Sustainability Through Sound Irrigation and Fertilization Practices

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Presentation Outline

- Sustainability and water quality
- Factors affecting offsite movement of chemicals
- Nitrate in ground and surface water
- Resources to improve nitrogen and water management
- THF study results
- N in organic systems
Merriam-Webster:
Of, relating to, or being a method of harvesting or using a resource so that the resource is not depleted or permanently damaged.

Oxford:
Avoidance of the depletion of natural resources in order to maintain an ecological balance.
Factors Affecting Offsite Movement of Chemicals

- Runoff and deep percolation (leaching): irrigation and rainfall exceeds soil infiltration and soil water holding capacity
- Solubility in water
- Mobility in soil
Exceeding nitrate levels in ground and surface water
Nitrogen Use Reporting

Responsibility Areas

Farm Bureau of Ventura County:
http://www.farmbureauvc.com/issues/water-issues/water-quality/management
Circumstances conducive to nitrate leaching:

- Crops sensitive to mild water stress (increased irrigation frequency)
- Crops with shallow, or relatively shallow root system
- Crops grown on well-drained soils
- High-value crops (small yield losses can cause significant impact on returns)

Most soil N is in the form of nitrate
- Nitrate is very soluble in water
- Nitrate is weakly held in the soil CEC

Typical number of irrigation events:
- Strawberries: 50-60
- Celery: 15-20

https://apps1.cdfa.ca.gov/fertilizerresearch/docs/Nitrate_Tool.html
Key to Successful Irrigation and N Management: Right Rate, at the Right time
mg/L (ppm) NO₃-N × 0.227 = lb of N/ac-in of water

Irrigation water of 10mg/L NO₃-N

- 1.5 AF: 41 lbs N/acre
- 2.5 AF: 68 lbs N/acre
Why is irrigation scheduling challenging?
ET-Based Irrigation

ETo

Kc
20%
60%
90%

Water recommendation

https://cimis.water.ca.gov/

University of California
Agriculture and Natural Resources
Soil Moisture Sensors

**Advantages (Pros)**

- Direct measure of tension
- Can interface with data logger
- No salinity interference
- Responsive at high moisture
- Contents independent of soil texture

**Disadvantages (Cons)**

- May require frequent maintenance
Ventura County:
- Strawberry
- Celery

Six replicated studies:
- Equal or higher yields
- Water and N fert. use varied
Assessing the Impact of Nitrogen Fertilizer Amounts and Sources on Strawberry Yield and Shelf Life

THF 2018/2019
## Treatments

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early season (Oct-Feb)</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Late season (Mar-May)</td>
<td>6</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>Total applied (Oct 8-May 31)</td>
<td>118</td>
<td>208</td>
<td>298</td>
</tr>
</tbody>
</table>

Applied as CN9 and as AN20

Previous Studies
Treatments

Cumulative Fertilizer Rates of Treatments and Rainfall Events

- Low
- Medium
- High

Rainfall (in) vs. Lbs N/ac

- 5-Oct
- 5-Nov
- 5-Dec
- 5-Jan
- 5-Feb
- 5-Mar
- 5-Apr
- 5-May
- 5-Jun

* Soil and leaf blade sampling events
* Fruit sampling and shelf-life assessment events
Treatments Application

Early season, lower rates

Mid-late season, higher rates
Results
Total Marketable Yield, Fronteras

![Box plots showing boxes/acre for different yield levels (Low, Medium, High) for CN9 and AN20. The plots indicate statistically significant differences denoted by different letters (a, b). An F value of 5.58 with a probability of 0.0037 is also provided.]
Soil Mineral Nitrogen (NH4 + NO3), Proprietary cv.

- Low CN9
- Medium CN9
- High CN9
- Low AN20
- Medium AN20
- High AN20

N (ppm)
NO$_3$-N at 12-24 in depth
(at crop termination)
Organic Production and its Challenges to Sustainability
Organic Systems

Soil Organic Matter

In-Season Fertilizers

Organic Amendments

Major N contributions

Cover Crops

Crop Residues

<table>
<thead>
<tr>
<th>Common name</th>
<th>Estimated N fixed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Berseem clover</td>
<td>240 - 360 lbs/acre/year</td>
</tr>
<tr>
<td>Purple vetch</td>
<td>130 - 300 lbs/acre/year</td>
</tr>
<tr>
<td>Field pea</td>
<td>210 - 300 lbs/acre/year</td>
</tr>
<tr>
<td>Lana woolypod vetch</td>
<td>230 lbs/acre/year</td>
</tr>
<tr>
<td>Subterranean clover</td>
<td>140 - 180 lbs/acre/year</td>
</tr>
<tr>
<td>Austrian winter pea</td>
<td>150 lbs/acre/year</td>
</tr>
<tr>
<td>Bell bean</td>
<td>80 - 150 lbs/acre/year</td>
</tr>
<tr>
<td>Medic</td>
<td>80 - 130 lbs/acre/year</td>
</tr>
<tr>
<td>Cowpea</td>
<td>50 - 70 lbs/acre/year</td>
</tr>
</tbody>
</table>

Crop Residues

<table>
<thead>
<tr>
<th>Crop</th>
<th>Example yield (tons/acre)</th>
<th>Expected crop residues (lb N/ton yield)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lettuce</td>
<td>16-21</td>
<td>4.9</td>
<td>78-102</td>
</tr>
<tr>
<td>Tomato (fresh-market)</td>
<td>20</td>
<td>4.5</td>
<td>88</td>
</tr>
<tr>
<td>Tomato (processing)</td>
<td>54</td>
<td>2.2</td>
<td>119</td>
</tr>
<tr>
<td>Sweet potato</td>
<td>17</td>
<td>0.2</td>
<td>4</td>
</tr>
<tr>
<td>Broccoli</td>
<td>7 - 10</td>
<td>25.4</td>
<td>178 - 255</td>
</tr>
<tr>
<td>Carrot</td>
<td>20</td>
<td>7.1</td>
<td>142</td>
</tr>
<tr>
<td>Melon</td>
<td>23</td>
<td>3.0</td>
<td>69</td>
</tr>
<tr>
<td>Potato</td>
<td>24</td>
<td>4.7</td>
<td>114</td>
</tr>
<tr>
<td>Strawberry</td>
<td>36</td>
<td>2.7</td>
<td>95</td>
</tr>
<tr>
<td>Spinach</td>
<td>9-16</td>
<td>3.2</td>
<td>29-51</td>
</tr>
</tbody>
</table>
Organic Nitrogen Availability and Uptake
NO₃-N at 12-24 in depth

ppm

- Fronteras
- Proprietary cv.

Bar chart showing the concentration of NO₃-N at different levels of CN9 and AN20.
Best practices for irrigation and fertilization can leverage production efficiency, yields and environmental sustainability.
Summary

- Sustainable irrigation and fertilization depend on the use of information and technology; creating local information is key.

- Irrigation: ET-based irrigation, soil moisture sensors and accurate crop coefficients.

- N fertilization: robust uptake curves, frequent soil analysis and adequate choice of fertilizer type.

- Sustainability depends on using the Right Rate and Right Time of water and fertilizers.
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Questions/comments?
Thank you!

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