Mealybug and Spider Mite Control in Vineyards

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Grape Mealybug
_Pseudococcus martitimus_

To date the only mealybug found feeding on grape vines in WA
Pheromone monitoring

• Dr. Jocelyn Millar has synthesized the sex pheromones for obscure, long-tailed, vine, and grape mealybug.

• All 3 species are present in California vineyards.

• Pheromones are species specific.

• First deployed in WA in 2009.
Pheromone monitoring

- You only need one trap per 30 acres of vineyard to get an accurate snapshot of what the mealybug population is doing at any given time of the year.

- No economic benefit to placing more than one per 30 acre block.
CHEMIGATION

About as convenient a way to deliver an insecticide as possible.

DINOTEFURAN- Venom™ (very water soluble)

THIAMETHOXAM- Platinum™ Intermediate solubility

IMIDACLOPRID- Admire™ among many other generics  Not especially water soluble

Thiamethoxam and dinotefuron have provided superior control compared to imidaclorpid under deficient irrigation conditions
Broadcast mealybug sprays

**SPIROTETRAMAT Movento™**  
**FLUPYRIDIFURON Sivanto Prime™**

**ACETAMIPRID Assail™**  
**DINOTEFURAN Venom™**  
**THIAMETHOXAM Actara™**  
**CLOTHIANIDIN Clutch™**  
All 4 are effective neonicotinyl sprays

**IMIDACLOPRID** as a foliar spray  
Has never worked very well in my trials

**BUPROFEZIN Applaud™**  
Time against early instar crawlers

**CHLORPYRIFOS Lorsban™** *(probably gone soon)*
• Acts as an inhibitor of lipid biosynthesis and affects juvenile stages with additional effects on adult fecundity.

• After foliar application spirotetramat penetrates through the leaf cuticle and is translocated as spirotetramat-enol via xylem and phloem, up to growing shoots and down to roots.

• This two-way systemicity (phloem and xylem transport) ensures the control of hidden and soil living sucking pests after foliar application and protects new shoots and roots.
Implications for Viral Transmission

• Targeting insect vectors is still integral to most virus management programs.

• Regulatory policy decisions have required insecticides to be “softer” and more targeted towards the pest with greater emphasis on non-target effects.

• Many of the “new” insecticides require ingestion and metabolism of the compound for toxicity.

• Can these softer insecticides kill the insect vector soon enough to prevent virus transmission?

• 1 chemigation plus 1 (if needed) foliar spray ought to be enough to control mealybugs.
Spider mite control and resistance studies
Mites

- Two main groups attack crops and may become pests:
  - Spider mites (Tetranychidae)
  - Bud or Rust mites (Eriophyidae)

- One group preys on pest mites:
  - Predatory mites (Phytoseiidae)
Spider mites commonly found in wine grapes
-Washington State

High populations of spider mites are an important production constraint in grape cultivation, apart from diseases and other insects.
Spider mite infestation

• Considered a secondary pest
• Tend to be more serious in hot and dry years
• Cultivation practices, dust, and pesticides may cause high populations to build
• Imidacloprid applications are occasionally associated with spider mite outbreaks
  • Hi levels of infestation can cause damage and impact economic yield
Mite biology also influences pest status

1. Rapid development: Life cycle completes in as little as 7-8 days in the summer

2. Female mites produce up to 150 eggs in her lifetime

3. Lay unfertilized eggs (haploid males)

4. Overwinter as fertilized females
Spider mite detection

- Because of their small size (~0.5 mm), difficult to see
  - Look under leaves, use hand lens (10X), or naked eye
Eggs

Larva
Spider mite detection

• Because of their small size (~0.5 mm), difficult to see
  • Look under leaves, use hand lens (10X), or naked eye
  • Leaf sampling and collection, examine under microscope
• Or...look for signs and symptoms
  • Webbing or cast skins
Cast Skins
Nature of damage

• Specialized piercing-sucking mouthparts

• Puncture leaf tissue and feed off of cell contents
Feeding damage

Severe infestation of spider mites results in delay in maturing, ripening of grapes, and reduction in sugar content thereby affecting the quality.
Management

- Biological control: beneficial arthropods, predatory mites

- Cultural control: dust control, floor vegetation

- Chemical control: Acramite and Envidor are preferred miticides in grapes
Problem with chemical control:

