Successful nitrogen management

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University of Missouri
Crop Management Conference
November 30, 2011

Central Iowa, August 2008
Improving your game plan for N

• Timing!
• Rate
• Sources & additives
• Evenness of applications
Nitrogen timing

• Grain: It’s all about risk
  – Some big losses in recent years: our corn N game plans didn’t work

• Forage: It’s all about low-cost weight gain
Nitrogen timing: grain

• Too early: risk of losing N & yield
  – What’s ‘too early’?—depends on weather

• Too late: risk of losing:
  – Opportunity to get applicator through field
  – Yield potential due to N stress (with corn, less risk than you’d think)
Risk with fall ammonia

1) 8 bushel average yield loss in an average weather year
   a) Average 15 production fields in Missouri
   b) agrees with long-term study in Minnesota
2) Pencil this in when deciding if & how much fall N to use
3) 2 bushel average yield loss in two dry years
4) We’re lacking research in wet years, but I’ve seen plenty of yellow corn that got fall N
## Fertilizer source/timing: risk level

<table>
<thead>
<tr>
<th>Nitrogen source</th>
<th>Date applied</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anhydrous ammonia</td>
<td>before November 1</td>
<td>5</td>
</tr>
<tr>
<td>Anhydrous ammonia</td>
<td>Nov. 1 - Dec. 31</td>
<td>4</td>
</tr>
<tr>
<td>Anhydrous ammonia</td>
<td>Jan. 1 - Feb. 28</td>
<td>3</td>
</tr>
<tr>
<td>Anhydrous ammonia</td>
<td>March 1 - Feb. 28</td>
<td>2</td>
</tr>
<tr>
<td>Anhydrous ammonia</td>
<td>May 1 or later</td>
<td>1</td>
</tr>
<tr>
<td>Urea</td>
<td>&lt; 4 days before excess water</td>
<td>4</td>
</tr>
<tr>
<td>Urea</td>
<td>4-14 days before excess water</td>
<td>3</td>
</tr>
<tr>
<td>Urea</td>
<td>&gt; 14 days before excess water</td>
<td>5</td>
</tr>
<tr>
<td>Ammonium nitrate or UAN solution</td>
<td>before April 1</td>
<td>5</td>
</tr>
<tr>
<td>Ammonium nitrate or UAN solution</td>
<td>April 1 - 30</td>
<td>4</td>
</tr>
<tr>
<td>Ammonium nitrate or UAN solution</td>
<td>May 1 or later</td>
<td>3</td>
</tr>
</tbody>
</table>
This field got 150 lb N/acre as NH₃ in very late November (+ DAP)

Average yield loss = 45 bu/acre
Total yield loss = 11,925 bu
  (45 bu/ac x 265 acres)
Total economic loss = $44,720
  (11,925 bu x $3.75/bu)
Corn: applying dry N early

• Four Missouri experiments with applying dry N (ammonium nitrate, urea) in March

• Average yield penalty: 35 bu/acre
  – Compared to same N source applied day of planting
  – Two experiments in 1995 (flood year), lots of rain, corn planted late
  – Two experiments in 1994
Nitrogen timing in the corn belt

- All-preplant is normal
- Massive failure over the past four years
- Wet spring weather leading to N loss and yield loss
- My current estimate: 2 billion bushels
Four wet springs

Outlined areas > 16 inches rain April-June

2008

2009

2010

2011
Widespread deficiency symptoms

Northwest Missouri, August 2008

Western Missouri, August 2009

Central Illinois, August 2009

Western Illinois, June 2010
Bradford Farm 2008:
in-season N kicks butt

180 N at planting

+ 44 bu/ac

110 N sidedress V7.5
Bradford Farm 2009: in-season N kicks butt again

+ 68 bu/acre

153 N sidedress V7.5

180 N at planting
Bradford Farm 2010: Can you believe a 3-peat?

80 bu difference
Nitrogen Watch: A tool to assess risk of N loss

Rainfall maps to track risk with preplant N

Inches of rain, April 1 to July 3
What about risk of yield loss with delayed N?

