2017 Final Report Summary Sheet

Grantee Information

Project Title: A comprehensive corn nitrogen research program for Illinois

Institution: University of Illinois

Primary Investigator: Nafziger

NREC Project # 2014-3-360422-398

[redacted]

Is your project on target from an IMPLEMENTATION standpoint? ☒ Yes ☐ No
If you answered "no" please explain:

Is your project on target from a BUDGET standpoint? ☒ Yes ☐ No
If you answered "no" please explain:

Based on what you know today, will you meet the objectives of your project on-time and on-budget? ☒ Yes ☐ No
If you answered "no" please explain:

Have you encountered any issues related to this project? ☐ Yes ☒ No
If you answered "yes" please explain:

Have you reached any conclusions related to this project that you would like to highlight? ☒ Yes ☐ No
If you answered "yes" please explain:

A number of these are scattered throughout the report, but since we are running most aspect of this project one more year it's not clear that these are final conclusions. The most conclusive finding to date are in regard to late-split N (p. 2) and planting-time versus split/sidedressed N (p. 4.) Results from on-farm trials (p 1-2) are also noteworthy.

Have you completed any outreach activities related this project? Or do you have any activities planned? ☒ Yes ☐ No
If you answered "yes" please explain and provide details for any upcoming outreach:

These are detailed under "Outreach" pp. 4-5

Additional Notes:

None to report.

A COMPREHENSIVE CORN NITROGEN RESEARCH PROGRAM FOR ILLINOIS

2017 Annual Report to the Nutrient Research & Education Council

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This project includes as a primary objective gathering data on the response of corn grain yield to N fertilizer rates with replicated, field-scale N rate trials at numerous on-farm locations throughout Illinois, representing the large diversity of soils and weather in the State. In some cases these trials include comparing fall-applied and spring-applied or early spring and sidedressed fertilizer N rates. The second primary objective is to evaluate combinations of fertilizer N rate, form, inhibitor treatments, and application timing on corn yield and economic return using smaller-plot trials on UI research centers.

On-Farm Trials: EONR versus MRTN

In 2017, 61 trials were completed under this project, including 8 strip trials at UI Crop Sciences Research & Education Centers, done using the same design as in producer fields. This exceeded the goal of completing 50 on-farm trials in 2017, not including the research center trials.

Figure 1 shows the N response data from 51 sites with corn following soybean in 2016. Each response was fitted with an appropriate function and the point at which return to N was maximized (the economically optimum N rate, or EONR) was calculated using a price of $0.35 per lb. of N and a corn price of $3.50 per bushel. In addition, we used the MRTN N rate from the N rate calculator, run for the appropriate Illinois region and previous crop for each trial, and for each curve we show that rate and the yield at that N rate. Averaged across all 51 S-C sites, the average EONR value (168 lb. N/acre) was 4 lb. less than the average MRTN value (172 lb. N/acre); and the average yield at the EONR (229 bushels per acre) was 3 bushels more than the average yield had we used the MRTN at each site (226 bushels per acre).

At 4 lb. less N and 4 bushels more yield, using the EONR (if we could have known what it was for each field beforehand) would have returned on average about $12.50 per acre more than using the MRTN in 2017. In 2016, The EONR averaged about 17 lb. N less and yield about 1 bushel more than using the MRTN rate, for an advantage of about $10 per acre over 33 trials. In contrast, averaged over 36 corn following soybean trials in 2015, the average EONR was 25 lb. N per acre higher than the MRTN rate (191 v 166 lb. N) and yields at the EONR averaged 9 bushels per acre more than yields calculated at the MRTN rate (220 v 211 bu./acre). The net effect was a return to N about $24 per acre higher using the EONR rates in 2015 rather than the MRTN. We think that wet June weather raised the amount of N needed in 2015, low-loss conditions lowered this amount in 2016, and even with a lot of rainfall soon after planting in 2017, conditions for soil supply of N were favorable, and the amount of N needed was very close to the N calculator rate (MRTN). In other words, research over previous years (the MRTN from the N rate calculator) predicted very closely how much N the 2017 corn crop needed.

Figure 2 shows the N response from 10 on-farm sites with corn following corn in 2017. Averaged across sites, the EONR was 18 lb. N/acre less than the MRTN N rate (172 v 200 lb. N/acre), and average yield at the EONR was the same (224 bu/acre) as at the MRTN rate. The net return to N averaged about $10 more at the EONR than at the MRTN. In contrast, in 2015 the corn following corn trials produced an average EONR value that was 16 lb. more than at the MRTN and produced 6 more bushels, for a net advantage of $15 per acre for the EONR.

The MRTN values, which are calculated based on many previous trials, cannot anticipate field conditions before the season for a given field, so are almost never exactly the amount of N needed in a field. Only an N rate trial can show the actual need. We will use the results from the 2017 trials to update the database that is used by the N rate calculator by spring 2018. Because the trials showed an overall N response similar to that of the trials already in the database, adding in the 2017 data will not change the MRTN calculation by very much. We routinely remove some of the older data from the database when we update it, and removing older data may influence the MRTN. While the fact that the MRTN "moves around" is seen as a negative by some, the advantage to continuing to add to the data is that the real changes do occur over years, more some years than others. For example, data from 2016, when N fertilizer needs were relatively low, helped to offset the higher N need we saw in 2015 trials.

Trials in which N application rates were split to compare fall versus spring or early spring versus sidedress N rates showed inconsistent, but mostly small, responses to N timing. In one on-farm trial in 2017, spring-applied N produced almost exactly the same yield at the same EONR for fall- and spring-applied N (Figure 3.) Three other trials in 2017 showed similar results. But we also saw, in a trial conducted on silt loam soil in the Mississippi River bottoms in Pike County, higher yield at a substantially lower N rate from spring- compared to fall-applied N (Figure 4.) At this site, 69 fewer lb. of N produced 18 more bushels of corn when the N was applied in the spring versus in the fall; the return to N was $89 higher from spring-applied N. Applying the MRTN N rate (172 lb. N/acre) in the fall would have produced a yield of 223 bushels per acre, while that same rate applied in the spring would have yielded 245 bushels per acre. This field is near the bluff, so likely catches some water draining from higher elevation. And the soil has good internal drainage. But this does illustrate that fall-applied N will sometimes be less available to the crop than spring-applied N.

