Thanks to:

• Amador Wine Grape Growers Association
• Betsy Tsumbas, Beth Rosenthal, Pat Rohan
• Amador Fairgrounds
• Donating Wineries
• All of our speakers
• Robin Cleveland ✭

Packets: Please fill out the gold comment postcard and return to me!!

EGVM posters available to post in your farmshed.
What’s happening with the WEATHER?
National Weather Service “daily observer” site near Camino
May 15, 2011

Max: 56°
Min: 32°
Observ: 35°
3.5 in. snow
Average Max Air Temp, Average Min Air Temp, Average Air Temp (all °F) and Total Precipitation (in.) for the month of May 1990-2011.

*Camino CIMIS station data.*
Comparison of foothill CIMIS stations, Diamond Springs (DS), Plymouth (PLY) and Camino (CA): Monthly average max, min, and average air temperature and total precipitation, Nov 2010-May 2011.
Comparison of CIMIS stations: Diamond Springs, Plymouth and Camino, Precip. Nov 2010-present

<table>
<thead>
<tr>
<th>Month</th>
<th>Diamond Springs precip</th>
<th>Plymouth precip</th>
<th>Camino precip</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov-10</td>
<td>3.76</td>
<td>2.15</td>
<td>6.02</td>
</tr>
<tr>
<td>Dec-10</td>
<td>7.99</td>
<td>0.32</td>
<td>13.94</td>
</tr>
<tr>
<td>Jan-11</td>
<td>2.26</td>
<td>1.39</td>
<td>2.6</td>
</tr>
<tr>
<td>Feb-11</td>
<td>4.04</td>
<td>2.22</td>
<td>5.47</td>
</tr>
<tr>
<td>Mar-11</td>
<td>11.58</td>
<td>3.17</td>
<td>15.24</td>
</tr>
<tr>
<td>Apr-11</td>
<td>0.69</td>
<td>0.43</td>
<td>1.65</td>
</tr>
<tr>
<td>May-11</td>
<td>2.66</td>
<td>1.16</td>
<td>3.35</td>
</tr>
<tr>
<td>sum</td>
<td>32.98</td>
<td>10.84</td>
<td>48.27</td>
</tr>
</tbody>
</table>
UCCE Foothill Grape Research Project Summary

Recurrent theme: What’s causing the “Red Leaf” phenomenon? Increasing our knowledge over time

- Nutritional deficiencies: can we mitigate symptoms and show petiole uptake with fertilizing?
  - Understanding foothill soils and potential for nutrient management recommendations based on soil type

- Leafroll virus: which species are present here?
  - Mealybugs and other potential leafroll vectors Phylloxera?
  - Gill’s mealybug biology and management

New collaboration: Pierce’s Disease cold curing study
Case study: What’s causing the red leaf? (nutritional deficiency or leafroll virus or?)
Background: Grapevine leafroll associated virus (GLRaV)

- Transmitted by planting or grafting infected material and by mealybugs or scale (vector-lr species specific).
- Symptoms appear in fall as “red leaf”; reduced yield, poor color, and sometimes trouble with Brix, ripening.
- Currently 9 distinct virus species GLRaV-1 to GLRaV-9
- Detection methods continue to improve-vary in accuracy to pick up virus.
Leafroll and other viruses can cause “red leaf” symptoms

What symptoms you see depends on:

- Time of year
- Rootstock, scion and the interaction
- Stress of the vine (drought conditions, other pest issues, etc.)
  - “worse some years than others”
- Nutritional status.
- Viruses are unevenly distributed
  - In the vine
  - In the vineyard
- Some viruses can be present but asymptomatic
- Not much known about a lot of other viruses—over 50 viruses known in grape.
Nutrient deficiencies can look similar and confuse the picture

Potassium deficiency
Cab Franc
Pete Christensen

Boron deficiency

Phosphorous deficiency Cab. Sauvignon P. Christensen
Case study: What’s causing the red leaf?
(nutritional deficiency or leafroll virus or?)
“Red Leaf” case study

- Located in SE El Dorado County
- Boomer-Sites soils series - tend to be P deficient
- Two blocks, Primitivo on St. George and Barbera on 1103P, St. George, 110R
- Planted in 2002, “Red leaf” showing up beginning in 2007 across both varieties
- Several Barbera clones, some certified scions; rootstocks not certified
- Petiole history inconsistent
- LR virus tested by Golino lab using PCR (Oct. 2009): 3 samples, one + for GLRaV-5

