2019 Final Report Summary Sheet

Grantee Information

Project Title: Nitrogen placement and applications timing for best efficiency, growth, and yield of corn across Illinois

Institution: University of Illinois

Primary Investigator: Fred E. Below

NREC Project # 2019-3-360267-438

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:

This year's weather had delayed planting beyond the typical date in Illinois, resulting in abnormal corn growth responses to N and reduced yields. Additionally, drought conditions though pollination and grain fill at Champaign resulted in poor pollination and most plots yielding less than 100 bu acre^{-1}. Because of this anomaly, yield and nutrient data collected from the Champaign site has been removed from analysis.

Have you reached any conclusions related to this project that you would like to highlight? ☒ **Yes** ☐ **No**

If you answered "yes" please explain:

This data collected in the first year of this study supports the hypothesis that concentrating N fertilizer belowground near the crop row (i.e. banding) can increase grain yield and N removal, while limiting N loss to the environment. While some interaction between optimal initial N rate and placement of N was observed in grain yield, this study will need to be repeated in more environments before determining the optimal rates for each placement method.

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:

The data collected in 2019 and preliminary conclusions have been presented by Eric Winans at numerous meetings this winter, including with representatives from Liqui-Grow, Syngenta, The Mosaic Company, CHS Inc, Montag Manufacturing, and John Deere. Eric has also made the data available to Stewart Farms, the land-owner at the Yorkville site, and Talon Becker, the manager at the Ewing Demonstration Center.

The results of this study were presented by Eric at a round-table hosted by Nutrien at the Top Producer Summit in Chicago, IL on January 30, 2019, which was attended by over 20 growers from Illinois and surrounding states.

Dr. Below has presented this data to farmers at the Fertilizer Outlook and Technology Conference in Savannah, Georgia on November 19, 2019 and the DEKALB/Asgrow NextGen Select Grower Meeting at Bloominington, IL on Jauary 13, 2020.

Dr. Below will be presenting results from this study at the Fluid Fertilizer Forum and Annual Meeting on February 17th, 2020 in Phoenix, Arizona.

Having the first year of data collected and analyzed will increase our opportunity to present the data to growers and industry members at field-days during the summer of 2020, including at the Illinois Agronomy Day.

NITROGEN PLACEMENT AND APPLICATION TIMING FOR BEST EFFICIENCY, GROWTH, AND YIELD OF CORN ACROSS ILLINOIS

Cooperators and locations

Dr. Frederick E. Below is a Professor of Crop Physiology in the Department of Crop Sciences at the University of Illinois. His research is focused on sustainably and efficiently producing high corn and soybean yields. fbelow@illinois.edu, 217-333-9745

Eric T. Winans is a third-year Graduate Research Assistant in the Department of Crop Sciences, University of Illinois. He earned his M.S. degree in 2019 and is now working towards his Ph.D. with a focus on hybrid evaluation and nitrogen fertilizer management. winans2@illinois.edu, 217-414-9504

Project Locations: Crop Sciences Research and Education Center, University of Illinois, Champaign, IL; Stewart Farms, Yorkville, IL; and the U. of I. Ewing Demonstration Center, Ewing, IL

Synopsis

It is a common understanding that delaying a portion of applied N, as opposed to a single pre-plant application, could increase N availability to the growing corn crop and improve N recovery and grain yield. However, research shows that the yield response to split applications of N is entirely dependent on the environment, and is often uneconomical. What's typically more important for increasing yield potential and nutrient use is assuring adequate N availability at the start of the growing season. It is hypothesized that concentrating N in a band near the crop row at planting, as opposed to broadcasting across the entire soil surface, will increase early-season availability and potentially allow for split applications. Thus, the objectives of this study were to assess the effect of N placement on N use efficiency and grain yield and determine if placement changes the optimal N rate at planting. Across three sites in Illinois, UAN was broadcast incorporated or banded next to the crop row (2" x 2") at 45, 90, 135, and 180 lbs N acre^{-1} near the time of planting. All treatments were balanced for 180 lbs N acre^{-1} with sidedress applications at the V6 growth stage. Across N rates and locations, banding N near the crop row increased grain yield, post-flowering N uptake, season-long N uptake, yield efficiency (bu lb N^{-1}), and recovery efficiency (%). The optimal N rate at planting was more dependent on the environment, rather than placement. However, yield, N uptake, and efficiency at 45 lbs N acre^{-1} banded was always the same or better than any of the broadcasted rates. Even at low rates, banding N set a higher yield potential through increased early season N availability, and increased the amount of applied N recovered by the crop.

Objectives

The principal objective of this experiment is to investigate the possible improvement in nitrogen use efficiency and corn yield by increasing the concentration of nitrogen (N) near the plant through banding at the time of planting, allowing a greater proportion of total N to be applied later in the season. The trial was successfully established in its first year and will complete its anticipated objectives on budget and on time.

