Nutrient Management in Brassica Crops

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Nitrogen Management of Leafy Vegetables

- Nitrogen management of vegetables in the coastal production districts is under greater scrutiny.
- Growers will need to report nitrogen usage to the Central Coast Regional Water Quality Control Board in 2014.
Nitrogen Management of Leafy Vegetables

- As a result, growers are looking for tools to improve nitrogen use efficiency
Nitrogen Management of Leafy Vegetables

- An important tool in nitrogen management is to account for residual N mineralized from prior crop residues
Nitrogen Management of Leafy Vegetables

• Another way of improving nitrogen use efficiency is to capture nitrate that may have moved to deeper in the soil profile and bring it back to the surface for another opportunity to use it.
Nitrogen Management of Leafy Vegetables

- Crops like sugar beets and small grains, when they were viable crops in the Salinas Valley, were capable of retrieving nitrogen from deeper in the soil profile.
- Cover crops can do this but we are limited in their use.
Nitrogen Management of Leafy Vegetables

• In recent studies funded by the Fertilizer Research and Education Program (CDFA), we observed that cole crops can scavenge nitrate
Nitrogen Uptake by Broccoli, Cauliflower and Cabbage
Nitrogen Dynamics in Cole Crops – Summer Production

<table>
<thead>
<tr>
<th>Crop</th>
<th>Dry Biomass Lbs/A</th>
<th>Percent Nitrogen</th>
<th>Percent Potassium</th>
<th>Potassium Uptake Lbs/A</th>
<th>Phosphorus Uptake Lbs/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broccoli</td>
<td>8,585</td>
<td>4.0</td>
<td>4.2</td>
<td>360</td>
<td>44</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>6,930</td>
<td>4.1</td>
<td>4.3</td>
<td>299</td>
<td>45</td>
</tr>
<tr>
<td>Cabbage</td>
<td>11,564</td>
<td>3.0</td>
<td>3.2</td>
<td>361</td>
<td>42</td>
</tr>
</tbody>
</table>
# Nitrogen Dynamics in Cole Crops – Summer Production

<table>
<thead>
<tr>
<th>Crop</th>
<th>Harvest Product</th>
<th>Leaves</th>
<th>Stalks</th>
<th>Roots</th>
<th>Residue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broccoli</td>
<td>99 N/A</td>
<td>198 N/A</td>
<td>41 N/A</td>
<td>11 N/A</td>
<td>238 N/A</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>61 N/A</td>
<td>204 N/A</td>
<td>20 N/A</td>
<td>10 N/A</td>
<td>224 N/A</td>
</tr>
<tr>
<td>Cabbage</td>
<td>188 N/A</td>
<td>164 N/A</td>
<td>---</td>
<td>9 N/A</td>
<td>163 N/A</td>
</tr>
</tbody>
</table>
# Nitrogen Dynamics in Cole Crops – Summer Production

<table>
<thead>
<tr>
<th>Crop</th>
<th>Fertilizer applied</th>
<th>Crop Uptake</th>
<th>Scavenged from soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broccoli</td>
<td>181</td>
<td>337</td>
<td>155</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>260</td>
<td>285</td>
<td>21</td>
</tr>
<tr>
<td>Cabbage</td>
<td>215</td>
<td>337</td>
<td>97</td>
</tr>
</tbody>
</table>
Nitrogen Uptake Curve
Summer Broccoli

\[ y = 5.72x - 157.9 \]
\[ R^2 = 0.89 \]
Nitrogen Dynamics in Cole Crops – Winter Production

<table>
<thead>
<tr>
<th>Crop</th>
<th>Dry Biomass</th>
<th>Percent Nitrogen</th>
<th>Percent Potassium</th>
<th>Potassium Uptake</th>
<th>Phosphorus Uptake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broccoli</td>
<td>5,539</td>
<td>4.5</td>
<td>3.3</td>
<td>194</td>
<td>32</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>6,490</td>
<td>4.2</td>
<td>3.7</td>
<td>236</td>
<td>36</td>
</tr>
</tbody>
</table>
Nitrogen Dynamics in Cole Crops – Winter Production

<table>
<thead>
<tr>
<th>Crop</th>
<th>Harvest Product</th>
<th>Leaves</th>
<th>Stalks</th>
<th>Roots</th>
<th>Residue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broccoli</td>
<td>94</td>
<td>128</td>
<td>29</td>
<td>8</td>
<td>156</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>70</td>
<td>160</td>
<td>14</td>
<td>9</td>
<td>175</td>
</tr>
</tbody>
</table>
## Nitrogen Dynamics in Cole Crops – Winter Production