Not much of a problem!
My rescue N outcomes

• 11 tests, average yield response 34 bu/acre
• Yield response depended on visible stress
  – High stress: 57 bushels (2 tests)
  – Medium stress: 41 bushels (5 tests)
  – Low stress: 14 bushels (4 tests)
• How late is too late?
  – Six tests in 2010, all applied at tassel, ave 34 bu
  – Give up by 2 weeks after tassel (?)
Rescue N in Illinois: 37 bu
How do you balance all these N timing risks?
Winning game plans: Sander

- Ted Sander, producer, Randolph County
- About 70 lb N/acre preplant
  - In DAP
  - With herbicide
- Sidedress with Hagie UAN injector guided by crop sensors
Winning game plans: Riekhof

• Gary & Garret Riekhof, producers, Lafayette County

• Fall or spring NH₃
  – Some fields full rate, some fields lean rate

• Chicken litter on some fields (slow release)

• Tractor-drawn sidedress UAN injection for fields with visible stress (esp. lean NH₃ rate)
  – Corn up to 40’
Winning game plans: Ramsey

- Gabe Ramsey, Central Missouri Agri-Services (Marshall)
- Producers follow their normal N program
  - Suggest 130-150 lb N/ac as NH₃ + N-Serve
- Spinner with crop sensors
  - Help producers who experience N loss
Winning game plans: Schaefer

- Dan Schaefer, Illini FS (eastern Illinois)
- Held organizing meeting to sell new N program
- Reduce preplant N rates to 70% (fall NH₃)
- Apply N with herbicide
- High-clearance spinner to topdress urea
  - Always in corn after corn
  - In rotated corn based on appearance & weather
- Spinners are ‘combo’ machines
  - Use to spray if low need for topdress
  - Use for topdress if needed, lease sprayer(s)
Winning game plans: Brown

- Steve Brown, Macon MFA
- Organized rescue N airplane in 2010
- 2011 started planned in-season N program with some customers, either:
  - Tractor-drawn UAN injection (contractor) OR
  - Plane broadcasting SuperU
  - Choice based on customer preference
  - Reduced preplant N rates
Your New Game Plan

• If you’re not sidedressing, you MUST be ready to apply in-season N when preplant N is lost
• Planned low-rate sidedress N is catching on
  – Flexible to allow increased in-season N in seasons with N loss
## Nitrogen timing in wheat

<table>
<thead>
<tr>
<th>N Timing</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preplant</td>
<td>Stimulate tiller development</td>
</tr>
<tr>
<td>Greenup</td>
<td>Stimulate tiller development</td>
</tr>
<tr>
<td>Prejointing</td>
<td>Support rapid crop growth</td>
</tr>
</tbody>
</table>
Wheat: applying N early

- On average over 9 tests in Missouri, March N beats Feb. N by 3 bu/acre
- For four tests with yield > 70, March N beats Feb N by 8 bu/acre
If you must topdress early, use ESN!

Anytime you topdress urea, use Agrotain!

Columbia 2005, 2006
Late N applications for wheat

• Two experiments in Missouri
• Yield potential starts to drop if N is delayed until the two-joint stage
• By boot stage, there are only two reasons to apply N:
  – Extreme deficiency
  – You’re getting a high-protein premium
• Wheat is less forgiving than corn with late N
Nitrogen timing in grass

<table>
<thead>
<tr>
<th>N Timing</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>March</td>
<td>Hay—maximum tons</td>
</tr>
<tr>
<td>May</td>
<td>Increase summer grazing</td>
</tr>
<tr>
<td>August</td>
<td>Increase fall &amp; winter grazing</td>
</tr>
</tbody>
</table>

In pasture, N timing is about extending the grazing season!
What about N rate?
Optimal fertilizer N rate varies widely among fields

• 20 on-farm experiments in Missouri with corn after soybean, no manure
• Optimal N rates were 109, 114, 175, 0, 90, 190, 244, 63, 119, 300, 0, 146, 146, 180, 52, 175, 112, 149, 136, 114 lb N/acre
• Does anybody see a pattern?
• There is a lot of confusion about how much N to apply, and how to make the decision
Optimal N rate varies widely within fields, too

What happens when you apply 150 lb N/acre to the whole field?