Goal: *Maximize nitrogen use efficiency of corn in Illinois through optimum fertilizer placement, rates, and timing while maintaining or increasing grain yield and limiting N loss to the environment.*

Site characteristics and cultural practices

The 2019 experiments were conducted under conventional tillage in a corn-soybean rotations at all locations. The trial was planted using a precision plot planter with variable rate capability (SeedPro 360, ALMACO, Nevada, IA) at Yorkville, IL (41°36'53.01"N, 88°23'10.21"W; 9 June), Champaign, IL (40° 3'8.85"N, 88°14'2.46"W; 1 June), and Ewing, IL (38° 5'56.84"N, 88°50'50.49"W; 5 June). Corn hybrid DKC64-34RIB was planted at all locations to target a final stand of 36,000 plants/acre. Preplant applications of Acuron (3 qt/acre) at Champaign and Ewing and Breakfree ATZ (2 qt/acre) at Yorkville were used for weed control. Soil cores (0-12" deep) were collected from plot areas prior to planting and assessed for pH, organic matter, and fertility levels and are reported in Table 1. Monthly precipitation totals and temperature averages were compared to the 30-year average and are presented in Table 2. Excessive rainfall was observed at all locations in the month of May, delaying planting to June. Drought conditions during pollination and grain fill (July-August) led to poor pollination and yields at the Champaign location.

Table 1. Preplant soil properties and Mehlich 3-extraction-based mineral test results for the research areas in 2019.

Location	OM	CEC	pH	NO_3	NH_4	P	K	Ca	Mg	S	Zn
	%	meq/100g		ppm							
Yorkville	4.8	30.5	6.4	11.2	9.6	43	149	3872	863	14	2.4
Champaign	3.5	21.5	6.1	6.0	4.8	44	131	2747	457	10	1.3
Ewing	1.6	9.7	7.5	2.7	5.7	33	54	1797	69	11	1.2

Table 2. Precipitation and temperature during the production season at Ewing, Champaign, and Yorkville, IL in 2019 compared to the 30-year average (normal). Values obtained from the Illinois State Water Survey.

	Precipitation (in)		Temperature (°F)	
Month	**2019**	**Normal**	**2019**	**Normal**
			Ewing, IL	
May	7.0	4.7	67.4	66.5
June	3.5	4.0	72.8	75.0
July	2.1	3.6	78.5	77.7
August	2.2	3.1	76.0	75.9
September	0.3	3.5	75.1	68.7
October	8.0	3.5	56.8	58.0
November	4.7	4.0	39.9	46.2
			Champaign, IL	
May	5.2	4.7	63.7	63.4
June	3.7	4.4	71.7	72.5
July	2.3	4.2	77.3	75.1
August	2.1	3.4	73.5	73.5
September	3.3	3.1	71.7	66.7
October	5.0	3.2	53.5	54.9
November	2.2	3.2	36.0	42.2
			Yorkville, IL	
May	8.4	3.6	57.5	60.6
June	2.6	3.8	68.6	69.8
July	2.8	3.2	75.3	71.9
August	4.4	3.4	68.9	69.7
September	12.0	2.7	66.9	62.6
October	5.1	2.7	48.1	51.6
November	1.5	2.1	31.7	38.5

Nitrogen applications

Urea ammonium nitrate (UAN) was applied at five rates (0, 45, 90, 135, and 180 lbs N acre^{-1}) at the time of planting. Each initial rate was applied using two different applications methods: surface broadcast with light incorporation (1-3" deep) or banded two inches below and two inches away from the seed (2 x 2 band). Banding treatments were applied with the laboratory's custom Almaco liquid toolbar. All treatments were balanced to total 180 lbs N acre^{-1} with a Y-drop sidedress application of UAN at the V6 growth stage using the same Almaco liquid toolbar. All treatments were compared to an unfertilized check and are outlined in Table 3.

Table 3. Placement and rate of N applied at-planting (AP), N rate applied at V6 with Y-drop, and the total N rate applied for each treatment. Nitrogen was applied as UAN for all applications.

Treatment ID	AP Placement	AP	V6	Total
		lbs N acre^{-1}		
UTC	-	0	0	0
0:180	-	0	180	180
45:135 Band	Band	45	135	180
90:90 Band	Band	90	90	180
135:45 Band	Band	135	45	180
180:0 Band	Band	180	0	180
45:135 Broad	Broadcast	45	135	180
90:90 Broad	Broadcast	90	90	180
135:45 Broad	Broadcast	135	45	180
180:0 Broad	Broadcast	180	0	180

Experimental design and analysis

Experimental units were plots four rows wide and 37.5 feet in length with 30 inch row spacing. Plots were arranged in a randomized complete block design with six replications. Statistical analysis was performed using a linear mixed model approach with PROC MIXED in SAS (version 9.4; SAS Institute, Cary, NC) and means were separated using Fisher's protected LSD test at the 0.10 level of significance. The normalities of residuals were assessed using PROC UNIVARIATE and the assumption of homoscedasticity was tested using the Brown-Forsythe modification of the Levene Test in PROC GLM. Each location was analyzed separately with N treatment included in the model as a fixed effect and replication as a random effect. Because of the pollinations issues, yield and nutrient uptake data collected at the Champaign site was dropped from analysis and is not reported.

