A Comprehensive Corn Nitrogen Research Program for Illinois

2014 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. It includes as possible an evaluation of variable-rate N. 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

In 2014 a total of 21 farmer-cooperators completed trials under this project. Six of these sites including N timing splits, so a total of 27 N responses were generated. Personnel at the six UI Crop Sciences Research & Education Centers completed an additional 10 strip trials, each using the same design as in producer fields. The total of 37 trials completed exceeded our goal of having 30 to 35 trials in 2014.

Figure 1 shows the response curves from 18 sites with corn following soybean in 2014. Each response was fitted with a quadratic or a quadratic+plateau curve, whichever best fit the data, and the point at which return to N was maximized (the economically optimum N rate, or EONR) was calculated for each curve using a price of $0.45 per lb of N and a corn price of $3.75 per bushel. In addition, we used the N MRTN N rate from the N rate calculator at these same prices, and for each curve we show that rate and the yield at that N rate. Averaged across all 18 sites, the MRTN N rate was 17 lb N per acre less than the average EONR, and yield projected at the MRTN was 6 bu/acre less than actual yields at the EONR. The net effect was a return to N that was about $17 per acre less had the MRTN been used at each site rather than the actual EONR calculated from the N response in each field.

Figure 2 shows the response curves from 13 on-farm sites with corn following corn. Averaged across all 13 sites, the MRTN N rate was 17 lb N per acre less than the average EONR, and yield from using the MRTN rate was 7 bu/acre less than actual yields at the EONR. The net return to N was an average of about $20 less using the MRTN than if we could have known and used the EONR for each field. The responses to N for corn following corn included two sites where yield responded linearly to N, up to 250 lb of N. Those both had an EONR of 250 lb N, and of course showed large losses of yield and net return to N at the MRTN rate.

Results from the six sites where N was split to compare fall versus spring or early spring versus sidedress N rates showed little difference in response to N timing. A typical response to fall versus spring is shown in Figure 3. The slight advantage to fall-applied N in this case may be due to random chance rather than to an actual difference. Splitting N in the spring likewise tended to have little effect on N response or yield, as shown in Figure 4.

In three of the on-farm sites with corn following corn, uniform N rates of 110 to 140 lb N were applied as fall or early spring. Fields were sampled for soil nitrate-N on a grid pattern in the early spring, and three or four uniform N rates ranging from 0 to 100 or 0 to 150 were applied in strips atop the grids. This produced a wide range of soil N – measured as soil nitrate + fertilizer N – and yield monitor data were

matched to the total N amount within each grid point. Soil N in the top 2 ft. ranged from about 100 lb N/acre to more than 400 lb N/acre the site where the base N had been applied in the spring, to about 180 and 260 lb N at the two sites with fall-applied base rates of N. While there was a small response to adding N at different rates in the spring, we were unable to show that yields matched consistently with the amount of N – soil N plus fertilizer N – supplied to each grid. Yields averaged 220 to 240 bu/acre among these sites. Adding 100 lb of fertilizer N in the spring increased yields by 25 and 28 bu/acre at the two sites with fall-applied base amount of N, but by only 8 bu/acre where N was spring-applied. These modest increases result from the high yields produced by the base rate, and though they were higher with lower soil N and low with high soil N on a field basis, this was difficult to see using soil N and yield data from grid points.

Variable-Rate N

In-season variable-rate N application was assessed in a trial with corn following soybean on the UI South Farms near Urbana-Champaign. Unfertilized strips were left and the remainder of the field was fertilized with UAN broadcast at the rate of 60 lb N per acre before planting. A high-N reference strip was established using a rate of 300 lb of N. At stage V6-7, uniform rates of 60, 120, and 180 were applied, and the Greenseeker® was used to assess canopy color in real time and to apply N according to the company's algorithm. Color differences were visible in the strips at sidedress application time.

