Site specific nitrogen management in processing tomatoes

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Northern San Joaquin Valley Processing Tomato Meeting, Modesto

January 24, 2018
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\(^{st}\) foot: 13 ppm ⇒ 45.4 lbs/acre
  - 2\(^{nd}\) foot: 7.7 ppm ⇒ 27 lbs/acre
- Assumption: 50% of nitrate in 1\(^{st}\) foot and 90% in 2\(^{nd}\) foot are available

⇒ Available soil nitrate: 47 lbs/acre
⇒ Fertilizer N needed (incl. starter): 225 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

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

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

Total credit: 120 lbs/acre

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

<table>
<thead>
<tr>
<th>N sinks and sources</th>
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<tbody>
<tr>
<td>N uptake</td>
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</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>
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>
</tr>
<tr>
<td>Residual soil nitrate</td>
<td>120 lbs/acre</td>
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<tr>
<td>N credits</td>
<td>170</td>
</tr>
<tr>
<td>Fertilizer application rate</td>
<td>104</td>
</tr>
</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>242</td>
</tr>
<tr>
<td>N_225</td>
<td>2.99</td>
<td>166</td>
<td>38%</td>
<td>269</td>
</tr>
<tr>
<td>N_275</td>
<td>3.07</td>
<td>187</td>
<td>42%</td>
<td>319</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

- Assumption: annual N mineralization 75-125 lbs/acre
- N mineralized during growing season: 30-50 lbs/acre
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

- CDFA Fertilizer Research and Education Program (FREP)
- California Tomato Research Institute
- UC ANR California Institute for Water Resources
- Growers
- Gene Miyao, Brenna Aegerter, Tom Turini, Michael Cahn, Tim Hartz
- Israel Herrera and the Russell Ranch field team
- Kelley Liang, Irfan Ainuddin, Patricia Lazicki, Ken Miller