Placement and rate analysis only included 8 treatments (45:135 Band, 90:90 Band, 135:45 Band, 180:0 Band, 45:135 Broad, 90:90 Broad, 135:45 Broad, and 180:0 Broad) to compare the respective placements (band and broadcast) across rates and to compare the different rate ratios (45:135, 90:90, 135:45, and 180:0) across both placements. Summary figures for placement and rate analysis averaged across locations are included in this report (Figure 1).

Plant Stand

Final plant populations were measured prior to harvest by counting the second row of each plot. The target stand of 36,000 plants acre^{-1} was exceeded at Ewing and Yorkville for all treatments, while the average final stand at Champaign was only 34,393 plants acre^{-1}. At Ewing, there was minimal placement effect on final stand, while initial N rates of 135 and 180 lbs N acre^{-1} tended to decrease stand compared to lower rates of N for both placement methods (Table 4). There was an observed placement and rate interaction on stand in Champaign, where increasing rates in the band and decreasing rates broadcast tended to decrease final stand (Table 4). Unlike the other two locations, higher rates of N in the band at Yorkville had little detrimental effect on final stand (Table 4), likely do to the higher cation exchange capacity of the site.

Table 4. Final plant populations as affected by nitrogen treatment at Ewing, Champaign, and Yorkville, Illinois in 2019. Lowercase letters indicate a treatment mean significant difference within location at $P < 0.10$.

Treatment	Ewing	Champaign	Yorkville
		plants acre^{-1}	
UTC	37249 **cd**	34151 **bcd**	37946 **c**
0:180	37016 **d**	35080 **ab**	38410 **abc**
45:135 Band	37872 **abcd**	36140 **a**	38584 **ab**
90:90 Band	38406 **ab**	34983 **abc**	38565 **ab**
135:45 Band	37456 **abcd**	34164 **bcde**	38410 **abc**
180:0 Band	37349 **bcd**	33352 **de**	38178 **bc**
45:135 Broad	38007 **abc**	34074 **cde**	37946 **c**
90:90 Broad	38361 **a**	33117 **e**	38488 **abc**
135:45 Broad	37326 **cd**	34228 **bcd**	38797 **a**
180:0 Broad	37636 **abcd**	34771 **bc**	38333 **abc**
		†Level of Significance $P > F$	
Placement	ns	ns	ns
Rate	*(90:90)	ns	ns
Placement x Rate	ns	**	ns

† Placement (45 Band + 90 Band + 135 Band + 180 Band) and (45 Broad + 90 Broad + 135 Broad + 180 Broad) and rate (45 Band + 45 Broad) and (90 Band + 90 Broad) and (135 Band + 135 Broad) and (180 Band + 180 Broad).
* Significant at $P < 0.10$; **Significant at $P < 0.01$; ***Significant at $P < 0.001$; ns, non-significant at $P = 0.10$.

Nitrogen accumulation

Total above-ground plant biomass sampling was conducted at tasseling (VT) and physiological maturity (R6) by sampling three representative plants from each of the center two rows of each plot and then drying to 0% moisture. The plants sampled at R6 were partitioned into grain and stover. Dried stover samples were ground to pass through a 2 mm mesh careen and a representative 50 mg subsample was evaluated for N concentration using a combustion-based analyzer. Nutrient accumulation in the plant was determined using total plant biomass weight and stover N concentrations. Nitrogen concentrations in the grain was calculated by converting protein concentration in the grain, obtained using near-infrared transmittance spectroscopy (Infratec 1241 Grain Analyzer; FOSS, Eden Prairie, MN). Total N in the grain was determined using total grain weight and grain N concentration. Total N uptake is the sum of total N in the grain and stover. Post-tasseling N uptake is the difference of total N accumulated at R6 compared to VT.

Nitrogen uptake at VT was increased with N fertilization over the unfertilized check at both locations, but uptake was similar regardless of fertility treatment (Table 5). At both sites, there was no placement effect on N uptake at VT, rather there was optimal rate ratios across placement within each site. At the Ewing site, a slight negative trend in VT N uptake was observed as the at-planting rate increased (Table 5). This finding suggests that N supplied at planting, especially when broadcast, had low availability to the crop, increasing the necessity of the V6 sidedress. For both placement methods at the Yorkville site, the 90:90 split applications led to the maximum recorded VT N uptakes, with slightly lower accumulations observed at lower and higher at-planting rates (Table 5).

Post-tasseling N uptake was much greater at Yorkville than Ewing, demonstrating the differences in productivity between the sites. Nitrogen rate timing ratio had little effect on post-VT uptake; rather, banding increased N accumulated after tasseling at both sites (Table 5).

Table 5. Nitrogen uptake at VT and changed in N accumulation between VT and R6 as affected by nitrogen treatment at Ewing and Yorkville, Illinois in 2019. Lowercase letters indicate a treatment mean significant difference within location at $P < 0.10$.

