Intelligent Inputs for Corn: Nitrogen Considerations

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<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Historical</th>
<th>Nov. 2021</th>
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</thead>
<tbody>
<tr>
<td>Corn:Nitrogen</td>
<td>3.36</td>
<td>8.99</td>
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<tr>
<td>Wheat:Nitrogen</td>
<td>2.70</td>
<td>6.73</td>
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<tr>
<td>Corn:Phosphorus</td>
<td>5.02</td>
<td>7.26</td>
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<tr>
<td>Wheat:Phosphorus</td>
<td>4.05</td>
<td>5.43</td>
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</table>
Approaches to N Recs

• Maximum Return to Nitrogen (MRTN)
  – IA, MN, WI, IL, IN, MI, OH
  – State specific
  – No profile N credit, OM credit embedded

• NDSU MRTN
  – Does account for profile N
  – No explicit OM credit

• Mechanistic
  – KSU, CSU, UNL, OSU, ServiTech, AAL

Let's talk about the mechanistic approach to N recommendations

• The overall idea is to think about peak plant uptake needs, and then work backwards

\[ N_{\text{rec}} = YG \times \text{some factor} - \text{credits} \]

Organic Matter, Profile NO₃, PCA

Common misconception is that it’s a removal based system…. NOT TRUE!

Let's talk about the mechanistic approach to N recommendations

• So why this approach vs. what other states of done?
  – Residual Nitrate. In Kansas production systems it’s real, it’s measurable, and it’s valuable
  – Wide range of yield potentials and environmental factors
    • Irrigated vs. Dryland
    • East to West
    • Heavy silt loams vs. blow sand
Past K-State Recommendation

Corn Nitrogen Recommendations

<table>
<thead>
<tr>
<th>Yield (Bu/A)</th>
<th>1.0</th>
<th>1.5</th>
<th>2.0</th>
<th>2.5</th>
<th>3.0</th>
<th>3.5</th>
<th>4.0</th>
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Nrec = YG x 1.6 – Profile N – Soil OM Credit – Other Credits

But what about lbs/bu?

“You KSU guys are nuts! It doesn’t take 1.6 lbs/bu, I can do it on 0.7!”

• The farm press as well as many producers and consultants want to think in terms of lbs/bu
  – A nice simple number for bragging rights
  – Probably not a bad approach in the corn belt
  – Maybe useful in less dynamic systems in Kansas (e.g. continuous irrigated corn)
• BUT:
  – If you don’t know NO₃ at the beginning and end of the season, it’s really not that useful of a number

“Old” K-State Corn Nrec

Nrec = YG x 1.6 – Profile N – Soil OM Credit – Other Credits

(130 x 1.6) – 40 lb/ac – (2.5 x 20)
208 – 40 – 50 = 118 lb/ac
= 0.9 lb/bu
Lets talk about the mechanistic approach to N recommendations

- Limitations
  - At the end of the day, it's still a best guess (as is any N recommendation method)
  - Lots of moving pieces
    - Soil Efficiency
    - Fertilizer Efficiency
    - Organic Matter Mineralization

### Kansas Corn Nitrogen Response Database

\[ \begin{align*}
N \text{ lbs/a} &= \left[ \frac{ie}{fe} \right] \left( EY - (se)NO_3 - SOM - PCA \right) \times Price_{Adj} \\
\text{Minimum N rate} &= 30 \text{ lbs/a}
\end{align*} \]

**ie (corn internal efficiency), lbs/bu**
- Irrigated: 0.84
- Non-Irrig: 0.88

**fe (fertilizer recovery efficiency)**
- High efficiency: 0.70 (Injected + split applied)
- Default: 0.65 (Pre-plant)
- Low efficiency: 0.55 (Broadcast, fall-applied)

**se (“soil” NO3 efficiency)**
- Low N loss: 1.0 (Medium texture or western KS)
- High N loss: 0.7 (Corse texture or eastern KS)

**Corn**

\[ \begin{align*}
\frac{0.88}{0.70} &= 1.3 \text{ lb/bu} \\
\frac{0.88}{0.65} &= 1.4 \text{ lb/bu} \\
\frac{0.88}{0.55} &= 1.6 \text{ lb/bu}
\end{align*} \]

**DRYLAND**

\[ \begin{align*}
\frac{0.88}{0.70} &= 1.2 \text{ lb/bu} \\
\frac{0.88}{0.65} &= 1.3 \text{ lb/bu} \\
\frac{0.88}{0.55} &= 1.5 \text{ lb/bu}
\end{align*} \]

**IRRIGATED**

\[ \begin{align*}
\frac{0.84}{0.70} &= 1.2 \text{ lb/bu} \\
\frac{0.84}{0.65} &= 1.3 \text{ lb/bu} \\
\frac{0.84}{0.55} &= 1.5 \text{ lb/bu}
\end{align*} \]

### Sorghum

\[ \begin{align*}
N \text{ lbs/a} &= \left[ \frac{ie}{fe} \right] \left( EY - (se)NO_3 - SOM - PCA \right) \times Price_{Adj} \\
\text{Minimum N rate} &= 30 \text{ lbs/a}
\end{align*} \]

**ie (sorghum internal efficiency), lbs/bu**
- Sorghum: 1.2

**fe (fertilizer recovery efficiency)**
- High efficiency: 0.70 (Injected + split applied)
- Default: 0.65 (Pre-plant)
- Low efficiency: 0.55 (Broadcast and applied in the fall)

