Vineyard Irrigation in San Joaquin Valley of California

George Zhuang
Viticulture Farm Advisor
UC Cooperative Extension - Fresno County
Vineyard Irrigation and Sustainability
– Dr. Larry Williams, UC Davis

• Maintain productivity over time
• Maximize fruit quality
• Increase vineyard *water use efficiency* or decrease *water footprint* (in general, if the vineyard is irrigated any reduction in applied water will increase WUE, decrease water footprint).
• Minimize/maximize soil water depletion (function of soil type and rooting depth, cover crop management)
• Some of the above factors will be a function of location in California and price of grapes
How to Make Irrigation Decisions?
- Dr. Larry Williams, UC Davis

• When should one initiate irrigations at the beginning of the season?
• How much water should one apply?
• How does the design of your irrigation system affect the ability to irrigate your vineyards?
• Are there deficit irrigation practices to minimize production loss and maximize fruit quality?
When to Start?

• Visual estimation
• Soil moisture
• Plant water stress
Visual Estimation

- Budbreak
- Shoot tip
- Leaf
- Tendril
- Inflorescence/berry
Visual Estimation
Soil Moisture

• Tensiometer (centibar) – measures the attraction of soil to its water. Soil-water suction or tension is a measure of the soil’s matric potential.

• Gravimetric (%) – taking a known volume of soil and weighing it first and then taking its dry weight.

• Neutron probe, capacitance sensors, TDR – are used to measure soil volumetric water content ($\theta_v$).
Soil Moisture
Plant Water Stress

- Pressure chamber
- Sap flow sensor
- ...

Irrigation starts when midday leaf water potential reaches -10 bars
How Much to Irrigate?

• Evapotranspiration (ET)
  ▪ Historical ET
  ▪ Crop ET (ETc): \( ETc = ETo \times Kc \), Dr. Larry Williams, UC Davis
  ▪ Actual Crop ET (ETa): surface renewal method, e.g., Tule Technology
Crop ET

- \( ET_c = ETo \times Kc \)
- \( ETo \) from CIMIS Stations
- \( Kc \)
  - Measuring canopy cover
  - Estimate \( Kc \) by using GDD

\[
Kc = (0.017 \times \text{Shaded percentage of field}) - 0.008
\]
Crop Coefficient (Kc)

- Estimate Kc by using GDD (Dr. Larry Williams, UC Davis)

<table>
<thead>
<tr>
<th>Trellis/Canopy type</th>
<th>Row Spacing (ft)</th>
<th>Kc Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>VSP</td>
<td>7</td>
<td>$Kc=0.74/(1+e^{-(x-525)/301})$</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>$Kc=0.65/(1+e^{-(x-525)/301})$</td>
</tr>
<tr>
<td>CA Sprawl</td>
<td>10</td>
<td>$Kc=0.84/(1+e^{-(x-325)/105})$</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>$Kc=0.76/(1+e^{-(x-325)/105})$</td>
</tr>
<tr>
<td>Quad-cordons</td>
<td>11</td>
<td>$Kc=0.93/(1+e^{-(x-300)/175})$</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>$Kc=0.85/(1+e^{-(x-300)/175})$</td>
</tr>
</tbody>
</table>
How to Calculate Kc?

UC IPM offers interactive tools and models that can help you make pest management decisions based on conditions at your site.

California weather data | Pest and plant models | Additional tools | Degree-day calculator

California weather data
Current daily and hourly data from stations throughout California, plus long-term data for climate stations. PestCast research networks provide hourly and daily values from selected locations.
How to Calculate Kc?

• GDD is based on 10 °C
How to Calculate Kc?

How to Manage Pests
Degree-Days: Custom Calculation

- Lower threshold: 10°C
- Calculation: single sine/horizontal
- Weather station: PARLIER.A (CIMIS #39, Parlier)
- Time period: March 15, 2018 to July 11, 2018, retrieved on July 12, 2018 (119 days).

