BY-PLANT SIDEDRESS NITROGEN IN CORN (ZEA MAYS L.) BASED ON PLANT HEIGHT AND NORMALIZED DIFFERENCE VEGETATION INDEX

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CHAPTER I

ABSTRACT

Current methods of applying nitrogen (N) fertilizer do not treat small scale variability that is known to exist. Variations in corn grain yield can be found from one plant to the next. With knowledge that yield potential can be predicted by-plant, this in turn can be used to adjust fertilizer N rates for individual plants. This study was conducted in 2010 and 2011 to evaluate by-plant sidedress N using plant height and normalized difference vegetation index (NDVI) sensor readings. Treatments included preplant N rates of 0, 45, 90, and 180 kg N ha^{-1} with 180 kg N ha^{-1} as a reference strip. Sidedress N was applied as a variable rate on a by-plant basis, uniform rate on a by-plant basis, and uniform rate on the entire row with a non-fertilized check included. By-plant sidedress N applications increased yields when the preplant N rate was optimized. When preplant N rates exceeded the optimum needed for maximum grain yields, no benefits of by-plant N fertilization were observed.

CHAPTER II

INTRODUCTION

Nitrogen (N) is the most abundant element in the atmosphere, but also the most limiting nutrient for crop growth. Nitrogen use efficiency (NUE) of applied fertilizer N by cereals is currently 33% worldwide, where NUE = [(N removed in grain)-(N removed from soil + N deposited in rainfall)]/(fertilizer N applied). Low NUE can be attributed to several factors including plant N loss, denitrification, surface runoff of fertilizer, volatilization of NH_3, and NO_3 leaching (Raun and Johnson, 1999). Poor management of N is commonly thought to be the cause of the eutrophic zones in the Mississippi River Delta and other sensitive water ways. The annual loss of N fertilizer to the Gulf of Mexico has been estimated at a value above $750, 000,000 (Malakoff, 1998). Increases in NUE can occur with better management practices, such as utilization of crop rotations including legumes, hybrid/variety breeding for selection of higher NUE, applications of NH_4-N fertilizers, and midseason and foliar applications of N (Raun and Johnson, 1999).

Precision farming can increase NUE through the application of N in a precise manner to treat by plant variability with fertilizer (Raun and Johnson, 1999). Solie et al. (1996) stated that the optimum field element size is one that provides the most precise measure of nutrient where levels of that nutrient change with distance. They further stated that variable rate applications on scales larger than 1.96 m^2 will result in a grid too coarse and thus misapply inputs.This indicates that the management zones have limitations as they do not match within field variability. Scharf et al., (2005) stated that spatially intensive information for N management has greater potential benefits than management zones. Soil nutrients have to be variable at the sub-meter level (Raun et al., 1998; Solie et al., 1999). This indicates that inputs should also be applied at the sub-meter level.

Individual plant N fertilization is needed because plant to plant variability in corn yields was shown to average 2765 kg ha^{-1}(Martin et al., 2005). The reasons for this variation can be attributed to: interplant competition (Maddonni and Otegui, 2003), non-uniform stands (Nafzinger et al., 1991), sub-meter variability of nutrients (Raun et al., 1998; Solie et al., 1999), biotic and abiotic factors – elevation, soil texture, soil NO_3-N, diseases, and drought (Machado et. al., 2000). Martin et al. (2005) stated that variability existed at less than 0.5 m, and this should be the target treatment scale. Similarly, work by Chung et al. (2008) stated that the optimum resolution for yield prediction should be less than 4 plants. Nitrogen uptake occurs within a 40 cm radius of corn plants (Hodgen et al., 2009). This small area allows for point source uptake of applied N. In order to match soil variability with plant N uptake access zones, it is likely that fertilizer N applications need to be made by-plant. Variable rate fertilizer applied to individual trees based on ultrasonic measurements reduced fertilizer input by 38 % (Zaman et al., 2005)