- Mites develop resistance after acaricide exposure

- Two-spotted spider mite is the most resistant pest in the world

- Further understanding of mite resistance and toxicity could improve management strategies
Objectives

1. Evaluate the resistance of spider mites in WA vineyards and hopyards to commonly used acaricides (Abamectin and Bifenazate)

2. Develop acaricide-resistant strains through artificial selection
2013 Sampling

Sampled four vineyards for spider mites in August 2013
Performed bioassay to evaluate response to Acramite 50 WS (bifenazate)

13 hopyards were sampled and evaluated with Acramite (bifenazate) and Epi-mek (abamectin)
Leaf disc bioassay

- Ten adult female mites transferred to each leaf disc
- Sprayed topically with 2ml of acaricide solution in the potter tower
- Mortality evaluated after 24 hours
Concentration-response data of susceptible and field populations

- Measures toxicity:
  - can determine % mortality, LC$_{50}$ values, and resistance ratios (RR) = LC$_{50}$ field population/LC$_{50}$ susceptible strain

- Analyzed with Probit regression Polo Plus

**Graphs:**

- **Bifenazate**
  - Proportion Dead vs. Dose (mg a.i./L)

- **Abamectin**
  - Proportion Dead vs. Dose (mg a.i./L)
Concentration-response data of susceptible and field populations

- Measures toxicity:
  - can determine % mortality, LC$_{50}$ values, and resistance ratios (RR) = LC$_{50}$ field population/LC$_{50}$ susceptible strain

- Analyzed with Probit regression Polo Plus
2013 *T. urticae* hopyard populations to bifenazate

<table>
<thead>
<tr>
<th>Population</th>
<th>% Mortality at 224 mg a.i./L</th>
<th>LC$_{50}$ (mg a.i./L) (95% CI)</th>
<th>RR-LC$_{50}$</th>
<th>Slope±SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prosser 1</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Prosser 2</td>
<td>85</td>
<td>55.80 (30.4-85.40)</td>
<td>68.04</td>
<td>1.583±0.220</td>
</tr>
<tr>
<td>Prosser 3</td>
<td>88</td>
<td>25.486 (3.87-66.98)</td>
<td>31.08</td>
<td>1.503±0.211</td>
</tr>
<tr>
<td>Prosser 4</td>
<td>90</td>
<td>6.867 (1.36-13.66)</td>
<td>8.37</td>
<td>1.581±0.420</td>
</tr>
<tr>
<td>Prosser 5</td>
<td>95</td>
<td>9.314 (3.913-15.69)</td>
<td>11.39</td>
<td>1.298±0.238</td>
</tr>
<tr>
<td>Mabton 1</td>
<td>96</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Granger 1</td>
<td>82</td>
<td>47.859 (11.39 –138.08)</td>
<td>58.29</td>
<td>1.723±0.219</td>
</tr>
<tr>
<td>Granger 2*</td>
<td>100</td>
<td>3.929 (0.343-7.113)</td>
<td>4.79</td>
<td>1.891±0.642</td>
</tr>
<tr>
<td>Granger 3</td>
<td>76</td>
<td>78.967 (55.99 –107.5)</td>
<td>96.30</td>
<td>1.707±0.191</td>
</tr>
<tr>
<td>Granger 4</td>
<td>75</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Granger 5</td>
<td>92.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Moxee 1</td>
<td>90</td>
<td>18.882 (9.714 – 30.14)</td>
<td>23.02</td>
<td>1.379±0.224</td>
</tr>
</tbody>
</table>

*Susceptible strain LC50= 0.820
## 2013 Vineyard Populations

<table>
<thead>
<tr>
<th>Vineyard Population</th>
<th>Mite Species</th>
<th>Acaricide used in bioassay</th>
<th>Mortality Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population 1</td>
<td><em>Eotetranychus sp.</em></td>
<td>Bifenazate</td>
<td>n/a</td>
</tr>
<tr>
<td>Population 2</td>
<td>McDaniel mite</td>
<td>Bifenazate @224 mg a.i./L</td>
<td>@224 mg a.i./L 95% mortality</td>
</tr>
<tr>
<td>Population 3</td>
<td>McDaniel mite</td>
<td>Bifenazate @ 224 mg a.i./L</td>
<td>@ 224 mg a.i./L 98% mortality</td>
</tr>
<tr>
<td>Population 4</td>
<td>Two-spotted spider mite</td>
<td>Bifenazate</td>
<td>n/a</td>
</tr>
</tbody>
</table>

