Understanding real field irrigation & water monitoring for optimal scheduling.  

MAKING TECHNOLOGY WORK for YOU!

PISTACHIO IRRIGATION TRAINING MODULE & MONITORING DEMO SITES

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Proposed Research Plan for 2019

PROJECT HYPOTHESIS AND OBJECTIVES:

Using three pistachio production fields currently part of the Zaccaria ET trial as a demonstration platform promote optimal irrigation practice by:

1. Provide a web-based Pistachio Irrigation Training Module similar to training modules for other crops covered by the Commodity Irrigation Training Program developed by Bali and Zaccaria (CDFA-Bali).

2. Promote training through 3 or more workshops and UCCE / industry newsletters.

3. Utilize existing and as needed install appropriate new irrigation-related monitoring technologies at one to three of our current pistachio ET study orchards.

4. Provide real-time web-based access to field monitoring data at demonstration sites to show:
   a. How monitoring technologies reveal excess or deficit irrigation.
   b. How these technologies compare across saline to non-saline soils.
   c. (Most importantly): How to use this data to do optimal irrigation scheduling.
   d. Allow for expression of grower understanding / opinions on these irrigation-related data using some kind of blog attached to the website.

5. Provide a monthly blog-type summary of the irrigation monitoring data, what this means as to how good a job was done irrigating and how the summary research project (ET / Kc) data relate to the monitoring technologies.
MONTHLY SUMMARIES, BLOG MASTER – this is the summary point that potentially makes the critical difference in this training/demo idea and would require a significant season-long investment of time and availability to the larger pistachio production and research community and may be the difference between real success and “just another project”. Sanden (coordinator)

EXPECTED PROJECT OUTCOMES:

- Improve grower accuracy in estimating actual water use of mature pistachio orchards.
- Improve grower understanding and comfortability of soil and plant water status monitoring.
- Improve grower understanding of the impact of salinity on crop water use.
- Improve almond-pistachio cross-commodity collaboration on irrigation.

MINIMUM TIMELINE: 2019 and 2020 seasons
Pistachio Monitoring Sites
Kerman on PG1 rootstock

2016 - 19
Westside non-saline

2018 - 19
Kerman on PG1 rootstock

Lemoore semi-saline & saline

2016 - 19
Eastside non-saline

Cover WM
No Cover WM
On-going Pistachio ET/Kc by salinity project

Eddy-covariance energy flux towers to measure ET
Pistachio ET for low to high rootzone salinity compared for the 2016 and 2017 seasons

Salt-affected orchards have consistently lower ET (30-50%) than non salt-affected orchards, depending on the level of salinity.
**2018 ET for non-saline Cover vs. Bare middles**
(2019 ET not yet available)

When combining Yield and ET, the Coalinga site has higher water productivity: more Yield/ET, more crop per drop

ET at Coalinga site is higher than at Nichols, because of higher net radiation and higher wind

Average annual inshell yield at the Cover site ~4500 and at the Bare site ~3200 lb/ac
Tensiometers with pressure transducers and WaterMark blocks attached to manual download Irrrometer logger.

Phytech bluetooth dendrometers to measure trunk “shrink-swell”. (real-time web upload)

Sentek “Drill&Drop” capacitance probe powered by Jain Logic System (formerly PureSense, real-time web upload)

Neutron probe access tube to 9 feet.
Soil moisture tension 7/1-10/2/2019

Eastside non-saline fine sandy loam

7/31/2019
19.8" applied
Goldhamer ET @ 23.9"

Westside (Coalinga) non-saline sandy loam

7/1-10/2/2019
17.0" applied
Goldhamer ET @ 23.9"
Westside (Lemoore) semi-saline sandy clay loam

7/31/2019

14.5” applied Goldhamer ET @ 23.9”

Westside (Lemoore) sodic saline clay loam
(Same orchard, same age trees as above)
Soil moisture tension (WaterMark, electrical resistance sensor and Tensiometer, mechanical vacuum) compared to Capacitance Volumetric water content (Sentek/Jain).

Eastside non-saline fine sandy loam (high frequency 3 to 12 hr sets)

Actual hose pressure

388 Calculated hrs run
Soil moisture tension (WaterMark, electrical resistance sensor and Tensiometer, mechanical vacuum) compared to Capacitance, Volumetric water content (Sentek/Jain) highlighted colors.