	VT N Uptake		Post-VT N Uptake	
Treatment	Ewing	Yorkville	Ewing	Yorkville
	lbs N acre^{-1}			
UTC	54 **c**	79 **b**	0 **abc**	41 **cde**
0:180	103 **a**	143 **a**	2 **abc**	67 **ab**
45:135 Band	113 **a**	154 **a**	-5 **abc**	70 **a**
90:90 Band	103 **a**	165 **a**	7 **ab**	52 **abc**
135:45 Band	106 **a**	162 **a**	8 **abc**	61 **ab**
180:0 Band	102 **bc**	160 **a**	18 **a**	67 **ab**
45:135 Broad	109 **a**	162 **a**	-4 **abc**	31 **de**
90:90 Broad	114 **a**	167 **a**	-12 **c**	32 **de**
135:45 Broad	99 **a**	146 **a**	-6 **bc**	50 **bcd**
180:0 Broad	81 **b**	150 **a**	0 **abc**	23 **e**
	†Level of Significance $P > F$			
Placement	ns	ns	*(Band)	***(Band)
Rate	ns	ns	ns	ns
Placement x Rate	ns	ns	ns	ns

† Placement (45 Band + 90 Band + 135 Band + 180 Band) and (45 Broad + 90 Broad + 135 Broad + 180 Broad) and rate (45 Band + 45 Broad) and (90 Band + 90 Broad) and (135 Band + 135 Broad) and (180 Band + 180 Broad)
* Significant at $P < 0.10$; **Significant at $P < 0.01$; ***Significant at $P < 0.001$; ns, non-significant at $P = 0.10$.

Similar trends in stover, grain, and total N uptake at physiological maturity were observed with banding N at planting, maximizing N content in the plant at both locations (Table 6). At Ewing, total N uptake was maximized when higher rates (135 and 180 lbs N acre^{-1}) were banded at planting (Table 6). When broadcasting N, however, delaying half or more of the applied N until V6 was preferred for N uptake. It is evident that N broadcast applied at planting was less available to the plant than when banded or sidedressed at V6. Similar to observations at Ewing, plant total

N uptake at the Yorkville site was maximized when the majority of N was banded at planting (Table 6). Banding N at planting increased the total N removed in the grain by an average of 8 lbs N acre^{-1} at Ewing and 11 lbs N acre^{-1} at Yorkville (Table 6).

Table 6. Nitrogen uptake at R6 and partitioning between the stover and grain as affected by nitrogen treatment at Ewing and Yorkville, Illinois in 2019. Lowercase letters indicate a treatment mean significant difference within location at $P < 0.10$.

	Stover N Content		Grain N Content		Total N Uptake	
Treatment	Ewing	Yorkville	Ewing	Yorkville	Ewing	Yorkville
	lbs N acre^{-1}					
UTC	20 **e**	44 **c**	32 **f**	75 **g**	53 **f**	120 **e**
0:180	34 **ab**	86 **a**	76 **a**	124 **cdef**	110 **ab**	210 **bc**
45:135 Band	35 **abc**	84 **a**	75 **ab**	132 **abc**	110 **abc**	219 **ab**
90:90 Band	39 **a**	87 **a**	71 **bc**	130 **bcd**	111 **ab**	217 **ab**
135:45 Band	40 **a**	87 **a**	69 **cd**	135 **ab**	118 **a**	222 **ab**
180:0 Band	34 **abc**	87 **a**	70 **bc**	140 **a**	113 **ab**	227 **a**
45:135 Broad	35 **ab**	70 **b**	71 **bc**	123 **f**	106 **bc**	193 **d**
90:90 Broad	32 **bcd**	72 **b**	71 **bc**	128 **bcde**	103 **c**	200 **cd**
135:45 Broad	30 **cd**	77 **ab**	63 **d**	119 **f**	93 **d**	196 **cd**
180:0 Broad	27 **d**	66 **b**	54 **e**	120 **ef**	81 **e**	191 **d**
	†Level of Significance $P > F$					
Placement	**(Band)	***(Band)	***(Band)	***(Band)	***(Band)	***(Band)
Rate	ns	ns	***(45)	ns	*(45)	ns
Placement x Rate	ns	ns	***	*	**	ns

† Placement (45 Band + 90 Band + 135 Band + 180 Band) and (45 Broad + 90 Broad + 135 Broad + 180 Broad) and rate (45 Band + 45 Broad) and (90 Band + 90 Broad) and (135 Band + 135 Broad) and (180 Band + 180 Broad)
* Significant at $P < 0.10$; **Significant at $P < 0.01$; ***Significant at $P < 0.001$; ns, non-significant at $P = 0.10$.

Grain yield and components

The center two rows of each plot were mechanically harvested for determination of grain yield and harvest moisture, and the yield subsequently standardized to bushels acre^{-1} at 15.5% moisture. Subsamples of the harvested grain were evaluated for kernel number and individual kernel weight. Kernel weight is presented at 0% moisture.