Late-split N

In 2017 we completed the second year of this trial, which was designed to see if keeping back 50 lb. of N to apply at tasseling time will increase yields. The late N was dribbled using a hand-boom into the row near the base of the plants as a way to duplicate the "Y-Drop" tubes being marketed to apply N into standing corn, including into tall corn. Trials were conducted in corn following soybean at DeKalb, Monmouth, Urbana, Perry, and on a Cisne soil near Neoga, Illinois, and in corn following corn at Monmouth, Urbana, and Perry. A trial conducted in 2017 at Ewing field in Franklin County produced better results than in 2016 at that site, but results won't be included in the summary.

Applying N rates at planting or keeping 50 lb. N to apply at tasseling produced virtually identical N responses in corn following soybean (Figure 5) and in corn following corn (Figure 6). Responses at Urbana were similar to those at the other sites, so responses from the other sites won't be shown here. The only trial in which late-split N increased the return to N (at the optimum N rate and yield) in 2017 was at Neoga (S-C), where this treatment produced 4 bushels higher yield (at the optimum N rate) but needed 20 lb. more N than early-applied N; the return to N was about $9 per acre higher with late-split

N. Across five soy-corn trials in 2017, however, late-split N required 15 lb. more N and produced about the same yield as early application, so returned some $5 per acre less to N than early N. Over the three corn-corn trials in 2017, late-split N required 6 lb. less N but yielded 3 bushels less than early-applied N, for a net loss of almost $10 per acre. So with no yield advantage and no overall decrease in the amount of N needed, the cost of late application would lower profits in 2017 – the same outcome as we saw in 2016. In all but one site-year over the past two seasons (DeKalb in 2017), the actual EONR was less than the MRTN had; using MRTN rates instead of calculating differences from the actual N responses in each trial would have produced no change in relative performance; all sites would have received more N than needed.

N Rate, Timing, and Form

Small-plot trials were conducted according to the project plan at DeKalb, Monmouth, Urbana and Perry in 2017, all corn following soybean. All were planted on time and managed well, with treatments applied as planned. The base N response (against which other treatments were compared) was generated with UAN applied by injection at planting at rates ranging from 0 to 250 lb. N per acre in 50-lb. increments. The response to sidedressing N was tested using 50 lb. N at planting plus 50, 100, or 150 lb. N as UAN injected between the rows at stage V5-V6, with corn 12 to 16” tall. An additional 19 treatments were applied at the rate of 150 lb. N/acre using a range of timings, forms, and inhibitors. Table 1 lists these treatments.

Figures 7 to 10 show N responses in the N form/timing studies at DeKalb, Monmouth, Urbana, and Perry. Yields were generally high in these trials in 2017, and optimum N rates were somewhat higher than we’ve seen in previous years; EONR values ranged from less than 150 lb N/acre at Monmouth to about 175 at Perry (where yields were lower) to more than 200 lb N/acre at DeKalb and Urbana. Yields without N fertilizer, which is an indicator of the amount of N supplied by the soil, were around 200 bu/acre at DeKalb and Monmouth, and around 150 bu/acre at Urban and Perry. Differences among forms and timing of N application at the same rate (150 lb. N/acre) should be more likely when the optimum N rate is higher than this rate, but the range in yield among these treatment (shown by the vertical display of green circles in Figure 7 to 10) was not much larger than we have seen in previous years, except at Urbana, where heavy rainfall after planting caused non-uniformity of stands and greater variability in yields.

The different timings and forms of N compared at 150 lb. N per produced different yields, with what we’ve come to expect as inconsistency among sites in 2017 (Table 1.) The yield range among treatments was 24, 22, 70, and 26 bushels per acre at DeKalb, Monmouth, Urbana, Perry, respectively, and only 13 bushels per acre when averaged across sites. Except at Urbana, where there was considerable variability in the trial, these ranges were generally smaller than in previous years. When the range of treatments was small, as it was at DeKalb, statistical differences are scarce, and value of ranking yields by treatment is decreased. Conversely, a site where the yield range among treatments is large has an oversized influence on the overall yield rankings. Still, inconsistency of performance among sites means less ability to declare differences to be statistically significant, so when averaged across sites there are few “significant” differences among treatments.

Over sites in 2017, the highest yield was from UAN with Agrotain broadcast at planting; this treatment produced the second-lowest yield among these 20 treatments in 2016, and has generally been a poor treatment (Table 2.) Urea with Agrotain broadcast at planting produced the highest yield in 2016, but the second-to-lowest yield in 2017, averaged across sites. And ESN broadcast at planting, which ranked third across sites in 2016, was the lowest-yielding treatment in 2017. That was a result of its very low yield at Urbana in 2017, where it's possible that heavy rainfall after application might have floated some of the product off the soil surface. Several inches of rain fell after planting and planting-time applications at all four sites in 2017, and this might have moved surface-applied UAN into the soil and prevented loss, and may have improved movement into the rooting zone. That treatments flipped from above average to below-average and vice versa in 2017 compared to earlier years seems likely to be a result of the different pattern of weather in 2017, including wet conditions after planting followed by dry weather conditions beginning a few weeks after planting. Some treatments, including UAN with Instinct injected at planting, NH_3 with N-Serve prior to planting, UAN with Nutrisphere injected at planting (Table 1 – treatment added in 2016), and dribbling all of the N as UAN between rows at V9, were among the lowest-yielding in 2017, as well as in most earlier trials.

Of the 20 current treatments to compare 150 lb. N using different forms and application times, 15 were used the first year (2014) and are still in the trials. Table 3 shows yields of these treatments averaged over the fourteen site-years – DeKalb, Monmouth, and Urbana 2014-2017 and Perry 2016-17. The base treatment – UAN injected at planting – ranked sixth in yield, 3 bushels (but not significantly) less than the highest-yielding treatments of SuperU broadcast at planting (Table 3). The top 9 of 15 treatments, when averaged over all site-years, did not yield significantly less than the highest-yielding treatment. And the 8 treatments with the lowest yields (yields followed by the letter "e") did not yield significantly more than the lowest-yielding treatment. This, along with the fact that only 8 bushels separate the highest from the lowest yield, points out the problem of trying to identify "best" N management practices when performance of individual treatments is so inconsistent among fields over years.