<table>
<thead>
<tr>
<th>Date</th>
<th>Air temperatures (°C)</th>
<th>Degree-days</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
<td>Daily</td>
</tr>
<tr>
<td>Mar 15 2018</td>
<td>5.6</td>
<td>16.7</td>
<td>2.38</td>
</tr>
<tr>
<td>Mar 16 2018</td>
<td>5.0</td>
<td>14.4</td>
<td>1.35</td>
</tr>
<tr>
<td>Mar 17 2018</td>
<td>2.2</td>
<td>15.0</td>
<td>1.39</td>
</tr>
<tr>
<td>Mar 18 2018</td>
<td>1.7</td>
<td>15.0</td>
<td>1.36</td>
</tr>
<tr>
<td>Mar 19 2018</td>
<td>2.8</td>
<td>20.0</td>
<td>3.47</td>
</tr>
<tr>
<td>Mar 20 2018</td>
<td>8.9</td>
<td>17.8</td>
<td>3.52</td>
</tr>
<tr>
<td>Mar 21 2018</td>
<td>11.1</td>
<td>17.2</td>
<td>4.15</td>
</tr>
<tr>
<td>Mar 22 2018</td>
<td>9.4</td>
<td>18.9</td>
<td>4.21</td>
</tr>
<tr>
<td>Mar 23 2018</td>
<td>6.1</td>
<td>17.2</td>
<td>2.67</td>
</tr>
<tr>
<td>Mar 24 2018</td>
<td>5.6</td>
<td>17.8</td>
<td>2.87</td>
</tr>
</tbody>
</table>
Too Much Work?

Grape Weekly ET Reports

2018 Weekly ET Reports

The California Department of Water Resources and the University of California Cooperative Extension have teamed up to provide Weekly ET Reports to agricultural water users. Reports include water use information for a variety of crops. Reports will be posted every Friday or Saturday for next week’s guidelines.

Weekly ET Reports for grapes use raisin grape (7’ x 11’ vine/row spacing with 566 vines/acre) and wine grape (7’ x 10’ vine/row spacing with 622 vines/acre on "California Sprawl" trellis) as examples. Acre-inch and gallons per vine will be reported this year. Growers might apply differently according to the vine/row spacing and trellis type in your vineyard.

04052018 FresnoEast Weekly Evapotranspiration Report
04122018 Fresno Weekly Evapotranspiration Report
04192018 Fresno Weekly Evapotranspiration Report
04262018 Fresno Weekly Evapotranspiration Report
05032018 Fresno Weekly Evapotranspiration Report
05102018 FresnoEast Weekly Evapotranspiration Report
### WEEKLY SOIL MOISTURE LOSS IN INCHES

*(Estimated Crop Evapotranspiration or ETc)*

**06/20/13 through 07/05/13**

<table>
<thead>
<tr>
<th>Crops (Leafout Date)</th>
<th>#188 Madera II ***</th>
<th>#39 Parlier</th>
<th>#86 Lindcove</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8-20-7/5</td>
<td>7/6-7/12</td>
<td>6-20-7/5</td>
</tr>
<tr>
<td></td>
<td>Water Use</td>
<td>Seasonal</td>
<td>Estimated</td>
</tr>
<tr>
<td>Almonds (3/16) *</td>
<td>1.97</td>
<td>20.45</td>
<td>1.90</td>
</tr>
<tr>
<td>Pistachio (4/21) **</td>
<td>2.08</td>
<td>10.68</td>
<td>2.04</td>
</tr>
<tr>
<td>Citrus (2/1)</td>
<td>1.26</td>
<td>18.71</td>
<td>1.20</td>
</tr>
<tr>
<td>Raisin Grapes (3/16) (11 ft. row spacing)</td>
<td>1.62</td>
<td>13.86</td>
<td>1.55</td>
</tr>
<tr>
<td>Winegrapes (3/16) (10 ft. spacing on CA Sprawl Trellis)</td>
<td>1.80</td>
<td>14.50</td>
<td>1.76</td>
</tr>
<tr>
<td>Walnuts (4/4)</td>
<td>1.82</td>
<td>15.75</td>
<td>1.83</td>
</tr>
<tr>
<td>Stone Fruit (3/16)</td>
<td>1.72</td>
<td>14.74</td>
<td>1.69</td>
</tr>
</tbody>
</table>

Past 7 days precipitation (inches) 0.00
Accumulated precipitation (inches) (1/1/2013) 6.33

---

Dates in parentheses above, indicate leaf out or starting date for ET accumulation for the specific crop.

* Estimates are for orchard floor conditions where vegetation is managed by some combination of strip applications of herbicides, frequent mowing or tillage, and by mid and late season shading and water stress. Weekly estimates of soil moisture loss can be as much as 25 percent higher in orchards where cover crops are planted and managed more intensively for maximum growth.

** Very vigorous, non-salt affected peak season pistachio KC can be as high as 1.19 - resulting in about 35% greater water use than shown in these tables.

*** CIMIS station #188 Madera II has been taken out of service due to a conversion of the pasture to permanent crops. For the remainder of 2013 irrigation season Historical Average ETc will be used for the weekly report.

