Addressing nitrogen controversies

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Objective:
The objective of this project is to collect data that will help to address several controversies about nitrogen management, including:

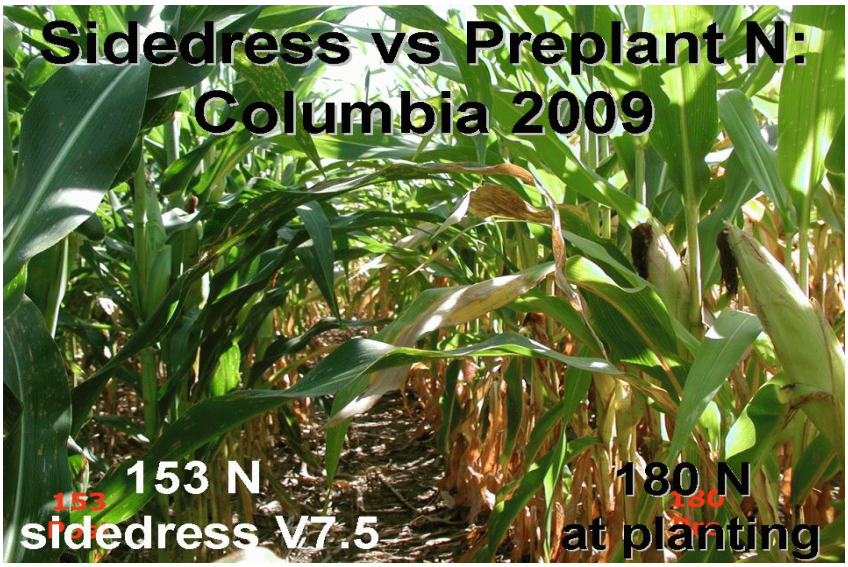
1) How do various nitrogen rate recommendation systems perform?
2) Is foliar N more efficient than soil-applied N, and is Coron more efficient than UAN?
3) Among the range of new N products and N-enhancement products, which are profitable to use and how do they rank?

Accomplishments for 2009:

- Three separate small-plot experiments (addressing objectives 1, 2, and 3 listed above) were conducted as planned at Bradford Farm near Columbia. All experiments used corn as the test crop. Unfortunately the foliar N experiment was harvested accidentally by the farm crew as bulk corn. We plan to extend this experiment an additional year (into 2011) to make up for the data lost this year. Results from the other two experiments are reported below.

Nitrogen rate recommendation systems experiment

- 2009 was, like 2008, a very wet year, especially in May and June.
- This wet weather apparently caused loss of much of the N applied at planting. By early August, all of the treatments with preplant nitrogen appeared severely nitrogen-deficient over the entire plant (see photo below). We observed the classic V-shaped nitrogen deficiency burn up the midrib on all plants in these treatments, usually up to the leaf below the ear leaf.
- The experiment was planted on April 25 and nitrogen treatments were applied the same day (broadcast ammonium nitrate). Many producers applied their N earlier than this, and there was a great deal of N deficiency across the state. I estimate that Missouri corn producers lost 110 million bushels due to N deficiency in 2009.
- All sidedress nitrogen treatments had much better leaf color (see photo). In early August these treatments were green right down to their lowest leaves (unlike 2008 when even sidedress plots had deficiency symptoms).



- Nitrogen timing had a large effect on yield in this experiment.
  - Plots receiving preplant N had an average yield of 70 bu/acre (see table next page).
  - Plots receiving sidedress N had an average yield of 168 bu/acre, an advantage of nearly 100 bu/acre.
  - Part of this advantage is due to the fairly high N rates recommended by all three sidedress recommendation systems in this wet year. Even so, two sidedress treatments applied less N than the 180 preplant N rate but out-yielded it by 68 or more bushels.
  - This large yield advantage to sidedress is in agreement with the appearance of the plants as shown in the photos on the previous page.

- After three years, the most profitable systems are the two systems in which N rate is based on corn color (Crop Circle sensor and Minolta chlorophyll meter).
  - These systems gave profits $160/acre/year above the profits given by the most profitable preplant N management system (which was the high N rate).
  - This is mostly due to the poor yields with preplant N in 2008 and 2009.
  - They also out-performed sidedress N management based on soil nitrate testing (Iowa State University interpretations) by about $25/acre/year.
    - Yield was higher with color-based management than soil-test-based management in the first two years.

Table 1. Nitrogen rates recommended and corn yields produced by eight different recommendation systems in 2009 and 2007-2009.

Nitrogen rate recommendation system	Nitrogen timing	Nitrogen rate(s) 2009	Yield 2009*	3-yr ave Nitrogen rate	3-yr ave Yield	Gross minus N cost (3-year ave)**
		lb N/ac	bu/ac	lb N/ac	bu/ac	$/ac
Crop Circle sensor	V7[†]	165, 191, 172, 166, 144, 162[‡]	166	132	148	513
Chlorophyll meter	V7	222	174	162	152	509
Sidedress soil test	V7	153	164	115	139	486
High	preplant	180	96	180	115	351
Yield goal / MRTN	preplant	140	64	137	102	322
Preplant soil test	preplant	132	64	140	99	313
Low	preplant	100	51	100	92	308
Check	-------	0	28	0	60	241

*2009 yields are different than each other (95% confidence) if they are 14 or more bushels apart.
**Used $4/bu corn price, $0.60/lb N price as estimates of average corn & N prices over these 3 years.
[†]Growth stage V7 is about knee high corn.
[‡]A different N rate was applied in each of 6 replications for this treatment. Average N rate was 167 lb N/acre. It is feasible to use this sensor to change N rate automaticallly while fertilizing a field, and we felt that this ability would be most accurately reflected by diagnosing N rate for each plot separately.

