Site specific nitrogen management in processing tomatoes

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Data collection in commercial fields in 2016

• Sites:  
  - 2 sites near Woodland  
  - 3 sites near Stockton  
  - 1 site near Huron

• Data:  
  - Canopy development (infrared camera)  
  - ET estimates from Tule stations  
  - N uptake (repeated plant sampling)
Expected N uptake

- N in tomatoes: 2.99 lbs/ton
- N in vines: 33% of total N

For a 55-ton total yield:
Expected N requirements

- Expected yield: 55 tons/acre
- Expected N uptake: 246 lbs/acre
  – 2.99 lbs/ton; 67% of total N in fruits
- N use efficiency: 90%
- Total N requirement: 274 lbs/acre (from all sources)
N sources at field site

• No nitrate in irrigation water
• Residual soil nitrate:
  – 1\textsuperscript{st} foot: 13 ppm $\Rightarrow$ 45.4 lbs/acre
  – 2\textsuperscript{nd} foot: 7.7 ppm $\Rightarrow$ 27 lbs/acre
• Assumption: 50\% of nitrate in 1\textsuperscript{st} foot and 90\% in 2\textsuperscript{nd} foot are available

\Rightarrow \text{Available soil nitrate: } 47 \text{ lbs/acre}
\Rightarrow \text{Fertilizer N needed (incl. starter): } 225 \text{ lbs/acre}
N budget for UC Davis trial

<table>
<thead>
<tr>
<th>N sinks and sources</th>
<th>lbs N/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>N uptake</td>
<td>246 lbs/acre</td>
</tr>
<tr>
<td>N efficiency</td>
<td>90%</td>
</tr>
<tr>
<td>N requirement</td>
<td>274</td>
</tr>
<tr>
<td>N in irrigation water</td>
<td>0 ppm</td>
</tr>
<tr>
<td>Residual soil nitrate</td>
<td>47 lbs/acre</td>
</tr>
<tr>
<td>N credits</td>
<td>47</td>
</tr>
<tr>
<td>Fertilizer application rate</td>
<td>227</td>
</tr>
</tbody>
</table>
Residual soil nitrate

Lazcano et al., 2015

150 lbs/acre * 50% = 75 lbs/acre

50 lbs/acre * 90% = 45 lbs/acre

Total credit: 120 lbs/acre

Preplant nitrate-N (lbs/acre)

Yolo  San Joaquin  Fresno

0-10"

10-20"

Lazcano et al., 2015
## N budget example I

<table>
<thead>
<tr>
<th>N sinks and sources</th>
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<tr>
<td>N uptake</td>
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<td>274</td>
</tr>
<tr>
<td>N in irrigation water</td>
<td>0 ppm</td>
</tr>
<tr>
<td>Residual soil nitrate</td>
<td>120 lbs/acre</td>
</tr>
<tr>
<td>N credits</td>
<td>120</td>
</tr>
<tr>
<td>Fertilizer application rate</td>
<td>154</td>
</tr>
</tbody>
</table>
Nitrate in irrigation water

1 acre-inch of water with a nitrate-N concentration of 1 ppm contains
0.227 lbs N/acre

Example:
- Irrigation water: 10 ppm nitrate-N
- Seasonal irrigation: 22 inches

⇒ N in irrigation water: 50 lbs/acre
### N budget example II

<table>
<thead>
<tr>
<th>N sinks and sources</th>
<th>lbs N/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>N uptake</td>
<td>246 lbs/acre</td>
</tr>
<tr>
<td>N efficiency</td>
<td>90%</td>
</tr>
<tr>
<td>N requirement</td>
<td>274</td>
</tr>
<tr>
<td>N in irrigation water</td>
<td>50 lbs/acre</td>
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<tr>
<td>Residual soil nitrate</td>
<td>120 lbs/acre</td>
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<tr>
<td>N credits</td>
<td>170</td>
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<td>Fertilizer application rate</td>
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</tbody>
</table>
Replicated trial at UC Davis

- 3 nitrogen treatments:
  - N_175: Optimal N minus 50 lbs N/acre
  - N_225: Optimal N
  - N_275: Optimal N plus 50 lbs N/acre

- Irrigation in all treatments was 100% ET
- 5 replicates
- Plot size: 3 beds x 200 feet
Trial management

• Transplanting date: 05/01/2017

• Fertilization:
  – Starter: 30 gal/acre of 8-24-6, Zn
  – 5 weekly fertigations of UAN between 06/01 and 06/29
  – Two applications of K-thiosulfate in July (total of 100 lbs K₂O/acre)

• Harvest date: 08/25/2017
Fertilization program

Residual soil nitrate not included
Marketable yield

- Average marketable yield: 58 tons/acre
- No statistically significant differences among treatments
Why are there no treatment effects?

• We may have overestimated N uptake
• We did not account for N mineralization during the growing season
## Measured N uptake

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N in fruits (lbs/ton)</th>
<th>N in vines (lbs/acre)</th>
<th>% of total</th>
<th>Total N (lbs/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N_175</td>
<td>2.59</td>
<td>148</td>
<td>39%</td>
<td>94</td>
</tr>
<tr>
<td>N_225</td>
<td>2.99</td>
<td>166</td>
<td>38%</td>
<td>102</td>
</tr>
<tr>
<td>N_275</td>
<td>3.07</td>
<td>187</td>
<td>42%</td>
<td>133</td>
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</tbody>
</table>
Soil N mineralization

Incubation: 10 weeks at 77 °F and optimal moisture content

Soil Properties:
- Yolo Silt Loam
- 1.8% soil organic matter
- pH$_w$ 7.6
Soil N mineralization

- If the top foot of the soil profile were constantly at field capacity:
Conclusions

- At common N application rates, plants take up more N than needed (luxury consumption)
- Root access to nitrate above the drip line is a rough estimate
- Even in soils with a low soil organic matter content, N mineralization during the season contributes to N supply
Acknowledgement

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