The VRN applicator applied 70 lb of N in addition to the 60 lb applied at planting, for a total of 130 lb N. Using the curve fit to the N rate data (Figure 5), the predicted yield at 130 lb N in the uniformly-applied N rates was 211 bu/acre. The VRN treatment produced 198 bu/acre, so 13 bu/acre less than the predicted yield at that same rate but applied uniformly. This difference is not large and is not statistically significant, but it does show that VRN did not increase the efficiency of N use. VRN rate differed considerably by rep, ads did yield and N response, but not in a way that improves insight.

N Rate, Timing, and Form

Small-plot trials were conducted according to the project plan at five UI Crop Sciences Research Centers located in different soils and regions of Illinois. The two trials at Perry (in Pike County in west-southwestern Illinois) and at Brownstown (south central Illinois) were done in coordination with the trials at Carbondale and Dixon Springs managed by Dr. Rachel Cook of SIU, and results will be reported by Dr. Cook.

Each of the trials at DeKalb, Monmouth, and Urbana included the same set of treatments. All were planted on time and managed well, with treatments applied as planned. Corn followed soybean at all locations. 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 of N at planting plus 50, 100, or 150 lb N at stage V5-V6, with corn 12 to 16" tall. An additional 13 treatments were applied at the rate of 150 lb N/acre using a range of timings, forms, and inhibitors; Table 1 gives the listing of these.

Figures 6-8 show N responses at the DeKalb, Monmouth, and Urbana sites. Responses and EONR values were relatively consistent among sites, with EONR values of 165, 198, and 196 lb N and yields at EONR of 220, 233, and 236 at DeKalb, Monmouth, and Urbana, respectively. Applying N as 50 lb at planting and the rest as sidedressed UAN showed no benefit at any of the three sites compared to applying all of the N at planting; at the 100-lb N rate, the yield at Monmouth was about 20 bushels lower for split/sidedressed N than for N at planting time, but this difference couldn't be confirmed statistically.

The different timings and forms of N compared at 150 lb N per produced different yields, without great

consistency in treatments among sites (Table 1.) The yield range among these treatments was 16, 25, 25, and 13 bushels per acre at DeKalb, Monmouth, Urbana, and averaged across all three sites, respectively. These are proportional to the EONR values and yields at the EONR at the three sites, and so reflect the yield change going from 150 lb N, used for all of these treatments, and the yield at the EONR. In other words, at DeKalb the response to N was already fairly flat at 150 lb N, with the yield increasing by less than 5 bushels from that at 150 lb N to its maximum at about 200 lb N, while at Urbana and Monmouth this increase was 15 to 20 bushels.

Yield rankings among the treatments at each location show a fair amount of inconsistency, as expected. Over all sites, urea+Agrotain broadcast at planting time produced the highest yield; it ranked 1st, 8th, and 3rd at Urbana, Monmouth, and DeKalb, respectively, and its yield was not significantly lower than that of the top-yielding treatment at any of the sites. Across the three sites, eight other treatments produced average yields that were not statistically less than the yield of the top-yielding treatment. The lowest-yielding treatment across three sites was ESN broadcast at planting, and it did not yield statistically significantly less than 11 other treatments averaged across sites. So even though trials were run well at each site, different treatments simply performed inconsistently among sites, with the result that it was not possible to pick a clear “winner” or “loser” among all 15 treatments.

In fact, both urea+Agrotain and ESN share urea as the N source and are designed to slow release, but they performed very differently in 2014. This is probably to be expected, and it points out that subtle differences in patterns of weather and crop growth may cause considerable differences in the ability of of different N sources to provide adequate N to crops in different years and soils. Most of the treatments showed effects at one or more locations, but across the three sites, very few stood out as much better or much worse than most other treatments. This points out the inadvisability of choosing a certain N program with the idea that is will consistently outperform alternatives. But it also indicates that a considerable number of different forms and timings might perform adequately, at least in most years and fields, thus making easier the choosing of an acceptable N program. Adding another set of data to this experiment in 2015 should help to further refine knowledge about variability of performance among these programs.

