayer; label rate (Applaud 12 oz per ac)
Clutch & Movento on 21 June 2011, Applaud & Assail on 7 July 2011
Planococcus ficus, Lodi-Woodbridge wine grapes, Lodi, CA
Source block

Minimize the number of infective MB leaving the block

Clean block

Kill incoming infective MB “immediately” (life history)

Consider “kill” time for insecticides

Longer kill times acceptable:
Systemic and IGR for VMB: MD and NE

Short kill times desirable at peak dispersal times:
Contact insecticides
Mating Disruption & Bio-Control for VMB, Cumulative effect of Annual Applications:

↓ incidence
↓ severity

Daane et al., unpublished data
Can we kill roots?

**Methods:**
- EZ Ject
- Hack (Ax) & Squirt
- Cut (chainsaw) & Paint
- Drill & Inject

**Timing:**
- Post-harvest

**Chemicals:**
- Glyphosate
- Triclopyr

Daane, Roncoroni, Cooper 2009-2010
4. Work strategically: remove (minimize) inoculum

Live roots harbor pathogens ...and pests.

(30% of samples positive for LR)
Can we kill roots?

Hack & Squirt

Drill & Fill
Can we kill roots?

1b) "22" inject roundup

Cut & Paint
Rated live or dead
Sampled for GLRaV

Treated:
Oct 26, 2009

Sampled:
July 6-8, 2010

0-20 cm
20-40 cm
40-60 cm
60-80 cm
80-100 cm
100-125 cm
125-150 cm
Can we kill roots? Not very well, yet...

<table>
<thead>
<tr>
<th>Treatment</th>
<th>% Live</th>
<th>% Dead</th>
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<tr>
<td>CP Gly</td>
<td>99.3</td>
<td>0.7</td>
</tr>
<tr>
<td>CP Tri</td>
<td>93</td>
<td>7</td>
</tr>
<tr>
<td>CP Water</td>
<td>99.3</td>
<td>0.7</td>
</tr>
<tr>
<td>DI Gly</td>
<td>87.3</td>
<td>12.7</td>
</tr>
<tr>
<td>EZ Gly</td>
<td>89</td>
<td>11</td>
</tr>
<tr>
<td>HS Gly</td>
<td>84</td>
<td>16</td>
</tr>
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CP = Cut & Paint
DI = Drill & Inject
EZ = EZ Ject
HS = Hack & Squirt
Gly = glyphosate
Tri = triclopyr
LR 3 detected at all depths

Daane, Roncoroni, Cooper 2009-2010
Virus, vector, host, environment: Critical management strategies and conclusions

Mealybugs are the host of concern, and LR-3 is the species of concern in most regions

Know your plant material (rootstock and scion)—plant certified

Know your mealybugs and their life cycle—when are transmission events likely to occur?

Identify sources of inoculum—proximity can be a factor

Minimize disease incidence by roguing plants and/or pulling blocks

Treat “source” blocks differently from “clean” blocks:
  - minimize infective vectors in and leaving the source block (insecticides, MD, natural enemies)
  - kill infective vectors quickly upon entering clean block

Continue to support research and extension projects—thank you for your continued support—this work would not be possible without it.
An invasive mealybug pest and an emerging viral disease: a dangerous mix for West coast vineyards

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