At the Ewing site, N fertilization increased kernel number, however there was little difference in kernel number between fertilized treatments (Table 7). Rather, there was a significant increase in kernel weight when N was banded at planting, which ultimately resulted in greater yields (Table 7). When averaged across fertilizer rate ratios, banding N increased grain yield by 10 bu acre^{-1} at Ewing. When banded, the ratio of applied N at planting did not affect yield (Table 7). However, when broadcasting N prior to planting, the crop preferred a portion of the N fertilizer delayed to V6, demonstrated by a decrease in yield with the 180:0 broadcast treatment (Table 7).

Banding N at planting at Yorkville increased the yield potential of the crop by setting a higher kernel number (Table 7). On average, banding N at Yorkville increased grain yield by 13 bu acre^{-1} and the highest yield was achieved when 180 lbs N acre^{-1} was banded at planting (Table 7).

Table 7. Grain yield and yield components (kernel number and kernel weight) as affected by nitrogen treatment at Ewing and Yorkville, Illinois in 2019. Grain yield is reported at 15.5% moisture and kernel weight is reported at 0% moisture. Lowercase letters indicate a treatment mean significant difference within location at $P < 0.10$.

	Kernel Number		Kernel Weight		Grain Yield	
Treatment	Ewing	Yorkville	Ewing	Yorkville	Ewing	Yorkville
	kernels m^{-2}		mg kernel^{-1}		bu acre^{-1}	
UTC	1981 **c**	4115 **d**	158 **d**	185 **d**	64 **c**	144 **e**
0:180	3449 **a**	5255 **bc**	187 **a**	204 **c**	122 **a**	202 **d**
45:135 Band	3486 **a**	5467 **ab**	192 **a**	210 **bc**	123 **a**	217 **bc**
90:90 Band	3250 **ab**	5573 **a**	191 **a**	210 **bc**	120 **a**	220 **ab**
135:45 Band	3408 **ab**	5642 **a**	190 **a**	210 **bc**	126 **a**	224 **ab**
180:0 Band	3348 **ab**	5626 **a**	191 **a**	218 **a**	119 **a**	231 **a**
45:135 Broad	3266 **ab**	5199 **bc**	184 **ab**	209 **bc**	114 **ab**	204 **d**
90:90 Broad	3348 **ab**	5381 **abc**	188 **a**	214 **ab**	120 **a**	217 **b**
135:45 Broad	3438 **a**	5150 **c**	180 **bc**	213 **ab**	117 **a**	207 **cd**
180:0 Broad	3128 **b**	5379 **abc**	174 **c**	215 **ab**	102 **b**	217 **bc**
	†Level of Significance $P > F$					
Placement	ns	***(Band)	***(Band)	ns	**(Band)	***(Band)
Rate	ns	ns	ns	*(180)	ns	*(180)
Placement x Rate	ns	ns	ns	ns	ns	ns

† Placement (45 Band + 90 Band + 135 Band + 180 Band) and (45 Broad + 90 Broad + 135 Broad + 180 Broad) and rate (45 Band + 45 Broad) and (90 Band + 90 Broad) and (135 Band + 135 Broad) and (180 Band + 180 Broad)
* Significant at $P < 0.10$; **Significant at $P < 0.01$; ***Significant at $P < 0.001$; ns, non-significant at $P = 0.10$.

Nutrient use efficiency

Nutrient use efficiencies were calculated for each treatment from the amount of fertilizer applied, total N uptake, and corn grain yield compared to the unfertilized check plot. Yield efficiency was calculated by subtracting the check plot yield from each treatment yield and dividing by the total fertilizer N rate applied (180 lbs N acre^{-1}). Recovery efficiency was calculated by subtracting the total N uptake of the check plot plants from the total N uptake resulting from each treatment and dividing by the corresponding total N rate applied (180 lbs N acre^{-1}).

As all fertilized plots received the same rate of N, yield efficiency follows a similar trend as grain yield. At both locations, yield efficiency was increased by banding N at planting compared to broadcast. Yield efficiency tended to be greater when a proportion of the N was sidedressed at Ewing, while applying all of the N in the band at planting resulted in the highest yield efficiency recorded at Yorkville (Table 8). Similar to yield efficiency, N recovery efficiency was increased when N was banded at both sites. At Ewing, N recovery efficiency numerically increased as initial N rate increased when banded, but decreased with greater initial broadcasted N (Table 8). The ratio of the initial N rate had little effect on N recovery efficiency at Yorkville.

Table 8. Yield efficiency and N recovery efficiency as affected by nitrogen treatment at Ewing and Yorkville, Illinois in 2019. Lowercase letters indicate a treatment mean significant difference within location at $P < 0.10$.