Yes: Minnesota, Kansas, Missouri, Pennsylvania

No: Wisconsin
So how can we improve N rate decisions?
How can we decide where to put more N? Where to put less?

<table>
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<tr>
<th>Predictor</th>
<th>% of variability in N need explained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield</td>
<td>13 to 20</td>
</tr>
<tr>
<td>Soil nitrate</td>
<td>17</td>
</tr>
<tr>
<td>Soil conductivity</td>
<td>8</td>
</tr>
<tr>
<td>Corn color</td>
<td>53 to 77</td>
</tr>
</tbody>
</table>
Color sensors: the most accurate & convenient diagnostic tool

Controller runs ball valve to change fertilizer rate

Computer in cab reads sensors, calculates N rate, directs controller

New N rate diagnosis every second

New N rate every second
Demonstration program: started in 2004 to help farmers try this technology
Sensor demo outcomes

- 55 replicated on-farm trials
- Increased corn yield by 2 bushels/acre
- Reduced N use by 14 pounds/acre
- Increased partial profit by $17/acre
- Reduced ‘surplus N’ by 27%
- Based on Missouri interpretations for sensors
- Works with all N forms, placements
Sensors also work to guide rate decisions for cotton, probably wheat
N rate: summary

• Optimal N rate varies widely
  – From field to field
  – From place to place within a field

• Difficult to predict
  – Influenced by many factors—fertilizer N loss, soil N supply
  – Many failed attempts to develop prediction systems

• Crop color is by far the most accurate
  – But doesn’t fit most N management systems in MO
N sources

- All N sources are good
- All can succeed
- All can fail
Two things NOT to do

• Don’t surface-apply untreated urea and leave it on top
• Don’t broadcast UAN solution on high-residue fields
Urea on the surface

• Will generate ammonia gas, escape to air
• Average 25% loss
  – Range 0 to 50%
  – Depends on weather after application
• Effectively prevented by:
  – Coating with Agrotain
  – Incorporating with tillage (within 3 days)
  – Incorporating with irrigation (within 3 days)
Surface urea and yield loss: How much?

• Missouri research
• Broadcast and left on surface
  – mostly no-till
• Corn: 14 bu/acre
  – Average of 38 tests in Missouri
  – (Yield with ammonium nitrate) – (yield with urea)
• Wheat: 5 bu/acre
  – Average of 9 tests, same comparison
UAN broadcast on residue

- Will get tied up on residue (even soybean)
- Not lost but not available to the crop
- Minimize contact between N and residue
  - Inject below surface residue (best)
  - Dribble on surface residue (OK)
- Broadcast UAN on low-residue fields is OK
UAN and yield loss: How much?

- Missouri research
- Broadcast in no-till
- Corn: 25 bu/acre
  - Average of 20 tests in Missouri
  - (Yield with ammonium nitrate) – (yield with broadcast UAN solution)
Even N application

• Aren’t we doing that already?
• My aerial photos say NO
Overall, about 2/3 of fields with yellow corn have streaks.
Why??

• Most common streak widths:
  – 30
  – 40
  – 60
  – 80

• Spinners & anhydrous bars
Spinners

• I think it’s mostly a material problem
• Increasing imports of dry N
  – Through more augers
  – More fines than in the past
• You can’t throw dust
• Also probably some failure to set spinners correctly
Anhydrous bars

- Mainly due to uneven distribution at manifold
- Two main solutions:
  - Use a new, ‘better’ manifold!
  - Randomize hoses so that low rates aren’t applied through adjacent knives
Nitrogen: summary

- Timing affects risk:
  - Loss
  - Logistics
  - Corn: more risk early than late
- Optimal rate varies widely, hard to predict
- Crop color is by far the most reliable predictor
  - Inconvenient for most producers
Nitrogen: summary

• N sources all good but avoid:
  – Untreated urea left on the surface
  – UAN broadcast onto a high-residue surface
• Problems with streaky applications are widespread
• Poor-quality dry N (lots of dust)
• Low-performing anhydrous manifolds
Thanks for your time & attention—comments or questions?

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