Planting-time versus split/sidedressed N

Our small-plot studies under this project include a comparison of N at three rates – 100, 150, and 200 lb. N/acre – applied either as injected UAN at planting or with 50 lb. N injected at planting and the remaining N sidedressed at V5-V6. Data from ten site-years comparing N responses between these two methods of application show that yield at the 100-lb. rate was higher (by 9 bushels) with all-early application than with split application (Figure 11). The two methods produced similar yields at the two higher rates, and the optimum N rates and yields at those rates were almost identical; the optimum N rate and yield at that rate were, averaged over sites, 3.6 lb. N higher and 1.5 bushels per acre lower for split/sidedressed compared to all-early N. Such differences are tiny, and it is clear that our expectation that split N with a sidedress application would require less N, and perhaps yield more, is not supported by the results. Finding a lower yield with split application at the low rate (100 lb. of N) supports the idea that not having all of the N in the soil early might sometimes result in N deficiency that can't be overcome by later application of N.

DAP as an N source

This study was added to this project in 2016, and consists of applying N rates of 100 (base rate using UAN only), 120, 140, 160, and 180 lb. N/acre by three N source/timing combinations: 1) DAP broadcast in the fall after soybean harvest 2) DAP broadcast in the spring before secondary tillage; and 3) UAN injected in the spring before secondary tillage. TSP (0-45-0) was used to bring the P rate to the same for each treatment. Rates were assigned to main plots, and source to subplots, with 6 reps to better detect small differences.

These trials were done exactly according to plan, at Monmouth and Urbana, in 2017. Results were, as was the case in 2016, somewhat unusual: there was no significant response to treatment at either location. Both trials produced high yields in 2017 (234 bu/acre at Urbana, 256 bu/acre at Monmouth) but barely a hint of a response, except at Urbana where fall-applied DAP seemed to give a response curve. We do not have a good explanation for such a responses for the second year in a row, but will hope that 2018 produces more usable information.

Outreach

Results of this work were made known through the Extension presentations, including the IFCA Conference in January 2018, and webinars in February, 2017, March 2017, October 2017, January 2018, and February 2018. Seven UI Bulletin articles addressing N management were published in 2017: February, April, May, June (2), September, and October. Of particular interest in May and June was the effect of early-season rainfall on N status and N nutrition. I spoke at meetings using results from this research project in Ontario (CAN), Livingston County, IL, Bloomington, IL (Growmark), Columbus, OH, Ada, OH, Belleville, IL, Baton Rouge, LA (NUE conference), Champaign, IL (Agronomy Day), Tampa, FL (ASA meeting), Springfield, IL (AgMasters, 2 presentations), and Indianapolis, IN (IN CCA conference.) Credit was given to NREC for funding in each presentation. Audience totals for in-person presentations over the past year is estimated at 1,500.

Budget

The budgeted amounts were spent as planned in FY 2017; following is the record of expenditure (from the beginning of the project on January 1, 2014 through February 8, 2018). Unspent funds (originally for payment to producers for on-farm trials; these are covered by IFCA in a separate budget) will be used for soil analyses and other expenditures ("participant support costs" are part of the "services" category used to pay for analyses, plot fees, etc.) This was a 3-year project originally scheduled to end on February 28, 2017; it has been extended (request for two more years) for 2017 and 2018.

C3787	**A Comprehensive Corn Nitrogen Research Program for Illinois**			
Line Description	**Budget**	**Expenditures**	**Encumbrances**	**Balance**
Total Salaries and Wages	152,559	138,388	9,891	4,280
Total Fringe Benefits	53,991	49,206	3,052	1,733
Total Travel	10,500	9,126	0	1,374
Total Participant Support Costs	70,000	0	0	70,000
Materials and Supplies	36,602	18,763	0	-15,746

Services	8,000	43,601	5,500	-41,101
Miscellaneous	580	0	0	580
Total Other Direct Costs	11,597	62,364	5,500	-56,268
Total Indirect Costs	33,090	28,759	2,047	2,284
Total Budget, Expenditures, Encumbrances, and Balance:	331,737	287,843	20,490	23,403

Plans for 2018

We plan to use the same set of treatments used in 2018, and to again run the same types of trials. The trial at the former DeKalb REC in 2017 was not managed as well as we needed it to be, and we located a cooperator on a farm field nearby for 2018. The smaller trial being conducted in southern Illinois (these started originally as part of Dr. Rachel Cook's project and I didn't report on them here) will continue at the Neoga site, where we have had trials since Brownstown closed after the 2015 season. This is on a Cisne soil, but a more productive one than we had at Brownstown.

Table 1. Effect of N form and timing on yield at four Illinois sites in 2017, and averaged across sites. All plots received 150 lb. of N per acre. Treatments are ranked (1=highest yield to 20) by site and across sites.

Treatment	**DeKalb**		**Monmouth**		**Urbana**		**Perry**		**4-site average**	
	Yield	Rank	Yield	Rank	Yield	Rank	Yield	Rank	Yield	Rank
All N applied at planting:	bu/ac	1 to 20	bu/ac	1 to 20	bu/ac	1 to 20	bu/ac	1 to 20	bu/ac	1 to 20
UAN injected mid-row	256	17	270	1	210	15	204	8	235	11
UAN dribbled mid-row	266	9	264	7	222	7	202	11	239	4
Urea/Agrotain broadcast	252	20	265	5	209	16	191	19	230	19
SuperU broadcast	257	15	259	10	226	4	203	9	236	7
ESN broadcast	263	12	263	8	164	20	211	3	229	20
UAN/Agrotain broadcast	276	1	269	2	219	10	205	6	242	1
NH3 injected mid-row	257	16	263	9	228	3	198	15	237	6
NH3/N-Serve injected mid-row	265	10	249	20	214	13	196	16	231	16
UAN/Instinct II injected mid-row	254	19	253	16	208	17	206	5	230	18
UAN/Nutrisphere injected	272	2	256	13	220	8	192	17	235	12
Split N application (1st at planting):										
UAN 50 broadcast+UAN 100 inj V5	270	5	257	11	207	18	200	12	233	14
UAN 100 inj+UAN 50 injected V5	262	14	250	19	233	1	203	10	236	10
UAN 100 inj+Urea/AT 50 brdcst V5	270	4	264	6	223	6	200	13	239	3
UAN 100 inj+UAN 50 drbl in-row V9	267	7	265	4	228	2	204	7	240	2
UAN 100 inj+Urea/AT 50 bdcst V9	263	13	254	15	219	9	215	1	237	5
UAN 100 inj+UAN 50 drbl in-row V5	270	6	251	18	214	12	190	20	231	15
UAN 100 inj+UAN 50 drbl mid-row VT	256	18	256	12	225	5	210	4	236	9
UAN 100 inj+UAN 50 drbl in-row VT	266	8	268	3	212	14	192	18	234	13
All N sidedressed:										
V5 UAN injected mid-row V5	264	11	255	14	214	11	213	2	236	8
UAN dribbled mid-row V9	271	3	251	17	201	19	198	14	230	17

Table 2. Effect of N form and timing on yield ranked averaged over three Illinois sites in 2015 and four sites in 2016 and 2017. All treatments included N at a total rate of 150 lb. N/acre. Means across all 11 site-years were separated at p=0.1.