Optical sensors that collect NDVI data to refine N rates, have been proven to increase NUE by 15% (Raun et al., 2002). Raun et al. (2002) used in-season estimates of grain yield (INSEY) and a response index (RI) to predict yield in winter wheat (Triticum aestivum L.) and calculate N fertilizer rates on a 1 m^2 scale. Teal et al. (2006) accurately used days from planting (DFP) and INSEY to predict corn grain yield, where INSEY was NDVI divided by the days from planting to sensing. The greatest variation in NDVI readings occurs at the V6-V8 growth stage, while the highest correlation between NDVI and grain yield occurs at V7-V9 (Martin et al., 2007). Sensor NDVI readings and plant height can accurately differentiate individual corn plants, and those measurements were highly correlated with plant biomass and N uptake (Freeman et al., 2007). Martin et al. (2011) was able to accurately predict yields for individual corn plants based on NDVI and a 5-plant competition factor using plant height and area occupied by plants. This work documented the potential of fertilizing individual corn plants based on predicted yield.

Objective

The objective of this study was to evaluate corn grain yield response to mid-season N applied on a by-plant basis, based on predicted yield using NDVI, plant height, and distance between plants.

CHAPTER III

MATERIALS & METHODS

Four field trials were established during the 2010 and 2011 growing seasons to evaluate different within-row sidedress methods of N fertilization in corn. One irrigated site was Lake Carl Blackwell (LCB) located on a Pulaski fine sandy loam: coarse loamy, mixed, superactive, nonacid, Udic Ustifluvent in both 2010 and 2011. Grain yield was not recorded at LCB in 2011, because severe weather stress and animal infestations. A rain-fed location at Haskell (Taloka silt loam: fine, mixed, active, thermic Mollic Albaqualf) was also used in 2010. The final location was Efaw in 2011 (Norge loam: fine-silty, mixed, active, thermic Udic Paleustolls). The Efaw location received supplemental water via surface drip tape. All experiments employed a randomized complete block experimental design with 13 treatments and three replications. Plots measured 6.09 m x 3.05 m. Treatments included four different preplant N rates (0, 45, 90, and 180 kg N ha^{-1}) with 180 kg N ha^{-1} as a reference strip for NDVI measurements. Fertilizer applications, planting information, and harvest information is located in Table 1. Nitrogen was applied as urea ammonium nitrate (28-0-0). Trials were planted with a 4-row John Deere (Moline, IL) MaxEmerge Planter with a row spacing of 0.76 m. Weed control was achieved via pre-emergence and mid-season application of glyphosate [N-(phosphonomethyl) glycine].

Plant distance measurements were collected at V8-V10 described by the leaf collar method. Measurements were made to the nearest centimeter by placing a measuring tape parallel with the row. Distance occupied by plants was made under the assumption that the plant in question occupies one-half the distance to the neighbor on either side.Distance between plants was calculated as follows (Martin et al. 2011):

$$D = \left[\frac{d_i - d_{i-1}}{2} + \frac{d_{i+1} - d_i}{2}\right]$$

Where: D is the linear distance occupied by the i^{th} plant (cm); $d_{(i\text{-}1)}$,d_i, and $d_{(i+1)}$ are the distances to the i-1, i, and i+ 1 plants (cm).

Individual plant height measurements were also collected at V8-V10. Plant height was used to calculate a 5-plant competition adjustment factor (C_{adj}), which assumes that neighbors will compete for resources on both sides on the plant in question. This is a weighted comparison on the competitive ability of the third plant in the sequence (plant in question) to its neighbors. C_{adj} is calculated as follows (Martin et al. 2011):

$$C_{adj} = \left[\frac{Ht_{pq}}{\left(\left[\frac{Ht_{pq-1}}{(Ht_{pq-2} + Ht_{pq})/2}\right] + \left[\frac{Ht_{pq+1}}{(Ht_{pq} + Ht_{pq+2})/2}\right]\right)\Big/_{2}}\right]$$

Where: C_{adj} is the competition adjustment factor for the height of the plant in question Ht_{pq} is the height of the plant in question $\text{Ht}_{(\text{pq-2})}$, $\text{Ht}_{(\text{pq-1})}$, $\text{Ht}_{(\text{pq+1})}$, and $\text{Ht}_{(\text{pq+2})}$ are the heights of the pq-2, pq-1, pq+1, and pq+2 plants, respectively.

NDVI data were collected with a GreenSeeker™ (N Tech Industries, Ukiah, CA) optical sensor mounted on a bicycle with the sensor head centered above the row in question. A shaft encoder on the rear wheel of the bicycle enabled NDVI measurements to be collected in 1 cm increments. Individual plant NDVI measurements were achieved by matching distance occupied by each specific plant to the corresponding NDVI readings.

