Improving Irrigation and Nutrient Management in Ventura County Strawberry

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Objectives

➢ Better understand plant growth and needs for water and N

➢ Create a practical and efficient tool for water and N fertilizer management

✓ 6 + 6 field studies between 2014 and 2017
Previous Years Measurements

2014 - 2017:
(4 sampling locations per field)
• Canopy cover (7 fields)
• Root depth (7 fields)

2014-15:
• Aboveground biomass N (6 fields; 4)
Challenges with N management:

- Transition from low to high uptake rates may not be very clear
- Concern with fruit quality may lower yields
- Differences among cultivars
- Irrigation efficiency (leaching nitrate)
- Use of pre-plant fertilizer
Nitrogen Uptake

\[ G = \frac{a}{1 + \exp\left(-\frac{N-N_0}{b}\right)} \]

- \( a = 1.1074 \)
- \( b = 0.1526 \)
- \( N_0 = 0.6920 \)

\( R^2 = 0.96 \)
Canopy Cover

\[ F_c = \frac{1}{1 + \exp(A + B \times Ni)} \]

\[ A = 3.8974 \]
\[ B = -8.0527 \]

\[ R^2 = 0.93 \]
Database driven web application

Crop ET model

Water Recommendation

Crop N model

N fertilizer Recommendation

Soil and Ranch

CIMIS ETo

Soil nitrate test

www.cropmanage.ucanr.edu
How Much Water?

- ETo
- Kc

- Irrigation system application rate
- Irrigation system application uniformity (DU)
- Leaching fraction (water salinity)

Water recommendation
How is N fertilizer rate determined?

Fertilizer N = Crop N uptake and Soil N threshold

(weekly lbs N/acre)

(ppm NO₃-N)

UC Studies

Soil N: Quick Test
Field Assessments

6 fields total:
✓ 3 replicated
✓ 3 non-replicated (block comparisons)

2 treatments:
Water and N fertilizer managed according to
CropManage (CM) vs Grower Standard (GS)
Replicated (4 times)

<table>
<thead>
<tr>
<th>CM</th>
<th>GS</th>
<th>CM</th>
<th>CM</th>
<th>GS</th>
<th>CM</th>
<th>GS</th>
<th>GS</th>
</tr>
</thead>
</table>

Block comparison

CM

GS
When irrigate?

• Tensiometers
## Results Summary

<table>
<thead>
<tr>
<th>Study #</th>
<th>County</th>
<th>Study type</th>
<th>Marketable yield</th>
<th>Water use</th>
<th>Fertilizer use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ventura</td>
<td>Replicated</td>
<td>22% higher*</td>
<td>14% higher</td>
<td>34% higher</td>
</tr>
<tr>
<td>2</td>
<td>Ventura</td>
<td>Block comparison</td>
<td>2% higher</td>
<td>Same</td>
<td>35% lower</td>
</tr>
<tr>
<td>3</td>
<td>Ventura</td>
<td>Replicated</td>
<td>27% higher*</td>
<td>32% higher</td>
<td>26% higher</td>
</tr>
<tr>
<td>4</td>
<td>Ventura</td>
<td>Block comparison</td>
<td>Same</td>
<td>22% lower</td>
<td>Same</td>
</tr>
<tr>
<td>5</td>
<td>Monterey</td>
<td>Block comparison</td>
<td>Non-representative**</td>
<td>21% higher</td>
<td>11% higher</td>
</tr>
<tr>
<td>6</td>
<td>Monterey</td>
<td>Replicated</td>
<td>2% higher</td>
<td>29% lower</td>
<td>10% lower</td>
</tr>
</tbody>
</table>

* Difference is statistically significant
** Irregular lygus damage between comparison blocks
2017 Example

Field details

✓ Location: Oxnard, CA
✓ Cultivar: Fronteras
✓ 64” bed, two high flow tapes
✓ 25ft long plots
✓ Soil: Hueneme loamy sand (6% clay, 83% sand and 11% silt)
✓ Water: EC = 1.6 dS/m
✓ Pre-plant fertilizer (controlled release): 176 lbs N/acre
✓ Main in-season N fertilizer source: CN9
Flow meters

