

Timing and source of nitrogen for corn

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Objective & Relevance:

The objective of this project is to measure the yield impact of a range of nitrogen fertilizer application times for a range of nitrogen sources. Limited research in Missouri suggests that the timing of pre-plant N applications may have more impact on yield than most producers and crop advisors realize. The effect of timing is probably different for different N sources.

This project is relevant to Missouri agriculture because nitrogen fertilizer management has profound effects on profitability. Nitrogen deficiency has caused massive loss of corn yield in Missouri in 2008, 2009, and 2010 due to wet spring weather. Time of N application and N source have probably affected the degree of N deficiency and amount of yield lost. Data on the yield impact of N timing will help producers to balance risk of lost N and yield with the logistical factors that favor earlier application.

Procedures:

- Experiments will be conducted at Bradford Farm near Columbia. All experiments will use no-till corn as the test crop, with soybean as the previous crop.
 - This farm has claypan soils representative of the grain-producing claypan soils that are found across much of the northeast quarter of Missouri.
- Experimental treatments will be N timing and N source combinations as shown in the table below.

Nitrogen timing	Nitrogen Source							
	NH ₃	NH ₃ <i>with N-Serve</i>	Ammonium Nitrate	Urea	Urea <i>with Agrotain</i>	UAN <i>injected</i>	UAN <i>dribbled</i>	ESN <i>coated urea</i>
October	X	X						
December	X	X						
February	X	X	X	X	X	X	X	X
March	X	X	X	X	X	X	X	X
April	X	X	X	X	X	X	X	X
Knee-high	X		X	X	X	X	X	X
Waist-high				X	X			

- Nitrogen rate for all treatments will be 140 lb N/acre. This rate is usually sufficient under Missouri conditions, but not enough to mask N losses that may occur.
- All treatments will be replicated five times.
- Corn will be planted no-till as soon planting conditions are favorable.
- Corn appearance for each plot will be rated in mid-July.
- Yields will be measured with a plot combine.
- Statistical analyses (analysis of variance and analysis of covariance) will be used to evaluate the effects of N application timing and source on corn yield.

Current status and importance of nitrogen timing and source:

- Lag time between N application and crop uptake is a key factor affecting risk of N loss. Timing effect will depend on N source. In particular, anhydrous ammonia will be more resistant to loss at a given timing.
- The risk level associated with timing and source is not well understood. Decision rules about risk are over-simplified and need to be improved. Several regional and national groups that I am working with want to develop and deliver better information about risks associated with N timing.
- Early (mid-March) pre-plant application of ammonium nitrate carried a 35 bushel/acre yield penalty in four Missouri experiments in 1994 and 1995 compared to ammonium nitrate applied on the day of planting. Similar results would be expected with urea and UAN solution.
 - Average difference in the 1995 experiments was 50 bushels/acre. This was a flood year with excessive rainfall all spring. Corn was not planted until early June, so the 50 bushel advantage was for N applied in early June vs. N applied in mid-March.
 - 1994 was a more normal year but the yield advantage of applying N on the day of planting was still 20 bushels/acre.
- Recent (2008-2010) research by Kelly Nelson and Peter Motavalli in northeast Missouri has shown no yield difference between preplant and early preplant N timing for several dry N sources. However, yields for both timings were on average 85 bushels/acre lower than yields with anhydrous ammonia applied at the same time. This indicates massive loss of dry N even when applied right at planting in these wet years.
- Most nitrogen timing research has compared fall vs. pre-plant or pre-plant vs. sidedress N timing, with the 'preplant' treatments applied the same day as planting.
- The reality is that most producers apply all of their N, then start planting, resulting in a time interval between application and planting. Logistics, achieving timely planting despite weather risk, and sometimes price favor applying N as early as possible. The time interval between N application and planting varies from producer to producer, depending on how they manage these factors. It also varies from year to year for each producer, depending on spring weather.
- Counter-balancing logistics and timely planting is the risk that earlier-applied N will be lost before crop uptake. Very little research has been done to measure the yield impact of the time of pre-plant nitrogen application. We are fortunate to have some of this research in Missouri, as described in previous bullet points.
- More detailed information on effects of pre-plant N timing is needed to help producers make informed decisions that balance logistics vs. risk.
- The two main questions I get regarding anhydrous ammonia are level of risk with fall applications and whether N-Serve provides benefits in fall and/or spring. I think that there is a good chance that N-Serve is profitable with spring anhydrous on poorly-drained soils.
- Missouri research on top-dress timing for wheat also supports the idea that the time of spring N applications can have a big influence on yield. Two years of research showed that:
 - Mid-March top-dress applications out-yielded mid-February top-dress applications by about 10 bushels/acre.
 - Mid-March top-dress applications out-yielded mid-January top-dress applications by about 20 bushels/acre.

- This was true for all N sources except ESN, a coated urea product, which gave the same yield whether applied in January, February, or March.