Treatment	Rank (1 to 19)				Yield	
	2015	2016	2017	3-yr	bu/acre	
All N applied at planting:						
UAN injected mid-row	7	7	11	5	226	abcd
UAN dribbled mid-row	19	13	4	16	223	cdef
Urea/Agrotain broadcast	9	1	18	10	226	abcde
SuperU broadcast	1	2	7	1	229	a
ESN broadcast	12	3	19	12	225	abcdef
UAN/Agrotain broadcast	17	18	1	14	223	bcdef
NH3 injected mid-row	18	11	6	15	223	cdef
NH3/N-Serve injected mid-row	16	15	15	18	221	ef
UAN/Instinct II broadcast	13	16	17	17	222	def
Split N application (1st at planting):						
UAN 50 broadcast+UAN 100 injected V5	15	9	13	13	224	bcdef
UAN 100 inj+UAN 50 injected V5	4	14	10	9	226	abcde
UAN 100 inj+Urea/AT 50 broadcast V5	5	10	3	3	228	abc
UAN 100 inj+UAN 50 dribbled in-row V9	8	5	2	2	228	ab
UAN 100 inj+Urea/AT 50 broadcast V9	11	8	5	7	226	abcde
UAN 100 inj+UAN 50 dribble in-row V5	2	6	14	8	226	abcde
UAN 100 inj+UAN 50 dribble mid-row VT	14	4	9	6	226	abcd
UAN 100 inj+UAN 50 dribble in-row VT	3	12	12	4	226	abcd
All N sidedressed:						
UAN injected mid-row V5	6	17	8	11	225	abcde
UAN dribbled mid-row V9	10	19	16	19	219	f

Table 3. N form and timing effects among 15 treatments, all at 150 lb. N per acre, averaged across fourteen Illinois site-years, 2014-2017. Means are separated at p=0.1.

Treatment	**Rank**	**avg 14 sites**	
	1 to 15	bu/acre	
All N applied at planting:			
UAN injected mid-row	6	224	abcd
UAN dribbled mid-row	12	221	cde
Urea/Agrotain broadcast	3	225	abc
SuperU broadcast	1	227	a
ESN broadcast	11	222	bcde
UAN/Agrotain broadcast	13	221	cde
NH_3 injected mid-row	10	222	bcde
NH_3/N-Serve injected mid-row	14	220	de
Split N application (1st at planting):			
UAN 50 broadcast+UAN 100 injected V5	9	223	abcde
UAN 100 inj+UAN 50 injected V5	5	224	abcd
UAN 100 inj+Urea/AT 50 broadcast V5	4	225	abcd
UAN 100 inj+UAN 50 dribbled in-row V9	2	226	ab
UAN 100 inj+Urea/AT 50 broadcast V9	8	223	abcde
All N sidedressed:			
UAN injected mid-row at V5	7	224	abcd
UAN dribbled mid-row at V9	15	219	e

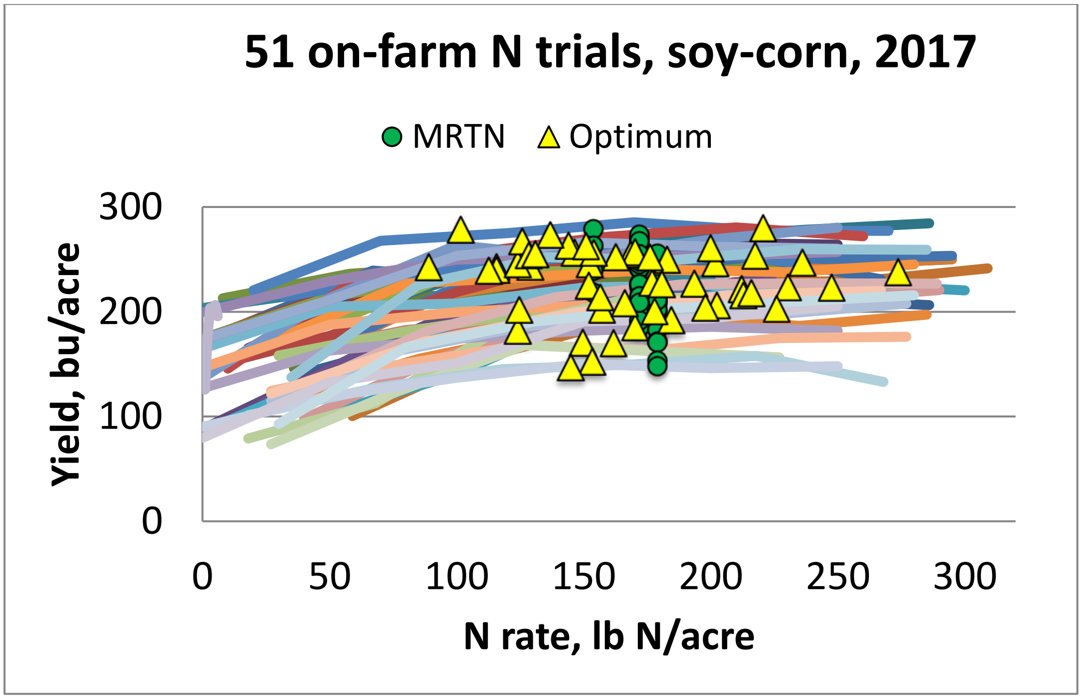

Figure 1. N responses in 51 on-farm N rate trials where corn followed soybean in Illinois in 2017. Yellow triangles indicate the optimum N rate for each trial, and green circles show yield at the MRTN N rate. The three columns of MRTN values, from left to right, are values for northern, central, and southern Illinois.