Table 1. Effect of N form and timing on yield at three Illinois sites in 2014, and averaged across sites. All plots received 150 lb of N. Numbers followed by the same letter are not statistically different. PT = planting time; AT = Agrotain®

	Urbana			Monmouth		
Timing and form	**Yield**	**Sep.**	**Rank**	**Yield**	**Sep.**	**Rank**
PT UAN 150	223	cdef	9	214	abc	9
PT UAN 50 bdcst + UAN 100 SD	230	bcd	4	213	abc	11
UAN 150 injected at SD (V5)	225	bcdef	8	224	a	1
UAN 150 dribble late SD (V9)	218	ef	13	218	ab	4
PT UAN 100 + UAN 50 at SD	218	ef	12	221	ab	2
PT UAN 100 + urea/AT 50 bdcst SD	216	f	14	214	abc	10
PT UAN 100 + UAN 50 dribble V9	227	bcde	6	219	ab	3
PT UAN 100 + urea/AT 50 bdcst V9	216	f	15	213	abc	12
PT UAN 150 dribble	220	ef	11	208	bc	14
PT Urea+AT 150	241	a	1	215	abc	8
PT SuperU 150 broadcast	233	ab	2	215	ab	7
PT ESN 150 broadcast	226	bcde	7	199	c	15
PT UAN+AT 150 broadcast	221	def	10	209	abc	13
PT NH3 150 injected	231	abc	3	218	ab	5
PT NH3+N-Serve 150	227	bcde	5	217	ab	6

	DeKalb			Avg. of 3 sites		
	Yield	**Sep.**	**Rank**	**Yield**	**Sep.**	**Rank**
PT UAN 150	216	ab	6	218	abcd	9
PT UAN 50 bdcst + UAN 100 SD	214	ab	8	219	abcd	5
UAN 150 injected at SD (V5)	218	ab	4	222	ab	2
UAN 150 dribble late SD (V9)	216	ab	5	217	abcd	10
PT UAN 100 + UAN 50 at SD	220	a	1	220	abc	3
PT UAN 100 + urea/AT 50 bdcst SD	214	ab	7	214	bcd	12
PT UAN 100 + UAN 50 dribble V9	209	b	13	218	abcd	7
PT UAN 100 + urea/AT 50 bdcst V9	211	ab	10	213	cd	13
PT UAN 150 dribble	219	a	2	215	bcd	11
PT Urea+AT 150	218	a	3	224	a	1
PT SuperU 150 broadcast	210	ab	11	219	abcd	4
PT ESN 150 broadcast	208	b	14	211	d	15
PT UAN+AT 150 broadcast	209	ab	12	213	cd	14
PT NH3 150 injected	204	b	15	218	abcd	8
PT NH3+N-Serve 150	212	ab	9	219	abcd	6

Outreach

Results of this work were made known through the Extension presentations, including the AgMaster's conference in December 2014, the Bi-State Extension meeting in Indiana in December 2015, the Corn & Soybean Classics in January 2015, the IFCA Conference in January 2015, to an Indiana Farm Bureau young leader meeting in January 2015, and at the Crop Management Conferences in January and February 2015; audience totals for all of these was estimated at 1,800. A Bulletin article will follow.

Budget

Category	2014 Budget	Spent in 2014	Remaining	2015 request
Materials and Supplies	500	165	335	500
Transportation Services	3,000	1,581	1,419	3,000
Services	36,000	4,501	31,500	36,000
Indirect Costs Pool	7,954	3,673	4,281	7,972
Academic Salary	22,500	21,021	1,479	23,175
Benefit Costs	9,662	5,822	3,840	9,071
Totals	79,616	36,762	42,854	79,718

Notes:

The large amount unspent in services is due to having budgeted to pay cooperators a participation fee; these were paid by CBMP instead for all of the producer sites. The project paid plot fees at REC sites.