<table>
<thead>
<tr>
<th>Crop</th>
<th>Fertilizer applied (N/A)</th>
<th>Crop Uptake (N/A)</th>
<th>Scavenged from soil (N/A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broccoli</td>
<td>272</td>
<td>249</td>
<td>23+</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>351</td>
<td>273</td>
<td>78+</td>
</tr>
</tbody>
</table>
Nitrogen Uptake Curve
Winter Broccoli

\[ y = 2.62x - 153.8 \]
\[ R^2 = 0.71 \]
Nitrogen Uptake by Broccoli, Cauliflower and Cabbage

- Where is the extra nitrogen coming from in the summer-grown broccoli?
- Is broccoli acting like a cover crop in that it is bringing up nitrate from deeper in the root zone?
Rooting Depth and Nitrate at the End of the Growing Season
Spinach Root Distribution

- **0-4 in**: 7 roots/in²
- **4-8 in**: 4 roots/in²
- **8-12 in**: 1 root/in²
- **12-16 in**: 1 root/in²
- **16-20 in**: 1 root/in²
- **20-24 in**: 1 root/in²

Depth (in) vs. roots/in²
Nitrate Distribution in Spinach Beds at Harvest
Root Density of Lettuce at Various Soil Depths

Bed Width (inches)

Drip line

Plant Line

Plant Line

Drip line

Depth (inches)

Root Number / 100 cm²

Legend:
- 0
- 10
- 20
- 30
- 40
- 50
- 60
- 70
Soil Nitrate Distribution in Lettuce

Bed width (inches)

Drip tape

Plant row

Plant row

Nitrate-N (ppm)

Depth (inches)
End of Crop Nitrate Dynamics

• Nitrate can accumulate at the bottom edge of the root zone of lettuce and spinach
• Nitrogen from crop residues is also disced into the soil, enriching the upper soil layers with nitrate
Measurements of nitrate in soil at various depths in the root zone following a prior crop and over the crop cycle of broccoli
Nitrogen in the Top Three Feet of Soil over the Broccoli Crop Cycle

One Field

Growth Stage of Broccoli

preplant  early growth  late growth  harvest

NO₃-N ppm

0  10  20  30  40  50  60  70  80  90

First foot  Second foot  Third foot
Residual Soil Nitrogen Utilized by the Broccoli Crop

One Field

<table>
<thead>
<tr>
<th>Depth</th>
<th>Lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>58</td>
</tr>
<tr>
<td>2nd</td>
<td>70</td>
</tr>
<tr>
<td>3rd</td>
<td>26</td>
</tr>
<tr>
<td>Total</td>
<td>154</td>
</tr>
</tbody>
</table>

Growth Stage of Broccoli

- preplant
- early growth
- late growth
- harvest
Evaluation of Nitrate in the 1st & 2nd Foot of Soil (5 fields)

Growth Stage of Broccoli

<table>
<thead>
<tr>
<th>Depth</th>
<th>Lbs N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>40</td>
</tr>
<tr>
<td>2nd</td>
<td>24</td>
</tr>
<tr>
<td>Total</td>
<td>64</td>
</tr>
</tbody>
</table>
Broccoli Rooting Depth

Depth - inches

Portion of the Growth Cycle

Early                        Mid                    Late                  Harvest

0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8

34.1”
Cauliflower Rooting Depth

Portion of the Growth Cycle

Depth - inches

34.1”
90 Day Old Cauliflower Roots
Cabbage Rooting Depth

![Graph showing the portion of the growth cycle vs depth, with a peak at 30.9 inches.]
Recommendations

• Measure the levels of residual nitrate in the second foot early in the growth cycle of cole crops

• Given that broccoli is taking up nitrogen from the top two feet, this information will give you a better sense of what nitrogen resources are available for that crop

• Careful water management will be necessary to maintain the nitrate in the top two feet before the broccoli roots reach there
Recommendations

• All of the cole crops leave sizeable quantities of nitrate in their crop residue
• This nitrate will rapidly mineralize nitrate for subsequent crop use
• Again, careful irrigation will better assure that this nitrogen is available for subsequent crops that are shallower rooted