*Susceptible strain 100% mortality @ 224 ppm
All populations were untreated
224 mg a.i./L is equivalent to ¼ the field rate of Acramite 50WS (1.5lb/A, 100 gal/A)
Summary

- Grapes:
  - *T. urticae* develop tolerance in presence of a selection pressure to bifenazate
  - High tolerances in spider mites on grapes have not been detected, but has the capability to increase
Conclusions

• To manage mite (and/or insect) pests, monitor your grapes frequently

• If early detection of mites, usually have time to react using control tactics

• Knowledge of what is present will lead to better management strategies
Spissistilus fesitnus as a vector of grapevine red blotch-associated virus

Brian Bahder
Frank Zalom
Maya Jayanth
Mysore (Sudhi) Sudarshana
Background of GRBaV

• 2008: Leafroll-like symptoms didn’t fit exactly, investigations began
• 2011-2013: Novel virus discovered and genome sequenced independently at Cornell and UC Davis
• 2014: Data demonstrates spread occurring in CA vineyard
• 2014 – 2015: Vector investigated
Grapevine Red Blotch-associated Virus (GRBaV)

- Genome: circular, ssDNA
- Belongs to the Geminiviridae
- Causal agent of grapevine red blotch disease (GRBD)
Distribution and Spread

- Widespread in North America, present in all major grape growing regions
- Spreading rapidly in CA 2011-2016
Transmission Assays

<table>
<thead>
<tr>
<th>Species</th>
<th>9-month post-inoculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erythroneura elegantula</td>
<td>0/15</td>
</tr>
<tr>
<td>E. variabilis</td>
<td>0/15</td>
</tr>
<tr>
<td>E. ziczac</td>
<td>0/15</td>
</tr>
<tr>
<td>Spissistilus festinus</td>
<td>14/30</td>
</tr>
<tr>
<td>Bactericerca cockerelli</td>
<td>0/10</td>
</tr>
<tr>
<td>Scaphytopius acutus</td>
<td>0/20</td>
</tr>
<tr>
<td>Melanolarius sp.</td>
<td>0/5</td>
</tr>
<tr>
<td>Delphacidae</td>
<td>0/10</td>
</tr>
</tbody>
</table>
**Spissistilus festinus** as a Vector

- Native species to North America
  - Present in the southern United States and California
  - No state records in WA
  - In OR present in the Rogue River Valley. Not Present in the Willamette Valley

- Historically a minor pest in grapes
- Research is ongoing to understand the biology of this species in CA to aid in management strategies
Alternate hosts:

• *Vitis californica*, with common names California wild grape, Northern California grape, and Pacific grape, is a wild grape species widespread across much of California as well as southwestern Oregon.

• Brian found GRBaV in *V. californica* in the foothills in and around Sonoma and Napa Valleys.

Ironically this is a photo from a commercial ornamental nursery in California. These plants are for sale. 5 gal pot is $26.99 1 gal pot is $8.99
**Vitis riparia**

- There are reports of isolated populations in the northwestern USA, but these are probably naturalized

**Vitis labrusca**

*aka* Concorde

- Virologists in New York are presently determining the status of GRBaV in Concorde---

- Stay tuned
• Unfortunately scientists in fall 2016 have observed substantial spread of GRBaV in the Willamette Valley in the absence of *S. festinus* (Threecornered alfalfa treehopper).
Pending proposals submitted by Walsh

- Conduct a qualitative survey of Washington State vineyards for potential insect vectors of grape vine red blotch disease (GRBaV).
- Submitted to the WSCPR for $8,190.
- To be submitted to Wine Advisory Committee for $12,279
- An SCRI proposal led by UC Davis is submitting a pre-proposal. If this is successful funding will kick in on October 1, 2017

Walsh objectives for 2017:

*Conduct a comprehensive survey of insects that might serve as potential vectors for GRBaV with a specific emphasis on insects in the Membracidae as well as insects in closely related families.*

*Concurrently we will look for alternative host plants.*
Brown Marmorated Stink Bug

• Established about everywhere in Washington at this point.

• An egg parasitoid *Trissolcus japonicas* has been discovered in WA.

• Efforts are underway to upscale rearing of *T. japonicas* by Elizabeth Beers group at WSU. There are similar efforts in OR.

• Release sites considered include Walla Walla and West Richland. These are sites where we’ve observed the greatest abundance of BMSB.
Any Questions?