The funds for services left over from 2014 and funds requested for services in 2015 will be used to establish more sites in 2015 than were covered by CBMP in 2014. This will provide needed data for regions (including southern Illinois) that have had fewer trials in the past.

Academic salary is half-time for one academic professional who works on this project.

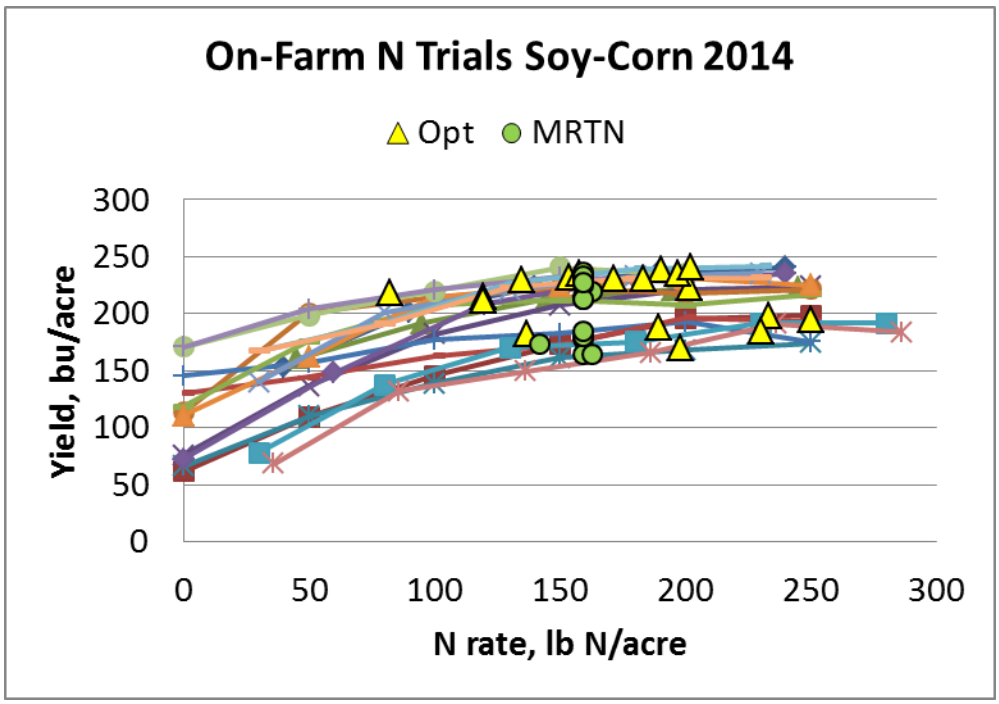

Figure 1. N responses from 18 on-farm N rate trials in Illinois in 2014. Yellow triangles indicate the optimum N rate for each curve, and green circles show yield at the MRTN N rate.