<table>
<thead>
<tr>
<th>Date sampled</th>
<th>Variety</th>
<th>Total % P</th>
<th>Total % K</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/28/2009</td>
<td>Barbera</td>
<td>0.54</td>
<td>3.13</td>
</tr>
<tr>
<td>5/27/2008</td>
<td>Barbera</td>
<td>0.34</td>
<td>1.86</td>
</tr>
<tr>
<td>6/11/2006</td>
<td>Barbera</td>
<td>0.39</td>
<td>1.44</td>
</tr>
<tr>
<td>5/28/2009</td>
<td>Primitivo</td>
<td>0.76</td>
<td>4.4</td>
</tr>
<tr>
<td>5/27/2008</td>
<td>Primitivo</td>
<td>0.21</td>
<td>1.1</td>
</tr>
<tr>
<td>6/11/2006</td>
<td>Primitivo</td>
<td>0.18</td>
<td>1.07</td>
</tr>
</tbody>
</table>

Christensen threshold for P is 0.15-0.20 (DellaValle 0.2-0.5)

For K is 1.5 (DellaValle 2-3)
Barbera positive for GLRaV-5

Negative Barbera

Negative Primitivo
**P & K fertilizer trial: Can we mitigate red leaf and/or see uptake in petioles?**

5 replicates, 9 vines/plot, sampled middle Babera and Primitivo

**Treatments:**
- Untreated
- 0.15 lb actual P per vine (1/3 lb P per vine 0-45-0)
- 1.25 lb actual K per vine (2.5 lb of 0-0-50 KS04)
- 0.15 lb P + 1.25 lb. K
- 2.5 lb. K
- 0.15 lb P + 2.5 lb. K

<table>
<thead>
<tr>
<th>Clone</th>
<th>Rootstock</th>
</tr>
</thead>
<tbody>
<tr>
<td>02</td>
<td>St. George - bare root from Sonoma Grapevine</td>
</tr>
<tr>
<td>110R</td>
<td></td>
</tr>
</tbody>
</table>

**Block III: Fertilization trial**

<table>
<thead>
<tr>
<th>Clone</th>
<th>Rootstock</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>+</td>
<td>Untreated</td>
</tr>
<tr>
<td>+</td>
<td>+</td>
<td>1/3 lb. P per vine 0-45-0</td>
</tr>
<tr>
<td>+</td>
<td>+</td>
<td>2.5 lbs. KS04 per vine</td>
</tr>
<tr>
<td>+</td>
<td>+</td>
<td>1/3 lb. P + 2.5 lbs. KS04 per vine</td>
</tr>
<tr>
<td>+</td>
<td>+</td>
<td>5 lbs. KS04 per vine</td>
</tr>
</tbody>
</table>

**Sampled for l.r. 10/15/09, came back negative**

**Row 27 valve station. Did not receive 0-50-30 on 10/8/09. Blocks 1 and 2 did.**
Fertilizer results

Petiole sampling is a valuable tool:

P uptake demonstrated in both trials.

K higher in all treatments; rootstock effect.

**Thank you to DellaValle Lab**

Christensen threshold for P is 0.15-0.20 (DellaValle 0.2-0.5)

For K is 1.5 (DellaValle 2-3)