### PAST WEEKLY APPLIED WATER IN INCHES, ADJUSTED FOR EFFICIENCY

<table>
<thead>
<tr>
<th>Crops</th>
<th>#188 Madera II</th>
<th>#39 Parlier</th>
<th>#86 Lindcove</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>65% 75%</td>
<td>85% 95%</td>
<td>95%</td>
</tr>
<tr>
<td>Almonds (3/16)</td>
<td>3.0 2.6 2.3</td>
<td>2.1</td>
<td>2.2</td>
</tr>
<tr>
<td>Pistachio (4/21)</td>
<td>3.2 2.8 2.4</td>
<td>2.2</td>
<td>2.3</td>
</tr>
<tr>
<td>Citrus (2/1)</td>
<td>1.9 1.7 1.5</td>
<td>1.3</td>
<td>1.4</td>
</tr>
<tr>
<td>Raisin Grapes (3/16) (11 ft. row spacing)</td>
<td>2.5 2.2 1.9</td>
<td>1.7</td>
<td>2.6 2.3 2.0</td>
</tr>
<tr>
<td>Winegrapes (3/16) (10 ft. spacing on CA Sprawl Trellis)</td>
<td>2.8 2.4 2.1</td>
<td>1.9</td>
<td>2.9 2.5 2.2</td>
</tr>
<tr>
<td>Walnuts (4/4)</td>
<td>2.6 2.3 2.0</td>
<td>1.8</td>
<td>2.8 2.4 2.1</td>
</tr>
</tbody>
</table>

---

1 The amount of water required by a specific irrigation system to satisfy evapotranspiration. Typical ranges in irrigation system efficiency are Drip, 90%-95%; Micro-sprinkler, 80%-95%; Sprinkler, 70%-85%; and Border-furrow, 50%-75%.

### PAST WEEKLY APPLIED WATER IN GALLON PER TREE OR VINE

<table>
<thead>
<tr>
<th>Crops</th>
<th>#188 Madera II</th>
<th>#39 Parlier</th>
<th>#86 Lindcove</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almonds 115 Trees/A</td>
<td>708 614 543</td>
<td>496</td>
<td>519</td>
</tr>
<tr>
<td>Pistachio 106 Trees/A</td>
<td>797 698 598</td>
<td>548</td>
<td>573</td>
</tr>
<tr>
<td>Citrus 110 Trees/A</td>
<td>469 420 370</td>
<td>321</td>
<td>346</td>
</tr>
<tr>
<td>Raisin Grapes 566 Vines/A</td>
<td>120 106 91</td>
<td>82</td>
<td>86</td>
</tr>
<tr>
<td>Winegrapes 622 Vines/A</td>
<td>122 105 92</td>
<td>83</td>
<td>87</td>
</tr>
<tr>
<td>Walnuts 76 Trees/A</td>
<td>1000 857 750</td>
<td>679</td>
<td>715</td>
</tr>
<tr>
<td>Stonefruit 172 Trees/A</td>
<td>410 363 316</td>
<td>284</td>
<td>300</td>
</tr>
</tbody>
</table>

For further information concerning all counties receiving this report, contact the Fresno Co. Farm Advisor’s office at (559) 241-7526.
Actual Grape ET

- Surface Renewal, e.g., Tule Technology: provide daily actual ET, e.g., gallons/vine/day
How to Schedule Irrigation?

• Obtain gallons/vine/week from crop ET reports, Tule, historical ET...
• Number of emitters per vine, e.g., 2 emitters/vine
• Flow rate per emitter, e.g., 0.5 gallon/hour
• Hours/week = (gallons/vine/week)/(number of emitters/vine × flow rate)
Double Check Flow Rate!
How to Deficit Irrigation?

• It depends on your production goal:
  ▪ Yield
  ▪ Quality

• Overall, berry size/yield is maximized with applied water at $80\%$ of ETc (Dr. Larry Williams, UC Davis)
How to Deficit Irrigation?

• Pre-veraison water deficit
  - Significant impact on berry size/yield, and generally beneficial for quality: *smaller berry with higher skin/pulp ratio*

• Post-veraison water deficit
  - Minimal impact on berry size/yield, and still beneficial for quality: *plant growth regulator, e.g., ABA?*
Water Deficit on Berry Size

65% - 75% of berry size
Irrigation Scheduling

• Midday leaf water potential well responds with ET in the SJV

Syrah: 80% ETc pre-veraison and 60% ETc post-veraison
Conclusion

• Deficit irrigation (at applied water amounts ~ 80% of estimated ET$_c$) had only minimal effects on berry size.

• Overall, yield is maximized with applied water at 80% of estimated ET$_c$.

• Water deficit can be applied at different phenological stages to achieve the production goal.
Acknowledgement

• Gaia Nafziger, UCCE Fresno County
• Dr. Larry Williams, UC Davis
• SJV wine growers and wineries
Questions?