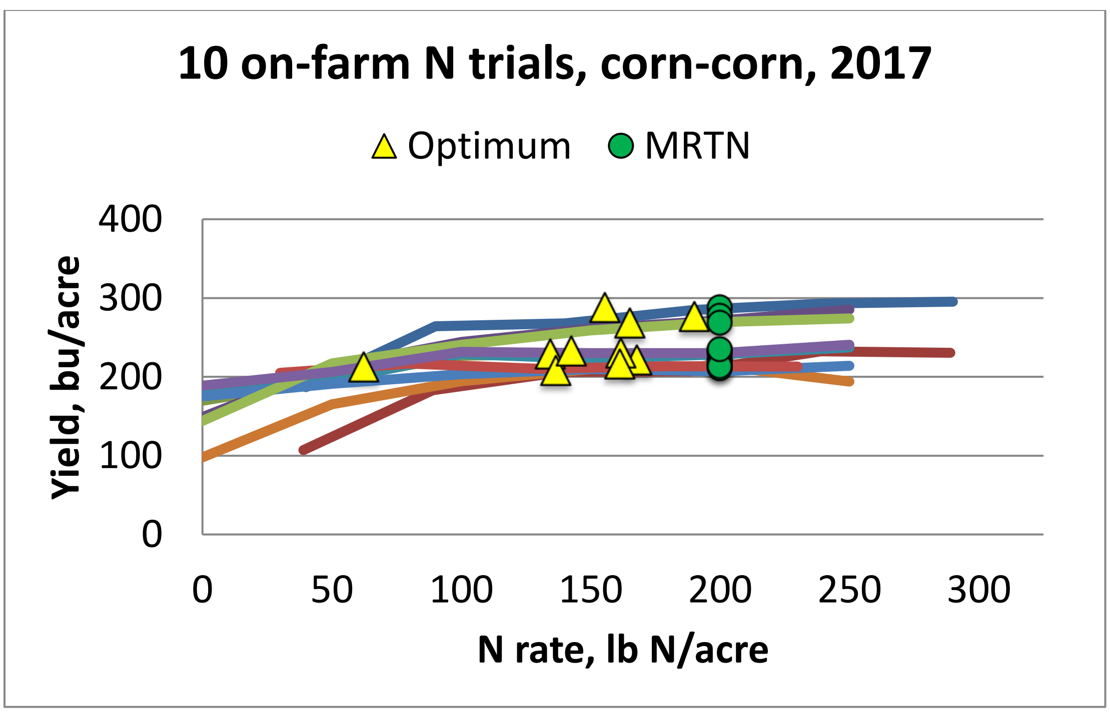

Figure 2. N responses from 10 on-farm N rate trials with corn following corn in Illinois in 2017. Yellow triangles indicate the optimum N rate for each curve, and green circles show yield at the MRTN N rate.

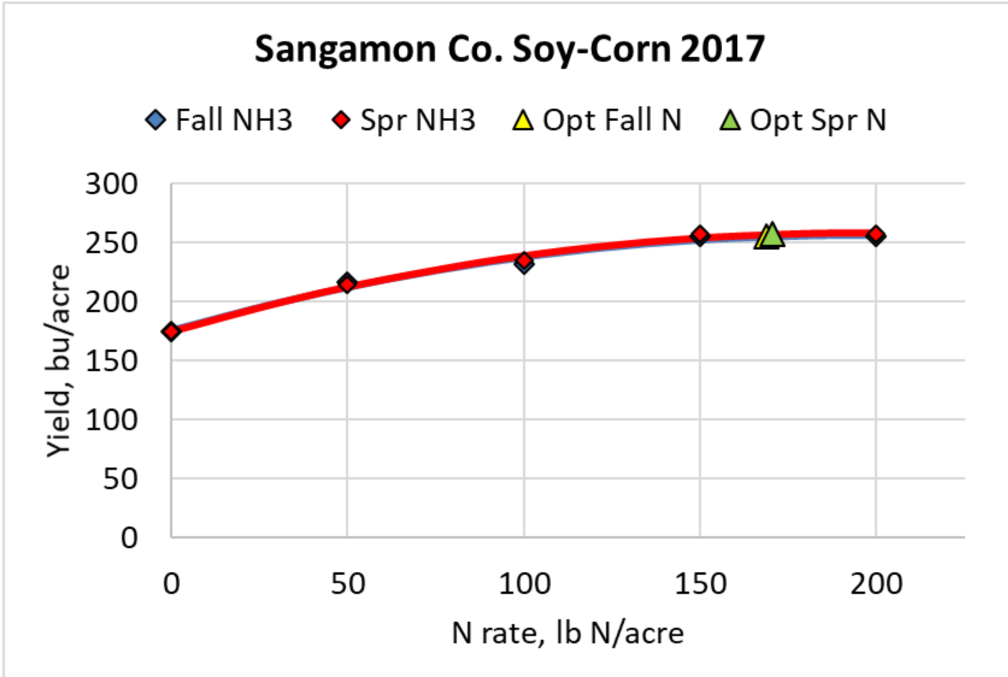

Figure 3. A comparison of fall versus spring N application at an on-farm site in central Illinois in 2017. The yellow triangle marks the N rate and yield at the point of maximum return to N for fall-applied NH_3, and the green triangle does the same for spring-applied NH_3.