<table>
<thead>
<tr>
<th>Description</th>
<th>Treatment</th>
<th>P</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampled 6/14/2010</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barbera 1 Pet</td>
<td>Untreated</td>
<td>0.41</td>
<td>3.66</td>
</tr>
<tr>
<td>Barbera 2 Pet</td>
<td>0.15 lb P</td>
<td>0.64</td>
<td>3.92</td>
</tr>
<tr>
<td>Barbera 3 Pet</td>
<td>1.25 lb K</td>
<td>0.44</td>
<td>3.92</td>
</tr>
<tr>
<td>Barbera 4 Pet</td>
<td>0.15 lb P+ 1.25 lb K</td>
<td>0.63</td>
<td>3.89</td>
</tr>
<tr>
<td>Barbera 5 Pet</td>
<td>2.5 lb K</td>
<td>0.48</td>
<td>3.83</td>
</tr>
<tr>
<td>Barbera 6 Pet</td>
<td>0.15 lb P + 2.5 lb K</td>
<td>0.59</td>
<td>3.98</td>
</tr>
<tr>
<td>Primitivo 1 Pet</td>
<td>Untreated</td>
<td>0.54</td>
<td>1.63</td>
</tr>
<tr>
<td>Primitivo 2 Pet</td>
<td>0.15 lb P</td>
<td>0.73</td>
<td>1.71</td>
</tr>
<tr>
<td>Primitivo 3 Pet</td>
<td>1.25 lb K</td>
<td>0.52</td>
<td>2.43</td>
</tr>
<tr>
<td>Primitivo 4 Pet</td>
<td>0.15 lb P+ 1.25 lb K</td>
<td>0.66</td>
<td>2.01</td>
</tr>
<tr>
<td>Primitivo 5 Pet</td>
<td>2.5 lb K</td>
<td>0.44</td>
<td>1.87</td>
</tr>
<tr>
<td>Primitivo 6 Pet</td>
<td>0.15 lb P + 2.5 lb K</td>
<td>0.58</td>
<td>1.67</td>
</tr>
</tbody>
</table>

Barbera on 1103P, Primitivo is on St. George

1103P tends to increase P uptake in literature

St George tends to increase K uptake in literature
Grapevine Leafroll Associated Virus Studies
Recall 2008: Local “red leaf” investigation with Amador growers

- 12 blocks: various symptoms; scion/rootstock combinations; fertilizer practices.

- Complaints: won’t ripen, can’t get sugar levels up, “chocolate to burnt” leaf color symptoms; turns red after verasion.

- Sampled for virus panel 9/24/08 and sent to Golino lab

- Goal: to identify which viruses are present in the region.

Sue Sim, FPS
2008 virus testing results (PCR method)

Leafroll virus testing results:
- Several samples + for
  - GLRaV-2, graft transmissible. (not mealybug vectored)
- A few samples + for
  - GLRaV-3, which is graft and mealybug transmitted.

Other virus testing results:
- Several samples + for
  - GVB.
- A couple samples + for
  - GVD, gives red leaf symptoms.
- Several samples + for
  - GFkV. (mealybug transmitted?? Symptoms in V. rupestris; otherwise not economically important…we think)
- Several samples + for
  - RSPaV (common; not economically important?)

Almost all samples that were positive for one virus also were positive for at least one other virus.
2008 conclusions:
What does this all mean?

• Viruses in grapevines are *really common*.
• Our knowledge is relatively “young”-only researched for 20-30 years and detection is improving.
• We do not know much about other vectors (i.e. Phylloxera?)

• Use CERTIFIED WOOD if you can.

• Do not top work graft onto rootstock that had a scion that showed virus symptoms. Rootstock  Scion

• If field selected, visit the field the fall before and flag vines without symptoms to take budwood from.

• Remember you still may see symptoms if you use a different rootstock, or if your cultural conditions are different (i.e. leafroll doesn’t show symptoms on own rooted).
2010 Collaborating Projects:
Investigating Grapevine Leafroll Associated Virus (GLRaV) Genetic Diversity and Distribution
Rodrigo Almeida, Monti Sharma, Breanna Baraff, Kent Daane, John Hutchinson (UC Berkeley)
Research questions: What species of *Grapevine leafroll-associated virus* are present in Amador, El Dorado, San Luis Obispo, and Lodi California?

Hypothesis: *Grapevine leafroll-associated virus*-3 is the most prevalent species of the virus in California.
Methods

- **COLLECT SAMPLES**
- **RNA EXTRACTION**
- **RT PCR**
- **FRAGMENT ANALYSIS - SPECIES LEVEL SURVEY**
- **SEQUENCING STRAIN LEVEL SURVEY** - allows for previously unknown strains to be discovered

*Reverse Transcriptase Polymerase Chain Reaction*

Amplifies the RNA so that small quantities can be detected. Fluorescent dye used to detect virus RNA.
### Samples Collected Fall 2010

**Varieties sampled:**
- Barbera
- Cabernet Franc
- Gamay
- Merlot
- Petite Sirah
- Pinot Noir
- Primitivo
- Zinfandel

<table>
<thead>
<tr>
<th>Site</th>
<th>Number of Vineyards</th>
<th>Total Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Luis Obispo</td>
<td>5</td>
<td>149</td>
</tr>
<tr>
<td>Lodi</td>
<td>8</td>
<td>167</td>
</tr>
<tr>
<td>Amador &amp; El Dorado</td>
<td>12</td>
<td>232</td>
</tr>
<tr>
<td></td>
<td>(4 in Amador, 8 in El Dorado)</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>548</strong></td>
</tr>
</tbody>
</table>