Treatment	Yield Efficiency		N Recovery Efficiency	
	Ewing	Yorkville	Ewing	Yorkville
	bu lb^{-1}		%	
0:180	0.32 **a**	0.33 **d**	32 **abc**	50 **bc**
45:135 Band	0.34 **a**	0.41 **bc**	32 **abc**	55 **ab**
90:90 Band	0.32 **a**	0.42 **ab**	33 **ab**	54 **ab**
135:45 Band	0.34 **a**	0.44 **ab**	37 **a**	57 **ab**
180:0 Band	0.31 **a**	0.49 **a**	34 **ab**	60 **a**
45:135 Broad	0.28 **a**	0.34 **d**	29 **bc**	41 **d**
90:90 Broad	0.31 **a**	0.41 **bc**	28 **c**	44 **cd**
135:45 Broad	0.30 **a**	0.35 **cd**	23 **d**	43 **cd**
180:0 Broad	0.22 **b**	0.41 **bc**	16 **e**	40 **d**
	†Level of Significance $P > F$			
Placement	**(Band)	***(Band)	***(Band)	***(Band)
Rate	ns	*(180)	*(45)	ns
Placement x Rate	ns	ns	***	ns

† Placement (45 Band + 90 Band + 135 Band + 180 Band) and (45 Broad + 90 Broad + 135 Broad + 180 Broad) and rate (45 Band + 45 Broad) and (90 Band + 90 Broad) and (135 Band + 135 Broad) and (180 Band + 180 Broad)
* Significant at $P < 0.10$; **Significant at $P < 0.01$; ***Significant at $P < 0.001$; ns, non-significant at $P = 0.10$.

Conclusions from 2019

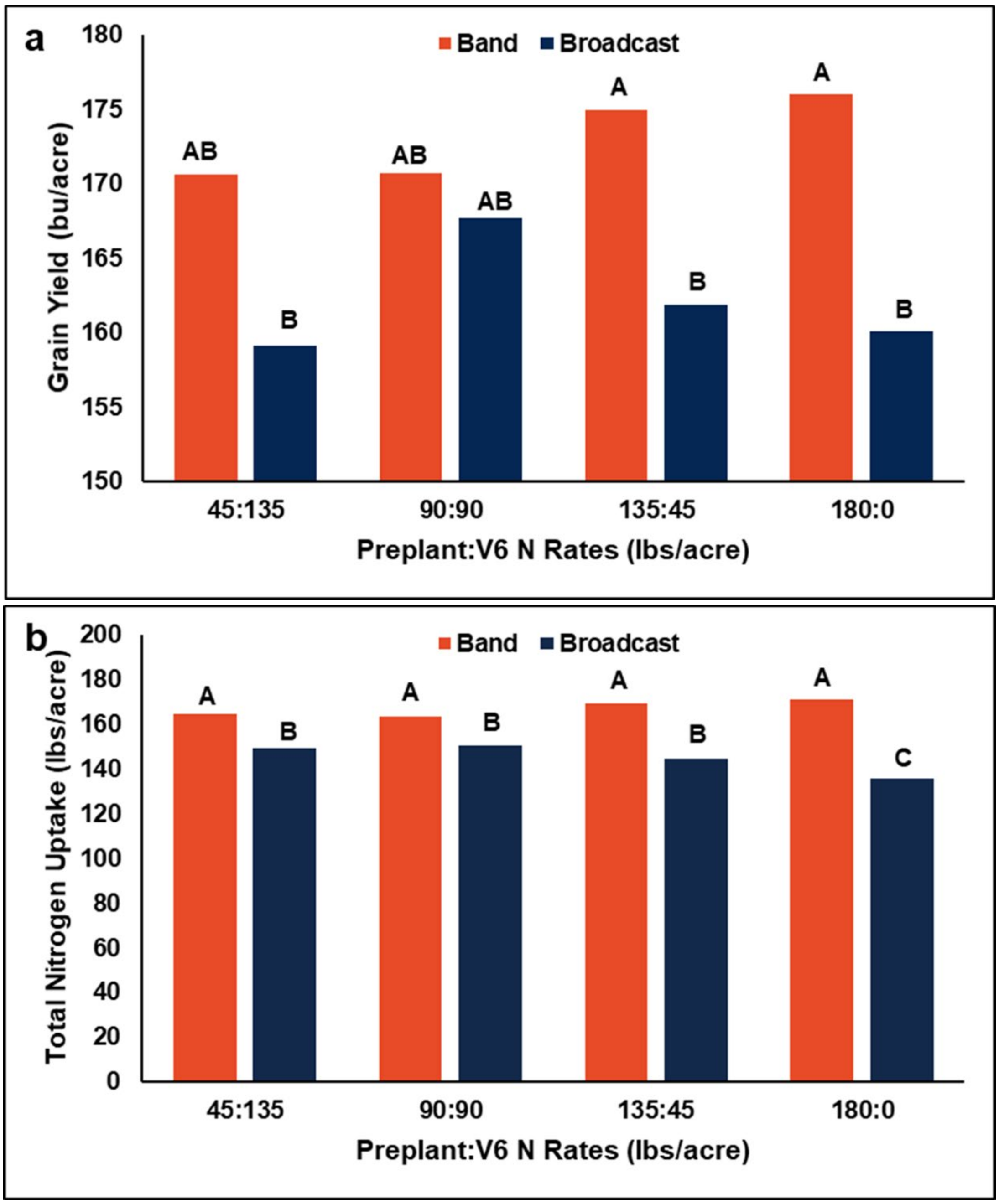
Averaged across preplant N rates and locations, banding nitrogen at planting increased grain yield by 10-13 bu $acre^{-1}$ compared to broadcast applications. While some interaction between optimal initial N rate and placement of N was observed for grain yield, this study will need to be repeated in more environments before determining the optimal rates for each placement method. Banding N led to greater season-end plant total nitrogen accumulation and tended to increase the amount of the N accumulated after tasseling. Additionally, yield efficiency and N recovery efficiency were increased when N was banded at planting. This data collected in the first year of this study supports the hypothesis that concentrating N near the crop row (i.e. banding) can increase grain yield and N removal, while limiting N loss to the environment.