New N products and N-enhancement products experiment

- This experiment was designed to test the new N products Calcium Ammonium Nitrate and Nurea, the new N-enhancement products ESN, Nfusion, and Nutrisphere, along with the established N-enhancement product Agrotain. All treatments are dry broadcast N products except for the Nfusion treatment which was mixed with UAN solution and injected.
- No-till corn is the test crop. Soybean was the previous crop.
- A nitrogen rate of 140 lb N/acre was used for all treatments, applied on April 24, followed by planting on April 25 and replanting on May 21 at 30,300 seeds/acre.

Table 2. Yields with new N sources or N additives compared to standard dry N products.

Nitrogen source	2009 yield*	2008 yield**	2-yr ave yield
ESN	140	124	132
UAN + Nfusion	136	----***	----***
Urea + Agrotain	126	107	117
Urea + Nutrisphere	124	104	114
Ammonium nitrate	115	102	108
Calcium ammonium nitrate	108	106	107
Urea	120	93	106
Nurea	122	84	103
Check (0 N)	74	----***	----***

*Yields are different than each other (95% confidence) if they are 13 or more bushels apart.
**Yields are different than each other (95% confidence) if they are 18 or more bushels apart.
***Not included in 2008 experiment.

- Yields were not very good in this experiment considering the lack of drought stress.
  - Nitrogen timing (leading to N deficiency) was probably the main reason.
  - Yields for sidedress treatments in the N Recommendation Systems experiment were 24 or more bushels higher than the best-yielding treatment in this experiment, even though that experiment is corn after corn and this one is corn after soybean.

- ESN gave the highest yield for the second year in a row, demonstrating its value in protecting against N loss in the wet conditions that we've had in 2008 and 2009. Yield with ESN was statistically better than every other treatment except UAN + Nfusion. This is consistent with other experiments in Missouri where ESN increased yield under wet conditions. ESN is a coated urea product that slowly releases the urea from the capsule.

- As noted above, yields with sidedress treatments in the N Systems experiment were considerably better than yields with ESN in this experiment. In 2008, split-applied N with an 80 lb N/acre total rate (30 pre, 50 in-season) out-yielded 140 lb N/acre

preplant as ESN. Although these numbers are from separate experiments, they suggest that pre-plant ESN does not perform as well as having some N applied in-season in wet years. ESN appears to be the best N source (except possibly anhydrous ammonia) when applied preplant in a wet year, but its performance is not good enough to avoid the need for in-season N under those conditions.

- UAN blended with Nfusion also produced an average yield statistically higher than most other treatments. Nfusion is a slow-release N producet produced by Georgia-Pacific. It is a blend of methylene urea and triazone. This treatment was a 80-20 blend of UAN-Nfusion and did surprisingly well considering that only 20% of the N was in a slow-release form.

- Evidence of yield differences between the remaining treatments is limited. Nearly 5 inches of rain fall within a week of treatment application, starting with 2 inches 2 days after treatment application. Thus urea volatilization would not be expected to be a problem. Leaching or denitrification of nitrate-N would be the main expected loss pathway. Only the slow-release N products are intended to prevent or reduce this type of loss.

Table 3. Details of experimental procedures for the three experiments in this project.

Operation	**Experimental details for:**		
	N rate rec. systems	Foliar / in-season N	New sources of dry N
Starting condition	Previous corn, no-till, 70-75% residue cover	Previous soybean, no-till, 20-30% residue cover	Previous soybean, no-till, 20-30% residue cover
Pre-plant soil sampling	March 31	none	none
Weed control: broadcast herbicide application	4/24/2009: Burn down - Graxmoxone 2.0 pts/ac Residual - Lexar 3.0 qts/ac Nonionic surfactant – 2 pt /100/gal		
Pre-plant broadcast fertilizer treatments	3 fixed rate treatments & MO pre-plant soil test treatment 4/25/2009	All plots 30 lbs/ac N Source - Ammonium Nitrate 4/09/2009	All treatments applied pre-plant 4/24/2009
Planting	Planted 4/25/2009, replanted 5/21-22/2009 Planter: John Deere 7000 w/finger pickup Variety: Pioneer 35F44, RR2 Herculex xtra Seed drop: 30,300, depth: 1.25" - 1.50" Conditions: Moist		
In-season weed control	Roundup 24 oz/ac 6/21/2009		
Side-dress Treatment Applications	July 2	July 1 July 8	none
Harvest	November 6	Mistakenly harvested by farm crew, no data taken	November 5

Objective for 2010

Repeat these three experiments:

- N rate recommendation systems
- Foliar vs. soil-applied N
- New N products/additives

Budget for 2010

Research Specialist time	$15,000
Benefits	4,500
Soil sample analysis	200
Field supplies and fuel	800
Total	**$20,500**