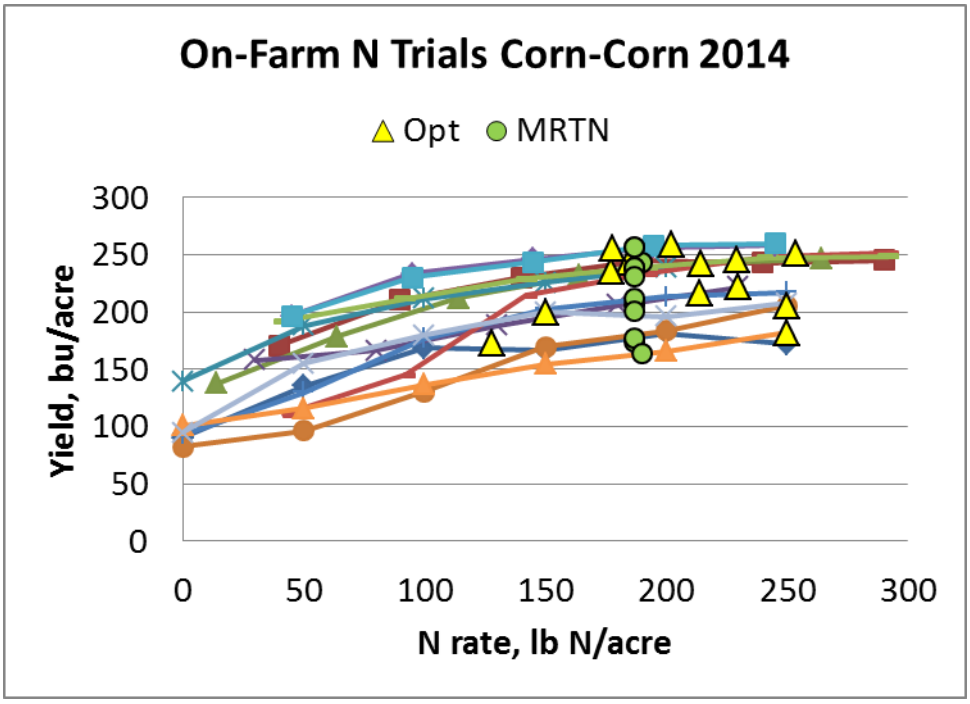

Figure 2. N responses from 13 on-farm N rate trials in Illinois in 2014. Yellow triangles indicate the optimum N rate for each curve, and green circles show yield at the MRTN N rate.

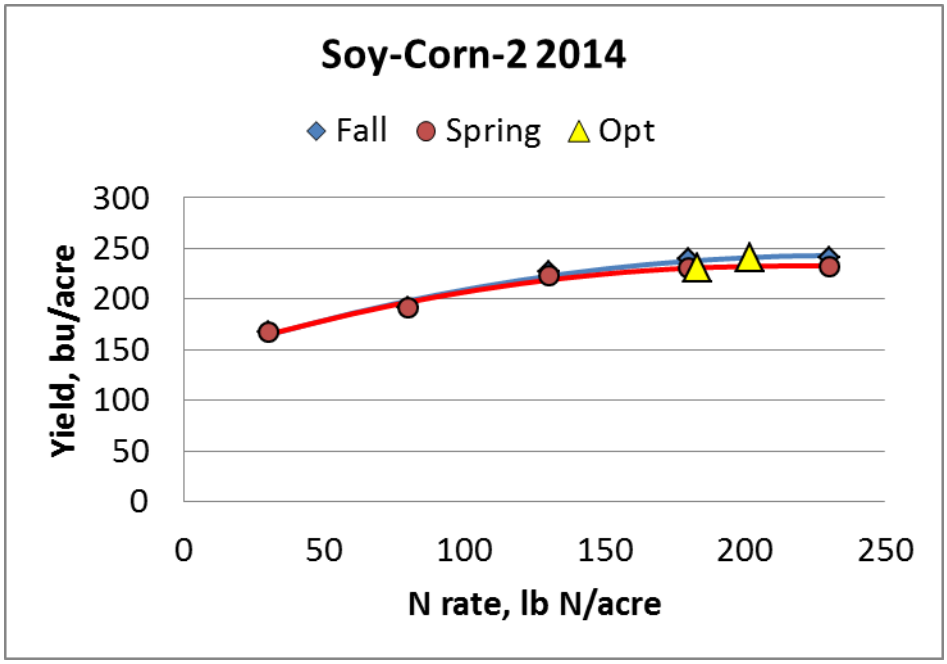

Figure 3. A comparison of fall versus spring N application at an on-farm site in central Illinois in 20014. The yellow triangles mark the N rates and yields at points of maximum return to N.

