Nitrogen Fertilizer Technology Evaluations and Nitrogen Uptake by Vegetables

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The Nitrate Dilemma

• Nitrate is just one of the sources of nitrogen used for crop growth
• It comes from nitrate in the fertilizer and from mineralization of urea and ammonium in fertilizer
• It also comes from mineralization of crop residues and soil organic matter
The Nitrate Dilemma

• Nitrate has a negative charge and is not absorbed by the clays or organic matter in the soil

• Ammonium has a positive charge and is attracted to the negative charges on clay and organic matter
The Nitrate Dilemma

- The issue is that once soils warm in the spring to >60 F
- Soil microbes convert ammonium to nitrate within 7-14 days
- Ammonium-N levels are typically in the 1-2 ppm range in the summer
- Nitrate-N levels vary greatly but can be quite elevated (20 - 40 ppm)
The Nitrate Dilemma

• If we could keep more of the plant available N as ammonium or protect it some other way, there may be an opportunity to increase the nitrogen use efficiency of applied N

• We could also reduce leaching losses from big irrigation events (i.e. germination phase of crops)
Nitrogen Fertilizer Technology

• There are fertilizer technologies that can help in this regard:
  ▪ Nitrification inhibitors
    ▪ DCD (Agrotain Plus, Koch Industries)
    ▪ Nitropyrin (Instinct, Dow AgroSciences)
    ▪ DMPP (Entec, BASF – used in Europe)
  ▪ Controlled & slow release fertilizers
    ▪ Coated prills (Duration, ESN)
    ▪ Chains of urea (Nitamin, N-Sure, Greenfeed)
Fertilizer Technology

AGROTA\textsuperscript{IN} PLUS

Dry Concentrate

ESN
SmartNitrogen

Duration\textsuperscript{45}
Controlled-Release Fertilizer

nitamin

GREENFEED™

N-Sure®
2011 Lettuce Yield (T/A)
Nitrification Inhibitor Trial

Lbs N/A

10  150  100  100 + Agrotain  100 + 4% DCD  100 + 8% DCD
# 2012 Lettuce Fertilizer Trial

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Total N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>25</td>
</tr>
<tr>
<td>Standard</td>
<td>155</td>
</tr>
<tr>
<td>Moderate</td>
<td>105</td>
</tr>
<tr>
<td>Agrotain Plus</td>
<td>105</td>
</tr>
<tr>
<td>G77</td>
<td>105</td>
</tr>
<tr>
<td>DMPP</td>
<td>105</td>
</tr>
<tr>
<td>N-Sure</td>
<td>105</td>
</tr>
<tr>
<td>D45</td>
<td>105</td>
</tr>
<tr>
<td>D45 + sidedress</td>
<td>155</td>
</tr>
<tr>
<td>D45</td>
<td>155</td>
</tr>
</tbody>
</table>

Fertilizer additives or slow release fertilizers at the moderate fertilizer rate
Injection of fertilizer treatments:
- Each treatment had its own main
- Treatments were injected into the ports and each main delivered the N to the associated beds
Yield Evaluation
Tons/A

Untreat 155 Standard 105 105+Agroain 105+G77 105+DMPP 105+N-Sure 105 D45 105 D45SD 155 D45

Legend:
a b c c d d d d
Nitrate-N at 2 – 3 Feet in Soil
August 15

Average at start of trial (July 2) = 1.6 ppm
2012 Spinach Evaluation
Spinach Biomass Evaluation

26 days after germ water

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Biomass Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>D45 120</td>
<td>1.8</td>
</tr>
<tr>
<td>D45 80</td>
<td>1.4</td>
</tr>
<tr>
<td>SU 80</td>
<td>1.2</td>
</tr>
<tr>
<td>Standard</td>
<td>1.0</td>
</tr>
<tr>
<td>Untreated</td>
<td>0.2</td>
</tr>
</tbody>
</table>
Ammonium-N in Soil

18 days after germ water

Fertilizer Type

ppm Ammonium

D45 120  D45 80  SU 80  DMPP  Stand  Untreat

60.00
50.00
40.00
30.00
20.00
10.00
0.00
Nitrogen Technology Summary

• These trials showed tremendous potential for these fertilizer technologies

• We will be very interested in the progress of Instinct as Dow AgroSciences pursues registrations of Instinct on lettuce and other cool season crops
Nitrogen Uptake by Cool Season Vegetables
Nitrogen Uptake by Broccoli, Cauliflower and Cabbage

- Research funded by the Fertilizer Research and Education (FREP) Program to determine the nitrogen uptake by cole crops

- 52,690
- 17,400
- 5,180
Nitrogen Uptake by Broccoli, Cauliflower and Cabbage

• A survey of 32 highly productive fields are being surveyed in 2012-13 to determine the total N uptake by these crops

• Also the rate of uptake is being evaluated and will ultimately be added to the CropManage program

• About half of the survey fields have been completed
## Fates of Nitrogen in Cole Crops Production and Harvest

### 2012 Survey Results

<table>
<thead>
<tr>
<th>Crop</th>
<th>Fertilizer applied</th>
<th>Crop Uptake</th>
<th>Scavenged from soil</th>
<th>Removed in harvest</th>
<th>Residue after harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broccoli</td>
<td>181</td>
<td>323</td>
<td>141</td>
<td>80</td>
<td>243</td>
</tr>
</tbody>
</table>
Broccoli

\[ y = 5.44x - 138.6 \]

\[ R^2 = 0.88 \]

Days after germination water

Lbs N acre\(^{-1}\)
Broccoli Nitrogen Uptake Dynamics

• The total biomass of broccoli averaged 4.1 tons/A
• Percent N in the tissue averaged 4.1%
• These two factors drive the total N uptake to over 300 lbs N/A
Broccoli Nitrogen Uptake Dynamics

• The question is: where is the non-fertilizer N coming from?
• Broccoli may have more efficient and deep root systems than we realize

90 Day Old Cauliflower Roots (note roots down to 3-4 feet)
Nitrate-N in the Root Zone of Broccoli
Broccoli Nitrogen Uptake Dynamics

• To fully understand the fertility dynamics of broccoli, we will have to measure the nitrate levels down deeper than the one foot level.
Implications of Broccoli Nitrogen Uptake

• Broccoli N uptake will affect the 1.0 nutrient applied to uptake ratio put forth in the Ag Order
Implications of Broccoli Nitrogen Uptake

• In addition, the nitrogen taken up by broccoli may potentially be keeping nitrogen that would otherwise be lost to leaching “in play” and provide another opportunity to utilize it for crop growth

• Broccoli as a rotational crop for lettuce may be retrieving unused that may be at risk of leaching from the soil and keeping it higher in the soil profile
Nitrogen in Broccoli Residue

• The tricky issue is that broccoli residue contains as much as 240 lbs N.
• More than half of the N in the residue can mineralize in 4-6 weeks.
Nitrogen in Broccoli Residue

• The nitrate released from broccoli residue can be measured and taken into account with use of the nitrate quick test.
## Fates of Nitrogen in Cole Crops Production and Harvest

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</tr>
</thead>
<tbody>
<tr>
<td>Cauliflower</td>
<td>260</td>
<td>264</td>
<td>5</td>
<td>57</td>
<td>207</td>
</tr>
<tr>
<td>Cabbage</td>
<td>249</td>
<td>328</td>
<td>81</td>
<td>178</td>
<td>149</td>
</tr>
</tbody>
</table>
Summary

• Looking at cole crops as a scavenging crop may change the way we look at ways to improve nitrogen use efficiency in our leafy green production system

• Effectively managing and utilizing residual N left behind following cole crops will be important for closing the loop