Westside (Coalinga) non-saline sandy loam (mostly 48 hr sets)

Actual hose pressure 870 Calculated hrs run
Soil moisture tension (WaterMark, electrical resistance sensor and Tensiometer, mechanical vacuum) compared to Westside (Lemoore) semi-saline sandy clay loam (3-12 hr sets, automated valve change)
Soil moisture tension (WaterMark, electrical resistance sensor and Tensiometer, mechanical vacuum) compared to Capacitance Volumetric water content (Sentek/ Jain)

Actual hose pressure

Westside (Lemoore) sodic saline clay loam (Same orchard as previous, 3-12 hr sets, automated valve change)

502 Calculated hrs run
**Site soils, irrigation systems characteristics and applied water (7/1 – 10/2/2019)**

<table>
<thead>
<tr>
<th>SITE</th>
<th>SOIL</th>
<th>*SATURATION %</th>
<th>*EC (dS/m)</th>
<th>Drip Hoses/tree</th>
<th>Flow (lph)</th>
<th>Design Gal/hr/tree</th>
<th>Design Inch/24 hrs</th>
<th>7/1/2019 - 10/2/2019</th>
<th>Pressure Sensor Hrs</th>
<th>Calculted Metrd Inches</th>
<th>Avg SWP (bars)</th>
<th>Canopy Cover (%)</th>
<th>Canopy Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastside</td>
<td>Colpien L (Nord)</td>
<td>32 37 29</td>
<td>1.8 2.7 3.8 8.9</td>
<td>2 8 4 8.5 1.01</td>
<td>388 16.29</td>
<td>17.0 -10.6 90</td>
<td>0.19</td>
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<tr>
<td>Westside</td>
<td>Cerrini SL (Excelsior)</td>
<td>26 21</td>
<td>2.8 3.4</td>
<td>1 5 1 4.2 0.50</td>
<td>870 18.26</td>
<td>19.8 -12.0 85</td>
<td>0.23</td>
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</tr>
<tr>
<td>Lemoore</td>
<td>Lethent CL</td>
<td>55 60 47</td>
<td>7.2 7.8 6.7 10.8</td>
<td>2 8 2 4.2 0.50</td>
<td>636 13.35</td>
<td>14.5 -14.5 65</td>
<td>0.22</td>
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<tr>
<td>Lemoore</td>
<td>Lethent SiCL</td>
<td>62 79 54</td>
<td>8.2 8.2 7.4 11.2</td>
<td>2 8 2 4.2 0.50</td>
<td>502 10.54</td>
<td>11.4 -13.8 30</td>
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</tbody>
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*Actual dates: 7/14/15, 11/15/16, 2/10/18, 4/25/19

**COMMENT:** Even though the Eastside non-saline site had an elevated EC soil sample in April 2019, the high frequency irrigation combined with a ‘good’ soil type and earlier lower salinity produced the least stressed stem water potential (SWP) from July through harvest 2019 on the least water per canopy cover.
Phytech dendrometers Eastside non-saline site (7/1-8/5/2019 only, system was unresponsive rest of season)

Pressure sensor calculated inches irrigation

Dendrometer daily shrink/swell and growth in trunk diameter for two trees (1000-7000 microns = 0.24”)

Volumetric soil moisture (Decagon EC5)
Phytech dendrometers Eastside non-saline site (8/4-9/27 only, system was unresponsive rest of season)

Pressure sensor calculated inches irrigation

Dendrometer daily shrink/swell and growth in trunk diameter for three trees (50-300 microns = 0.01”)

Volumetric soil moisture (Decagon EC5)
Phytech dendrometers Lemoore semi-saline site (7/1-10/2/2019, good response all season)

No functioning pressure sensor

Dendrometer daily shrink/swell and growth in trunk diameter for three trees (50-350 microns = 0.01”)

Volumetric soil moisture (Decagon EC5)
Phytech dendrometers Lemoore saline site (7/1-10/2/2019, good response all season)

No functioning pressure sensor

Dendrometer daily shrink/swell and growth in trunk diameter for three trees (50-850 microns = 0.03"

Volumetric soil moisture (Decagon EC5)
PhyTech dendrometer
shrink/swell
(5/20-7/10/2017 data for saline to non-saline)

FLO_DO3 Rootzone ECe ~ 11 dS/m

NIC Rootzone ECe ~ 2.5 dS/m
OBSERVATIONS / CONCLUSIONS

- Tensiometers measuring mechanical soil moisture tension are more sensitive to water content changes than Watermark blocks.
- In non-saline soils, WaterMark blocks can provide a good correlation with actual soil moisture tension.
- Tensiometer readings have a reasonable correlation with volumetric water content as measured by capacitance probes (Sentek), but appear to be more sensitive to day to day changes even in non-saline soils.
- Soil moisture tension does NOT tell you how much available water remains in the rootzone.
- Higher soil moisture tension readings (negative matric potential, soil moisture deficit) are not always well related to tree water stress in terms of stem water potential (SWP, pressure chamber readings).
- Dendrometer readings of daily shrink/swell and total growth provide a measurement of plant stress that appears to have a good relationship to SWP.