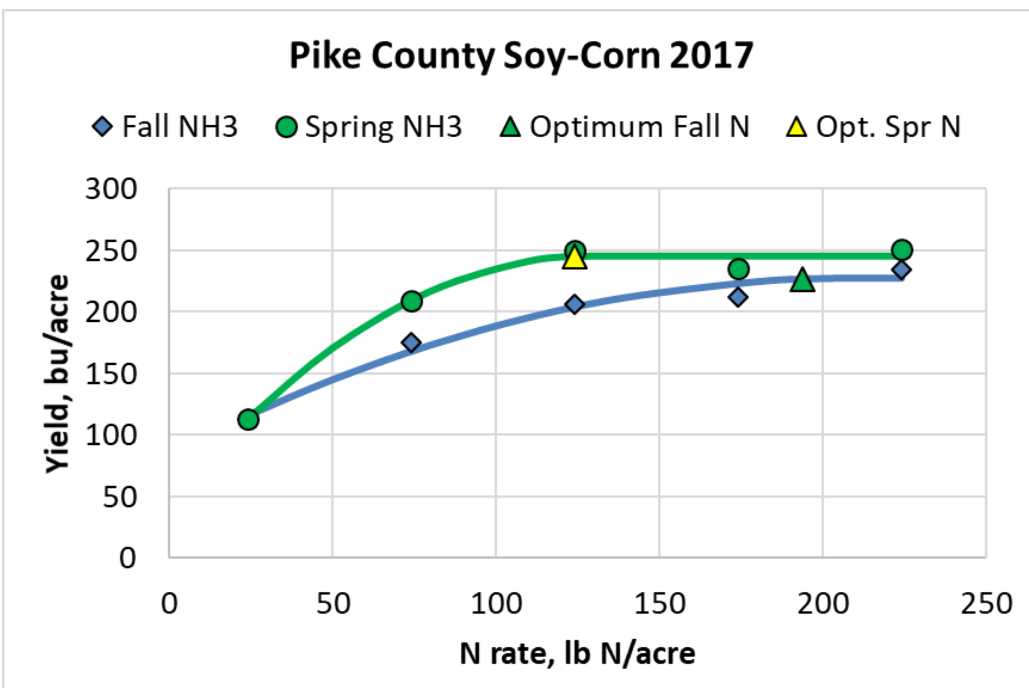

Figure 4. A comparison of fall versus spring N application at an on-farm site in west-central Illinois in 2017. The green triangle marks the N rate and yield at the point of maximum return to N for fall-applied NH_3, and the yellow triangle does the same for spring-applied NH_3.

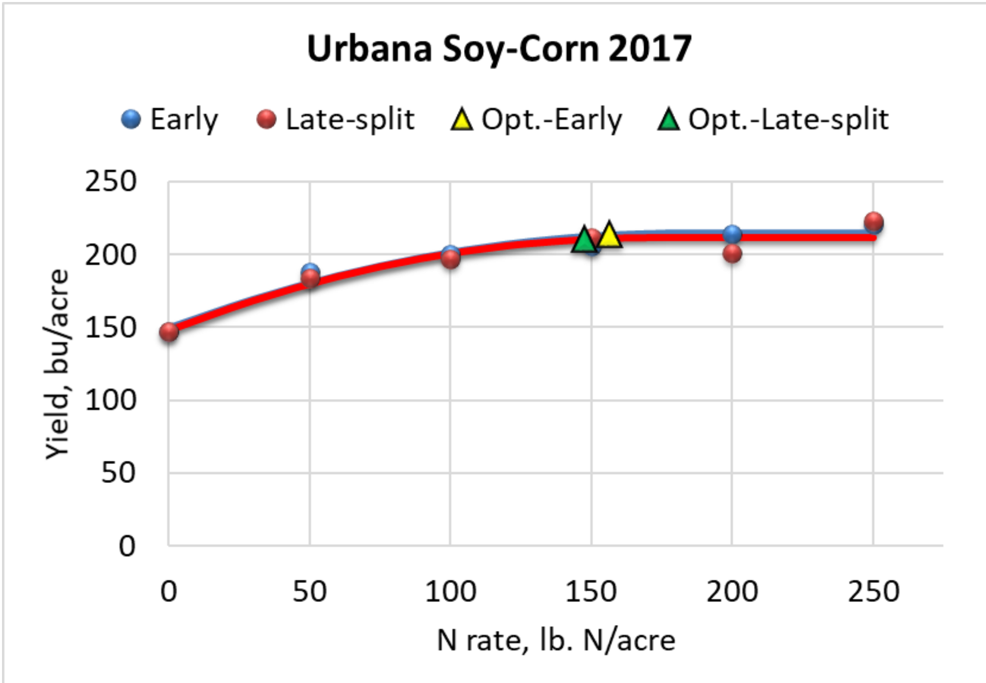

Figure 5. Response from N applied at planting time (Early) compared to N split into planting-time and 50 lb. N (Late-split) as UAN dribbled into the row at tasseling. Data are from a corn following soybean trial at Urbana, Illinois in 2017.

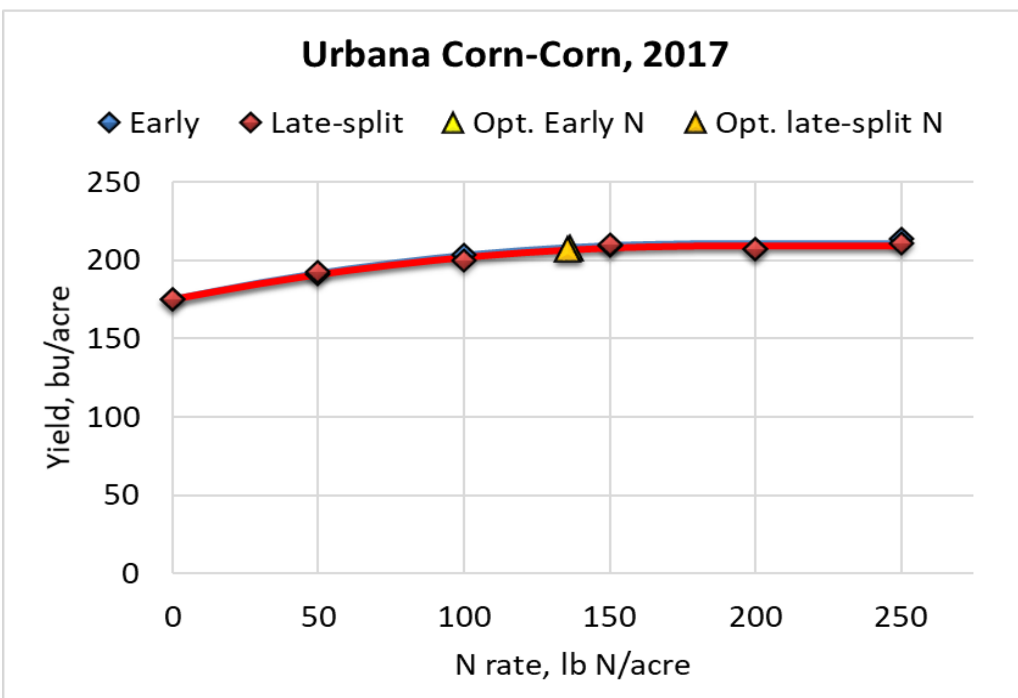

Figure 6. Response from N applied at planting time compared to N split into planting-time and 50 lb. N as UAN dribbled into the row at tasseling. Data are from a corn following corn trial at Urbana, Illinois in 2017.