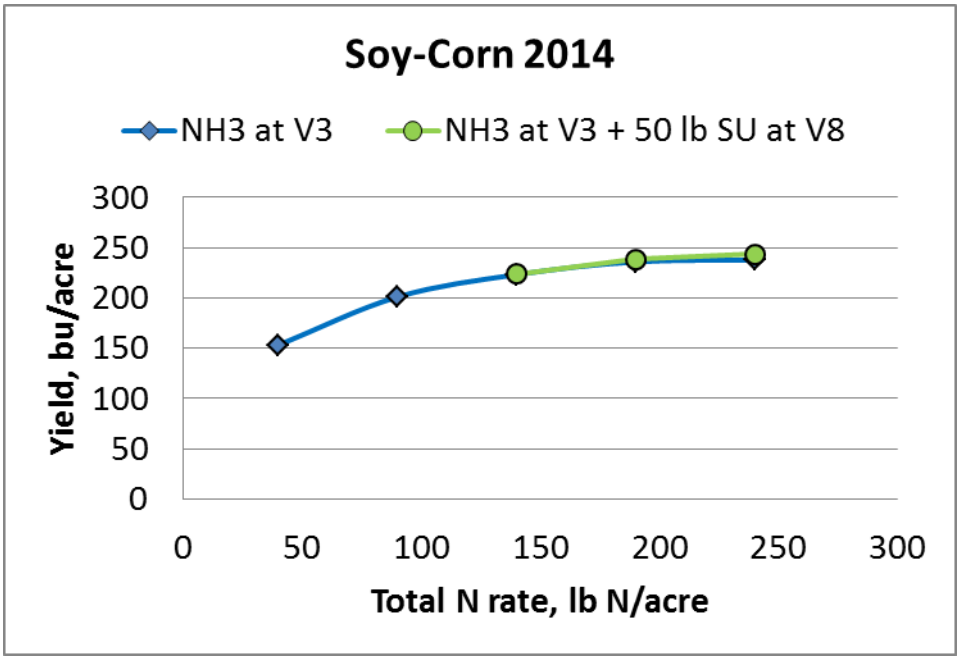

Figure 4. Response to N applied at NH_3 early in vegetative growth (at stage V3) compared to applying the same rate split, with all but 50 lb applied early and the remaining 50 lb applied as SuperU at mid-vegetative stage (V8).