**se (“soil” NO3 efficiency)**
- Low N loss: 1.0 (Medium texture or western KS)
- High N loss: 0.7 (Corse texture or eastern KS)

\[ \begin{align*}
\frac{1.2}{0.70} &= 1.7 \text{ lb/bu} \\
\frac{1.2}{0.65} &= 1.8 \text{ lb/bu} \\
\frac{1.2}{0.55} &= 2.2 \text{ lb/bu}
\end{align*} \]
Nitrogen Pays – Year over Year

**Dryland Nrec Comparisons**

Assumptions:
- Dryland
- 2.3% OM, f=0.65, se=1.0, ProfileN = 40 lb/ac
- CORNprice = 55.25/bu, Nprice = $0.60/lb

**Irrigated Nrec Comparisons**

Assumptions:
- Irrigated
- 2.5% OM, f=0.65, se=1.0, ProfileN = 40 lb/ac
- CORNprice = $2.25/bu, Nprice = $0.00/lb

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**Nitrogen Pays – How bad could it get?**

**Nitrogen Pays – Year over Year**

Net Returns to Nitrogen, $/lb Applied

- $3.80 Corn, $0.35 N
- $5.00 Corn, $0.60 N

YG=235 bu/ac, 2.5% OM, 30 lb/ac NO3 Standard Preplant N Application

Net Returns to Nitrogen, $/lb Applied

- $3.80 Corn, $0.35 N
- $2.00 Corn, $0.55 N

YG=235 bu/ac, 2.5% OM, 30 lb/ac NO3 Standard Preplant N Application
Economic Choices in N Management

OK, we said that applying whatever N it takes to meet the yield goal is essentially a “no-brainer”, even at today’s fertilizer prices (because it’s relative to crop prices).

Value of Knowing Soil Nitrate - Irrigated

Economic Choices

So where is there money to be made in Nitrogen management today?

1. Importance of using a proper yield goal
   1. For us in the west, this is heavily water driven

2. Knowing what we have. This is really important if we screwed up on step 1 last year (e.g. drought).

3. Economic benefits to implementing 4R
   i.e. reducing cost through improving fertilizer efficiency
Value of Knowing Soil Nitrate - Dryland

- Nrec = 10
- Ncost = $9.70/ac
- $82.45 / 65 lbs profile N = $1.50 /lb ?!!?!!

Economics of Timing and Placement

- Nrec = 195
- Ncost = $68.25/ac
- Difference of $19.22/ac
- YG=235 bu/ac, $3.80 Corn, $0.35 N, 5.4 Price Ratio

Economics of Product Price, Timing, and Placement

- Nrec = 195
- Ncost = $68.25/ac
- Difference of $31.75/ac
- Also ignores differences in volatilization risk
Timing

• Some limitations in dryland, but still important
  – Moisture to move N into profile
  – Avoiding “tie-up”, minimizing volatilization potential
• Great opportunities with fertigation

Source

• Cost per lb. of nutrient
  – Always do the math!
• Equipment Considerations
  – VRT Equipment
• Source vs. Timing of Application

Change in profit if true STN varies from expected STN
STP = 16 ppm; OM = 1.6%; Expected STN = 40 lb/ac
Corn @ $5.25, Wheat @ $7.46, N @ $1.00, P @ $0.65
95 bu/ac Corn, 60 bu/ac Wheat

Change in profit if true STP varies from expected STP
STN = 40 lb/ac; OM = 1.6%; Expected STP = 16 ppm
Corn @ $5.25, Wheat @ $7.46, N @ $1.00, P @ $0.65
95 bu/ac Corn, 60 bu/ac Wheat
Data Quality

- The proceeding economics are based on having good data, as good of a representation of “truth” as we can reasonably obtain.
- Good decisions require good data
- Good soil test data comes from good procedures in the field

Number of Cores to Make a Good Sample

- Soils vary across very short distances in nutrient supply due to many factors including:
  - Position on the landscape
  - Past erosion
  - Parent material of the soil
- We also induce variability on the soil
  - Band applications
  - Livestock grazing
- To account for this variation you should take 10-20 cores per sample

Example of the relationship between number of soil cores per composite sample and error

Mean soil P = 19ppm
Economics of Accuracy

Profits from soil sampling at different number of points relative to an all-point composite

- No other data is available (i.e. yield data)
- Field is located in NW Kansas and was grid sampled on 2.5 ac grids
- Samples consisted of 15 cores, so an estimated CI of +/- 3.5 ppm

Soil Test Bray P1

Soil Test P Histogram

Max = 217
Min = 7
Average = 21.7
(20.1 without outlier)

Not a good example of interpolation!
Returns to VRT

Difference in Gross Returns Less Fertilizer Field Composite vs. VRT

• Average gross return on VRT P for wheat = $3.81/acre/year
• Average gross return on VRT P for corn = $4.49/acre/year
• The above gross figures would need to cover sampling cost and the portion of machinery and labor cost related to VRT implementation

Can we stretch the value of intensive sampling?

• ROI on intensive sampling increases dramatically as the number crops benefiting from the information increases (spreading fixed cost)
• Checkbook approach for nutrients using initial intensive soil test and removal rates from yield monitor data

Questions?
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