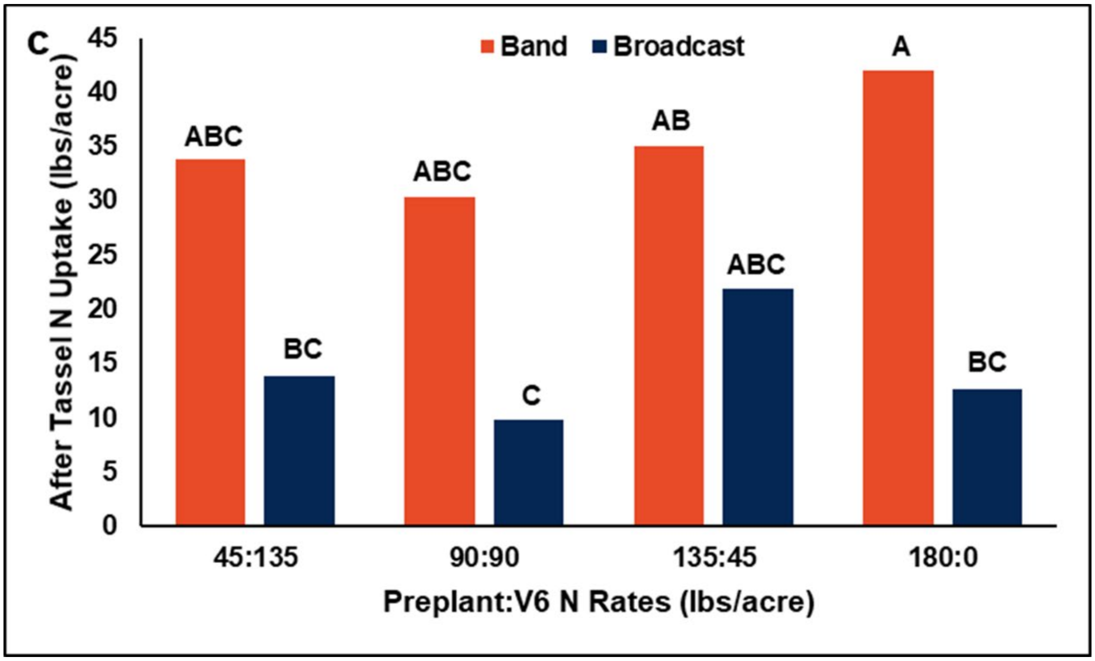
Plans for 2020

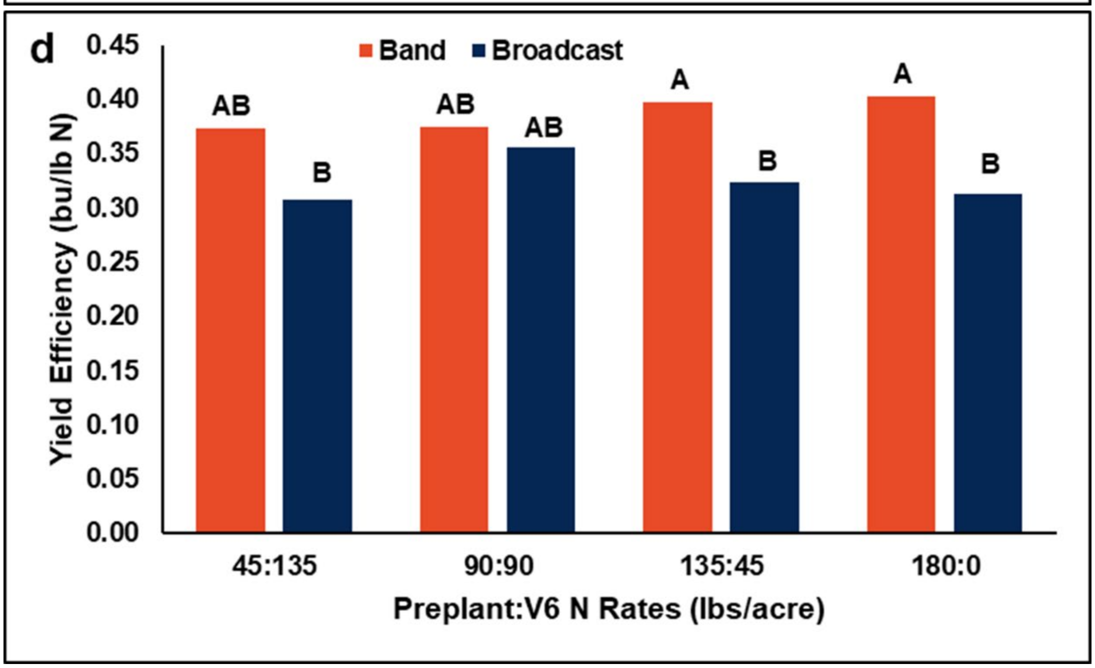
We are currently in the process of arranging field sites and materials to continue the study in 2020. We anticipate fertility treatments and measurements to be done in the same fashion, to increase replication.