Weekly soil sample for nitrate

Soil Moisture Sensors
In-Season N Fertilizer Applied

*Pre-plant fertilizer (controlled release): 176 lbs N/acre
Soil NO$_3$-N (0-12in)
Cumulative Drip-Applied Water
Soil Moisture at 6” depth

![Graph showing soil moisture levels at 6" depth with two lines representing CM and GS, with wet and dry levels indicated.]
## Marketable Yield

<table>
<thead>
<tr>
<th>Month</th>
<th>CM/GS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>2%</td>
</tr>
<tr>
<td>Feb</td>
<td>0%</td>
</tr>
<tr>
<td>March</td>
<td>-2%</td>
</tr>
<tr>
<td>April</td>
<td>36%</td>
</tr>
<tr>
<td>May</td>
<td>73%</td>
</tr>
<tr>
<td>June</td>
<td>26%</td>
</tr>
<tr>
<td>Avg</td>
<td>27%</td>
</tr>
</tbody>
</table>

**Graph**

- **Grams/plot**
- **CM**
- **GS**

- **Axes**
  - X-axis: Dates from 6-Jan to 6-Jun
  - Y-axis: Grams/plot from 0 to 10,000

**Legend**

- Blue line: CM
- Orange line: GS
Grams per fruit

University of California
Agriculture and Natural Resources
Cull rate (%)
## Results Summary

<table>
<thead>
<tr>
<th></th>
<th>CM</th>
<th>GS</th>
<th>CM vs GS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drip-applied water (acre-ft)</td>
<td>2.3</td>
<td>1.7</td>
<td>35% more</td>
</tr>
<tr>
<td>Total N fertilizer use (lbs N/acre) (Pre-plant + in-season)</td>
<td>286 (176 + 110)</td>
<td>219 (176 + 43)</td>
<td>30% more</td>
</tr>
<tr>
<td>Total marketable yield (fruits/plot)</td>
<td>5,417 (a)</td>
<td>4,334 (b)</td>
<td>25% more</td>
</tr>
<tr>
<td>Total marketable yield (grams/plot)</td>
<td>130,308 (a)</td>
<td>102,241 (b)</td>
<td>27% more</td>
</tr>
<tr>
<td>Cull rate (%)</td>
<td>15 (a)</td>
<td>18 (b)</td>
<td>3% less</td>
</tr>
</tbody>
</table>

(Different letters indicate statistically significant differences between treatments)

### Water Use Efficiency (WUE)

<table>
<thead>
<tr>
<th></th>
<th>CM</th>
<th>GS</th>
</tr>
</thead>
<tbody>
<tr>
<td>lbs/plot</td>
<td>287</td>
<td>226</td>
</tr>
<tr>
<td>acre-in</td>
<td>27.0</td>
<td>20.1</td>
</tr>
<tr>
<td>WUE (lbs/acre-in)</td>
<td>10.6</td>
<td>11.2</td>
</tr>
</tbody>
</table>
## Results Summary

<table>
<thead>
<tr>
<th></th>
<th>CM vs GS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2017</td>
</tr>
<tr>
<td>Water</td>
<td>35% more</td>
</tr>
<tr>
<td>N fertilizer</td>
<td>30% more</td>
</tr>
<tr>
<td>Yield</td>
<td>27% more</td>
</tr>
<tr>
<td>Cull rate</td>
<td>3% less</td>
</tr>
</tbody>
</table>
Final Thoughts

- CropManage showed to be efficient in guiding irrigation and N fertilization

- Algorithms for water and N need improvement/fine-tuning + more research

- Although not perfect, it’s a comprehensive approach
Final Thoughts

Answers to other pertinent issues:

- High N rates = low fruit quality? No.
- High N rates in the soil = low fruit quality? Most likely, but data doesn’t answer that.
- Bigger plants (due to higher N rates) = lower yield? No.
- Bigger plants + higher yields = slow down harvesting crew? Yes. 27% more yield = 25-30% more time to harvest
Acknowledgements

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Questions/comments?

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