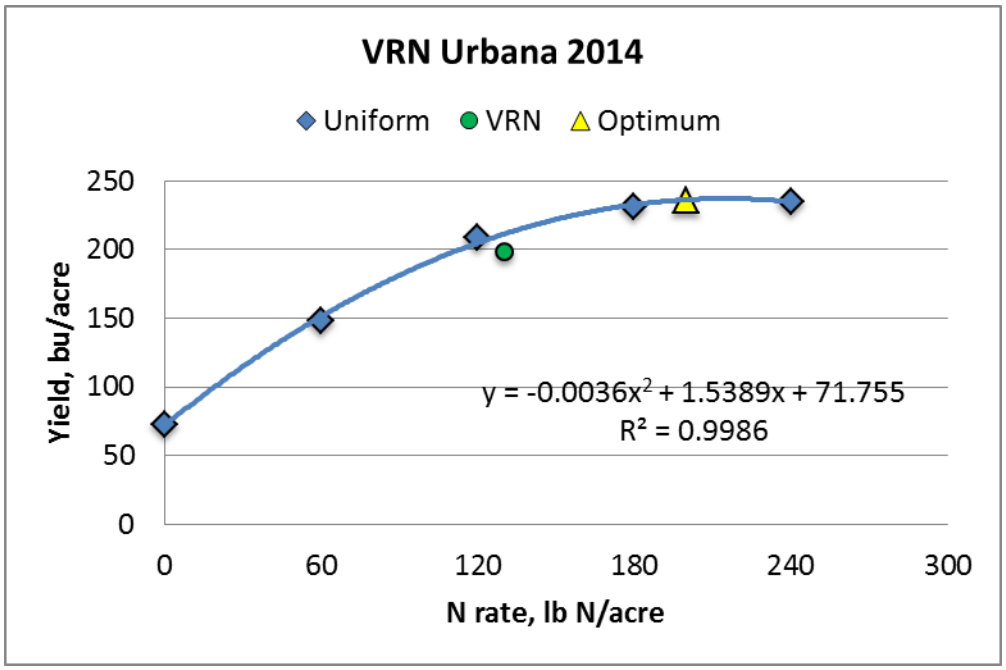

Figure 5. A comparison of variable-rate N (VRN) applied using Greenseeker® technology with uniformly-applied N in a trial at Urbana, Illinois in 2014. Uniform rates were applied as 60 lb N at planting plus additional N at V6, when the VRN was done.

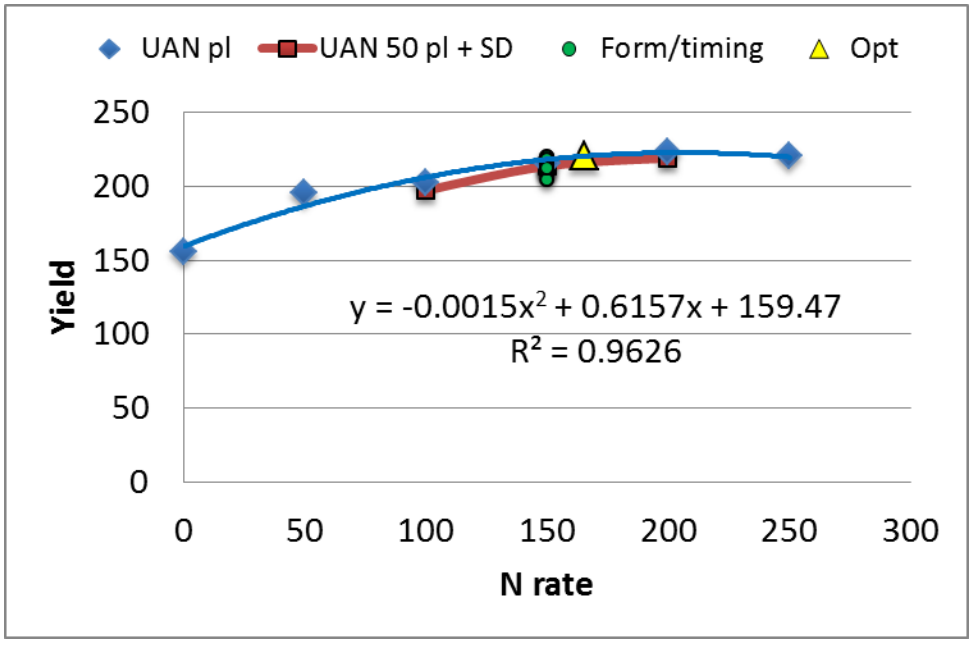

Figure 6. Responses to N rate, form, and timing at DeKalb, Illinois in 2014. Base rates were applied as UAN at planting time, and sidedress as 50 lb N at planting plus UAN at V5-V6. Form and timing treatments and yields are listed in Table 1.