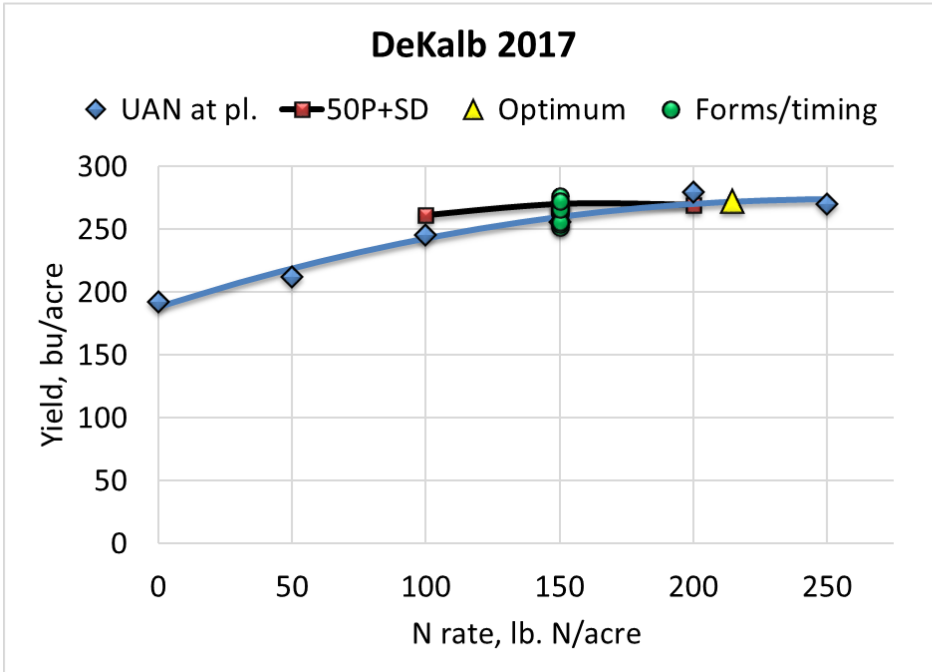

Figure 7. Responses to N rate, form, and timing at DeKalb, Illinois in 2017. Base rates were applied as UAN at planting time, and sidedress (SD) as 50 lb. N at planting plus UAN at V5-V6. Form and timing treatments and yields are given in Table 1.

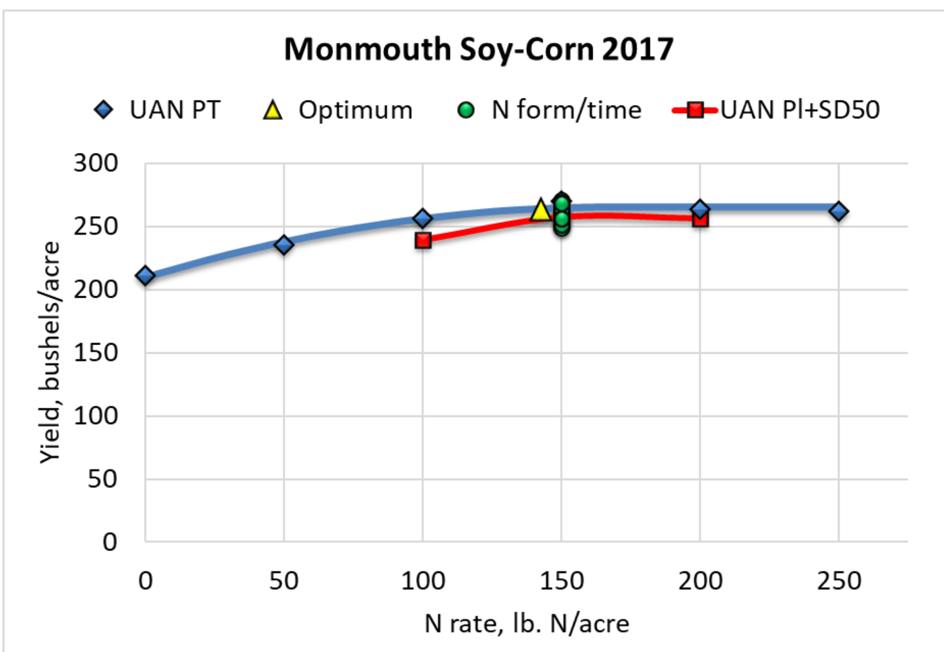

Figure 8. Responses to N rate, form, and timing at Monmouth, Illinois in 2017. Base rates were applied as UAN at planting time, and sidedress as 50 lb. N at planting plus UAN at V5-V6. Form and timing treatments and yields are given in Table 1.