Samples NOT random; collected from suspect sites with symptoms.
2010 RESULTS:
ALMEIDA LAB
% Positive Sites

- Amador & El Dorado: 60%
- Lodi: 60%
- San Luis Obispo: 40%
Species of GLRaV

<table>
<thead>
<tr>
<th>Location</th>
<th>GLRaV-1</th>
<th>GLRaV-2</th>
<th>GLRaV-3</th>
<th>GLRaV-5</th>
<th>GLRaV-7</th>
<th>GLRaV-9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amador &amp; El Dorado</td>
<td></td>
<td>35%</td>
<td>25%</td>
<td>10%</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>Lodi</td>
<td>10%</td>
<td></td>
<td>30%</td>
<td>5%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>San Luis Obispo</td>
<td></td>
<td></td>
<td></td>
<td>0%</td>
<td>5%</td>
<td>0%</td>
</tr>
</tbody>
</table>
Multiple Species Infections

- Amador & El Dorado: 31.47%
- Lodi: 4.79%
- San Luis Obispo: 4.70%
**Strains GLRaV-3**

- San Luis Obispo: strains A, B, C, E
- Lodi: strains A, B, C, G
- Amador & El Dorado: strains A, B, C
- Strains in these regions aren’t unique, they have been found around the world
Why should you care?

Pinot Noir
What about our case study site?
What about our case study site?

- Included in 2010 Berkely RNA fragment analysis
- Originally came back negative
  - Sampled late in season (Nov.)-virus titer low?
  - Virus titer unevenly distributed in vine (one petiole sampled per vine)

- Spoke with Monti Sharma (UCB), requested a second look
- Monti found 2 samples via sequencing and newly designed sequencing primers correlating with LR-5, possibly a new strain (current detection primers could not detect)
- Possible other effects: drought induced nutritional deficiency? B deficiency in Primitivo?
Collaborating project:
Testing Phylloxera for leafroll transmission
Kent Daane and Christina Wistrom, UC Berkeley
Phylloxera

• Tiny, aphid-like insect, *Daktulosphaira vitifoliae*

• Feeds on *Vitis vinifera* roots-stunting vines, sometimes killing them.

• Why rootstocks developed
  – St. George (*V. rupestris*)
  – 110R (*V. berlandieri x V. rupestris*)
  – 3309C (*V. riparia x V. rupestris*)
Can Phylloxera transmit leafroll virus?

- 13 vines from 4 blocks sampled in Amador county in Nov., 2010
- Blocks showed suspect signs of Phylloxera and leafroll and were own-rooted and not treated for Phylloxera
- Petioles and roots sampled and were tested for leafroll virus (strains 1, 2, 3, 5 and 9) using rapid RNA technique
- Roots washed and inspected for Phylloxera nymphs
- Phylloxera nymphs recovered were tested for leafroll virus
Results

• 23% sampled vines had Phylloxera recovered from roots (even in apparently sandy soils).

• None of the roots or the Phylloxera tested positive for leafroll.

• 38% of the sampled petioles tested positive for leafroll.

• All positives were for GLRaV-2

• Will repeat this year.
Conclusions

**Increasing our local knowledge of “red leaf”**

- Leafroll virus is common in the foothills
- GLRaV-1, 2, 3 (a,b,c), 5,9 found in our region
- Multiple infections common
- Mealybugs (vectors) becoming more prevalent
  - Viable management options that preserve parasitiods demonstrated
  - Applaud, Assail
  - Future work testing Gill’s mealybug for transmission ability
- So far Phylloxera negative for transmission ability
  - Testing continuing this year
- Sampling petioles at flowering will pick up fertilizer management
Looking back at 2008 conclusions: What does this all mean?

• Viruses in grapevines are *really common*.
• Our knowledge is relatively “young”-only researched for 20-30 years and detection is improving.
• We do not know much about other vectors (i.e. Phylloxera?)

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• Remember you still may see symptoms if you use a different rootstock, or if your cultural conditions are different.
Thank You!
Questions??