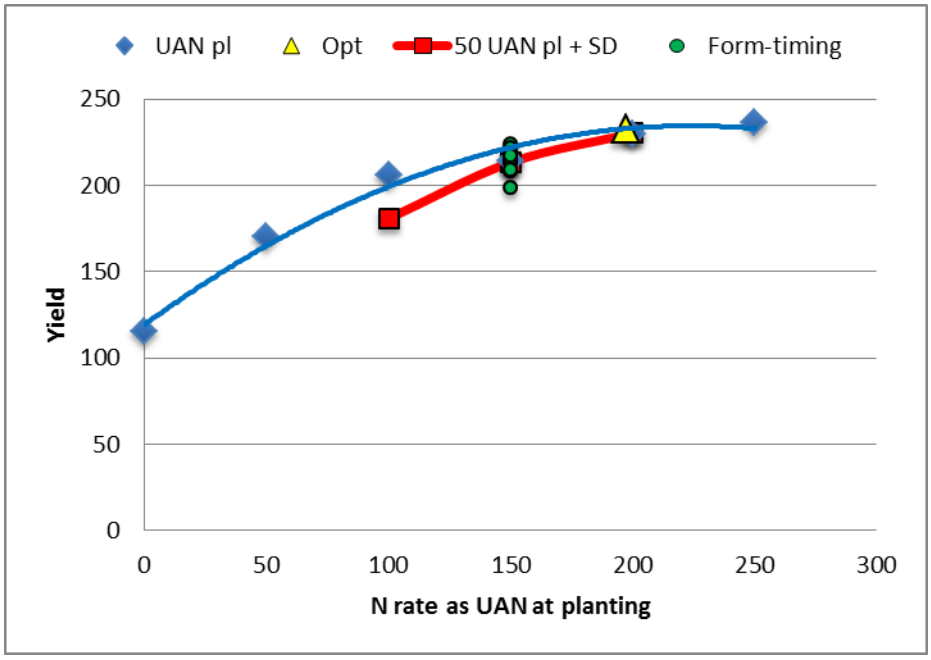

Figure 7. Responses to N rate, form, and timing at Monmouth, Illinois in 2014. Base rates were applied as UAN at planting time, and sidedress as 50 lb N at planting plus UAN at V5-V6. Form and timing treatments and yields are listed in Table 1.

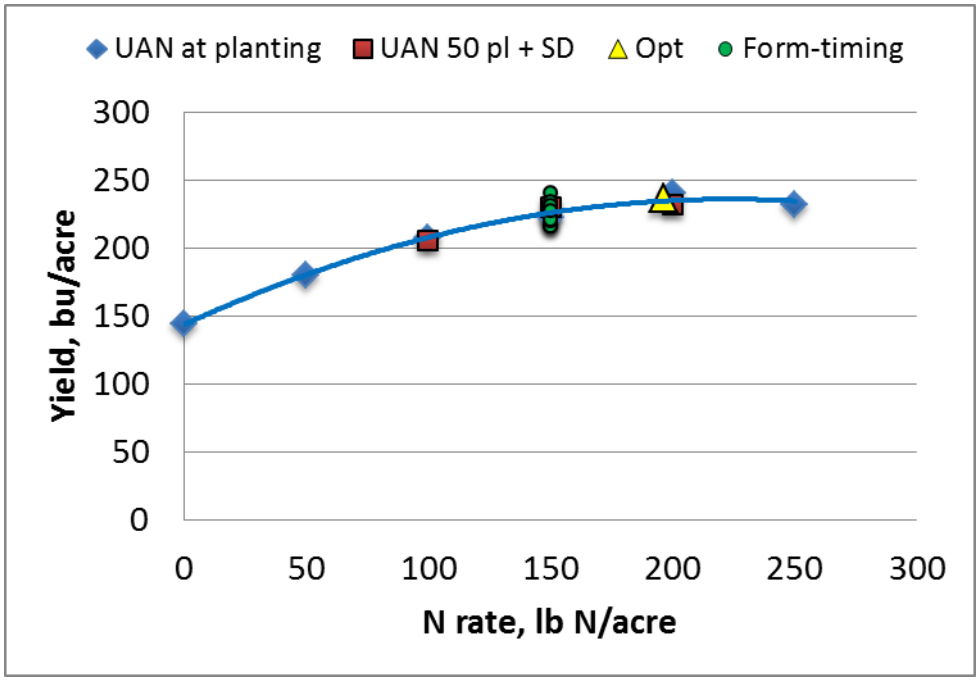

Figure 8. Responses to N rate, form, and timing at Monmouth, Illinois in 2014. Base rates were applied as UAN at planting time, and sidedress as 50 lb N at planting plus UAN at V5-V6. Form and timing treatments and yields are listed in Table 1.