Timetable:

February 2012	Select experimental areas at Bradford Farm
April 2012	Plant corn in 2014 experimental area
May 2012	Plant soybean in 2013 experimental area
July-August 2012	Acquire Sidekick for N-Serve injection, install, test
October 2012	Apply first anhydrous ammonia treatments Acquire all dry & liquid fertilizer materials
December 2012	Apply second anhydrous ammonia treatments
February 2013	Apply all N source treatments
March 2013	Apply all dry & liquid N source treatments Burndown herbicide application to experimental area
April 2013	Apply all N source treatments Plant corn in experimental area
May 2013	Plant soybean in 2014 experimental area
July 2013	Take notes on corn appearance in all treatments
September 2013	Harvest plots
Oct-Dec 2013	Analyze data Apply first and second NH ₃ timing treatments
Dec 2013	Progress report
Jan-Dec 2014	Repeat Jan-Dec 2013
Jan-Sept 2015	Repeat Jan-Sept 2013
Oct-Nov 2015	Analyze data
Dec 2015	Final report
Jan-Feb 2016	Develop educational programs, present results at Extension meetings.

Strategy for application/transfer of knowledge:

- Written and oral (presentation) educational materials will be developed to promote understanding and application of results.
- Written materials will include newsletter articles, press releases, a web page, and farm press interviews if possible.
- Presentations will be used in Extension meetings, sent to regional Extension Agronomists for their use, and shared with anyone who requests them.

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Research and Extension education interests

- developing, evaluating, and promoting tools to predict crop N needs, including variable-rate N management
- evaluating N management alternatives including source and timing
- minimizing environmental impacts of agricultural nutrients
- coordinated management of soil, fertilizer, and manure nutrients
- tailoring fertilizer and lime recommendations to account for soil properties
- economic comparisons of production alternatives

Education

<i>Degree</i>	<i>Date</i>	<i>Institution</i>	<i>Major</i>
Ph.D.	May 1993	Virginia Polytechnic Inst. and State University	Crop & Soil Environmental Sciences
M.S.	July 1988	Virginia Polytechnic Inst. and State University	Agronomy
B.S.	August 1982	University of Wisconsin	Biochemistry, Genetics

Recent Research Publications

- Scharf, P.C.**, D.K. Shannon, H.L. Palm, K.A. Sudduth, S.T. Drummond, N.R. Kitchen, L.J. Mueller, V.C. Hubbard, and L.F. Oliveira. 2011. Sensor-based nitrogen applications out-performed producer-chosen rates for corn in on-farm demonstrations. *Agron. J.* 103:1683-1691.
- Nelson, K.A., **P.C. Scharf**, W.E. Stevens, and B.A. Burdick. 2011. Rescue nitrogen applications for corn. *Soil Sci. Soc. Am. J.* 75:143-151.
- Souza, E.G., **P.C. Scharf**, and K.A. Sudduth. 2010. Sun position and cloud effects on reflectance and vegetation indices of corn. *Agron. J.* 102:734-744.
- Kitchen, N.R., K.A. Sudduth, S.T. Drummond, **P.C. Scharf**, H.L. Palm, D.F. Roberts, and E.D. Vories. 2010. Ground-based canopy reflectance sensing for variable-rate nitrogen corn fertilization. *Agron. J.* 102:71–84.
- Roberts, D.F., N.R. Kitchen, **P.C. Scharf**, and K.A. Sudduth. 2010. Will variable-rate nitrogen fertilization using corn canopy reflectance sensing deliver environmental benefits? *Agron. J.* 102:85–95.
- Scharf, P.C.**, and J.A. Lory. 2009. Calibrating reflectance measurements to predict optimal sidedress nitrogen rate for corn. *Agron. J.* 101:615-625.

Recent Extension Publications

- Scharf, Peter.** 2011. Nitrogen on corn: Serious deficiencies in 2010, plans for 2011. Integrated Pest & Crop Management 21:30-31.
- Scharf, Peter.** 2011. Topdressing winter wheat. Integrated Pest & Crop Management 21:28.
- Scharf, Peter.** 2011. Nitrogen Watch 2011 launches. Integrated Pest & Crop Management 21:73.
- Meissen, Roger. 2011. N to the rescue. MU press release based on information from **Peter Scharf.**
- Fee, Rich. 2010. Rescue nitrogen application often boosts corn yields. Successful Farming May-June issue. Using information from **Peter Scharf.**
- Fee, Rich. 2010. The grim face of N loss. Successful Farming May-June issue. Using information from **Peter Scharf.**
- Scharf, Peter.** 2010. Nitrogen Watch 2010. Integrated Pest & Crop Management 20:80-81.
- Meissen, Roger. 2010. Nitrogen loss beginning to show for Missouri farmers. MU press release based on information from **Peter Scharf.**
- Pocock, John. 2010. Wet-spring nitrogen application tips for corn. Corn & Soybean Digest. Using information from **Peter Scharf.**
- Scharf, Peter.** 2010. Streaky nitrogen applications: Why they happen and what you can do about them. Integrated Pest & Crop Management 20:27-28. Also ran in No-till Farmer.
- Scharf, Peter.** 2010. Nitrogen loss cuts into 2009 corn profits. Integrated Pest & Crop Management 20:20-22.
- Meissen, Roger. 2010. Nitrogen deficiency cost Missouri cornfields 113 million bushels in 2009. MU press release based on information from **Peter Scharf.** Ran in Delta Farm Press, Crop Management, Missouri Ruralist, Mid-America Farmer Grower, and AgWeb.
- Scharf, Peter.** 2009. Sensor-guided sidedressing. Integrated Pest & Crop Management 19:88-89.
- Scharf, Peter.** 2009. Streaky fields and uneven application of fertilizer. Integrated Pest & Crop Management 19:10-11.