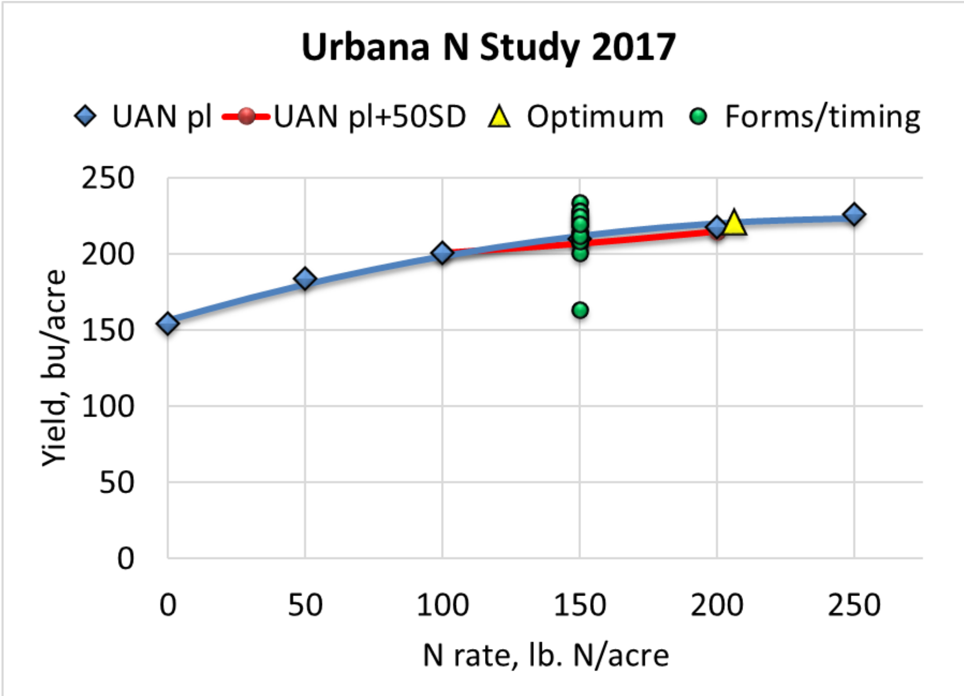

Figure 9. Responses to N rate, form, and timing at Urbana, Illinois in 2017. Base rates were applied as UAN at planting time, and sidedress as 50 lb. N at planting plus UAN at V5-V6. Form and timing treatments and yields are given in Table 1.

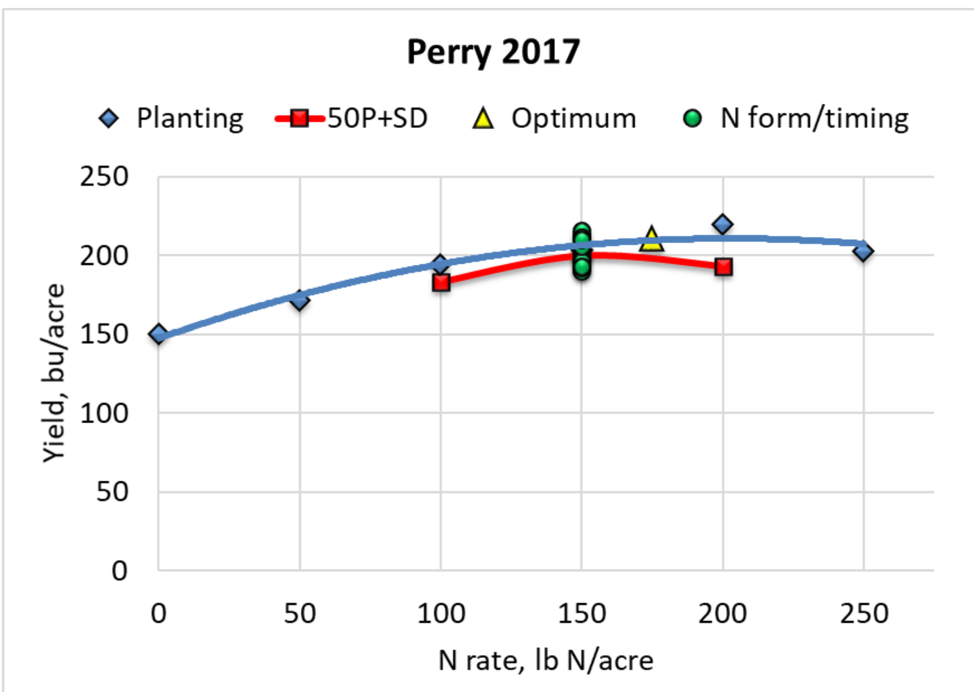

Figure 10. Responses to N rate, form, and timing at Perry, Illinois in 2017. Base rates were applied as UAN at planting time, and sidedress as 50 lb. N at planting plus UAN at V5-V6. Form and timing treatments and yields are given in Table 1.

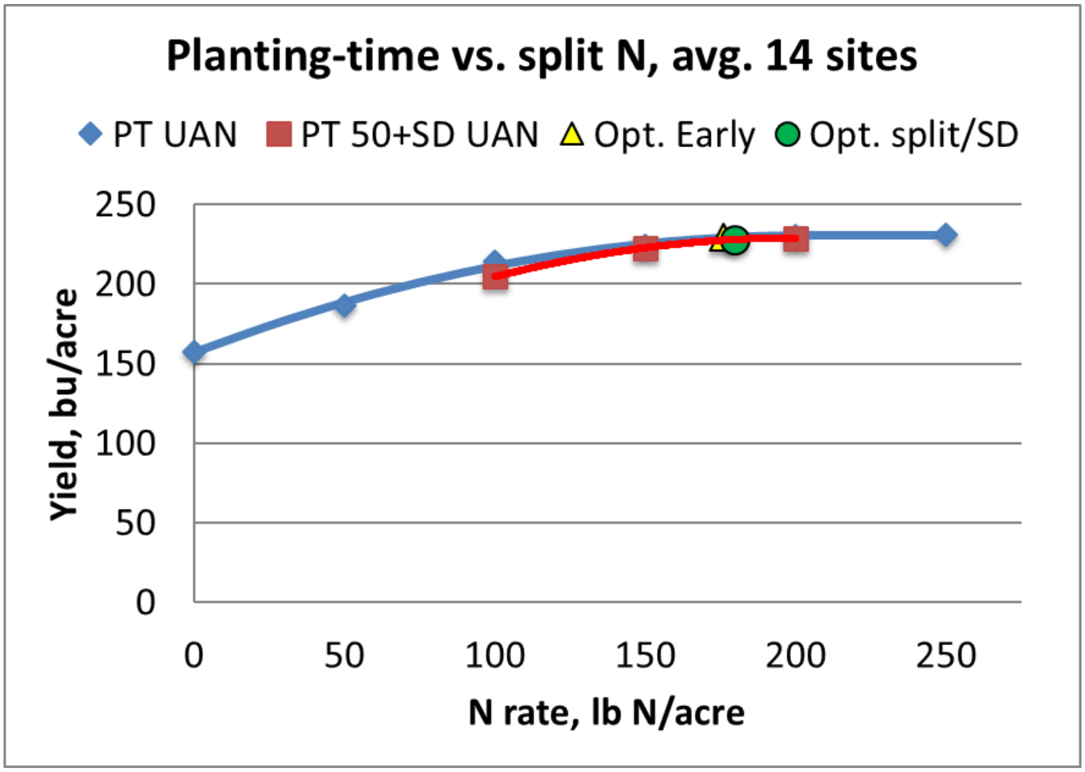

Figure 11. Responses to N rate for N applied as injected UAN at planting compared to 50 lb. N injected at planting and the remaining N sidedressed at V5-V6. Data are averages over 14 Illinois site-years, 2014-17.