A poster was presented with the 2019 findings at the Illinois NREC Investment Insights LIVE! Forum held February 13, 2020 at Champaign, IL. Dr. Below will be presenting results from this study at the Fluid Fertilizer Forum and Annual Meeting on February 17th in Phoenix, Arizona. The results of this study will also be shared to industry and farmers during winter meetings and field days in 2020. We also anticipate these research findings to be presented at the University of Illinois Agronomy Day, typically attended by several hundred producers and industry members from Illinois and surrounding states.

Appendix


a
Band
Broadcast
180
175
170
165
160
155
150
Grain Yield (bu/acre)
AB
B
AB
AB
A
B
A
B
45:135
90:90
135:45
180:0
Preplant:V6 N Rates (lbs/acre)
b
Band
Broadcast
200
180
160
140
120
100
80
60
40
20
0
Total Nitrogen Uptake (lbs/acre)
A
B
A
B
A
B
A
C
45:135
90:90
135:45
180:0
Preplant:V6 N Rates (lbs/acre)


c
Band
Broadcast
After Tassel N Uptake (lbs/acre)
45
40
35
30
25
20
15
10
5
0
ABC
BC
ABC
C
AB
ABC
A
BC
45:135
90:90
135:45
180:0
Preplant:V6 N Rates (lbs/acre)


d
Band
Broadcast
Yield Efficiency (bu/lb N)
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
AB
B
AB
AB
A
B
A
B
45:135
90:90
135:45
180:0
Preplant:V6 N Rates (lbs/acre)

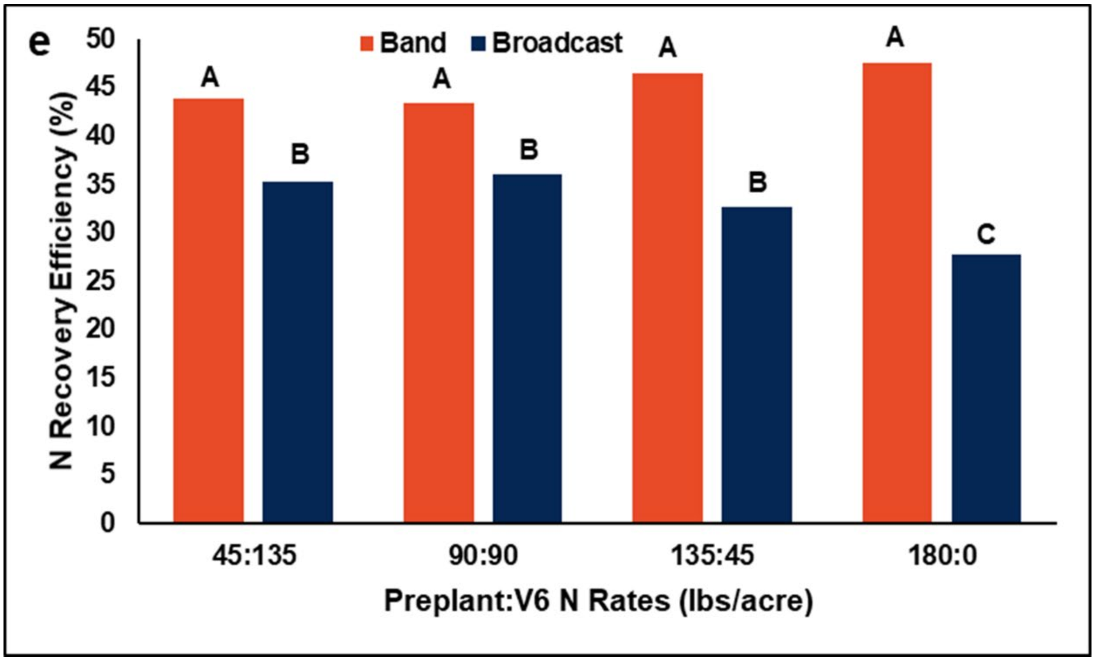


Figure 1. Corn grain yield at 15.5% moisture (a), total N uptake (b), post-tasseling N uptake (c), yield efficiency (d), and N recovery efficiency (e) as influenced by nitrogen placement and rate at planting averaged across Ewing and Yorkville, Illinois in 2019. Uppercase letters that differ indicate treatment mean significant differences at $P < 0.10$.