Four methods of sidedress N application were used in this trial. Sidedress N rates were determined using the Sensor Based Nitrogen Rate Calculator (SBNRC) with the current Oklahoma State algorithm for prediction. Variable Rate on a by-plant basis (VRBP) where sidedress N was applied to individual plants based on NDVI, height, distance between plants, and C_{adj}. Sidedress N rates were calculated to match the area occupied by the plant in question. Also included was a uniform rate on a by-plant basis (URBP) where the average N rate was applied by-plant. For this treatment, N applications were made to individual plants, but where all plants received the same sidedress N rate. The uniform rate of N applied to the entire row (URER) treatment utilized the same the total amount of N applied in VRBP, but where N was applied over the entire row. This allows for all sidedress methods to receive the same total amount of sidedress N, but where the methods were different. A zero N sidedress check was also included. Sidedress N applications of urea ammonium nitrate (28-0-0) were made with a 1 mL syringe at the base of the corn plants or beside the row depending on the sidedress method. By-plant fertilizer N rates employed ranged from 8-206, 0-95, and 0-140 kg N ha^{-1} for LCB 2010, Haskell 2010, and Efaw 2011, respectively.

At physiological maturity, the center two rows were hand harvested from each four row plot. Each individual ear was weighed from each plot. Corn ears were threshed in a Massey Ferguson 8XP experimental plot combine (AGCO Corp., Duluth, GA) equipped with a HarvestMaster weighing system (Juniper Systems Inc., Logan, UT) to obtain total plot weight and grain percent moisture. Grain moisture was adjusted to 15.5%. Grain sub-samples were collected, dried, and ground to pass a 140 mesh (100 µm) sieve. Total grain N was analyzed with a LECO TruSpec (LECO Corp., St. Joseph, MI) dry combustion analyzer. A summary of all field work (Preplant application, planting, population, hybrid, sidedress N, and harvest) for LCB 2010, Haskell 2010, and Efaw 2011 can be found in Table 1.

CHAPTER IV

RESULTS & DISCUSSION

LCB, 2010

Grain yield, NDVI collected at V8, grain N uptake, and NUE results for LCB, 2010 are reported in Table 2. Average grain yields at this site were 4408 kg ha^{-1}, and there was a positive response to fertilizer N applied preplant. Grain yields in treatments that received 0 kg N ha-1 preplant and 42 kg N ha^{-1} were lower than the yield level in the control treatment (0 kg N ha^{-1}). The highest yield level was observed at the 180 kg N ha^{-1} preplant rate, which had an average grain yield of 6586 kg ha^{-1}. This was twice the yield of the lowest treatment 0 kg N ha^{-1} preplant and 42 kg N ha^{-1} sidedress applied using a variable rate on a by-plant basis at 3300 kg ha^{-1}. This treatment also had the lowest NDVI collected at the V8 growth stage with 0.613. The treatment that received 90 kg N ha^{-1} preplant and 51 kg N ha^{-1} sidedress applied using a uniform rate on a by-plant basis was the highest yield when compared to VRBP and URER at the same rates. Across all sidedress methods, yields increased with increasing preplant N rate. When 90 kg N ha^{-1} was applied preplant with no sidedress application, it was the most efficient treatment in producing grain per unit of applied N with 19.3 kg ha^{-1} (accounting for the N in the check)

The highest recorded nitrogen use efficiencies of 25% were observed when 90 and 180 kg N ha^{-1} were applied preplant (Table 2). The 0 kg N ha^{-1} preplant and 42 kg N ha^{-1} sidedress applied on a by-plant basis had a negative NUE, indicating that these treatments had lower yields than the 0 kg N ha^{-1} control

Haskell, 2010

Grain yield, grain N uptake, and NUE results for Haskell, 2010 are reported in Table 3. Average yields at this site exceeded 5500 kg ha^{-1}, and where a positive response to applied fertilizer, preplant and sidedress was observed. Yield increases over the check (0 preplant and 0 topdress, 3720 kg ha^{-1}) approached 3700 kg ha^{-1} (treatment mean of 7214 kg ha^{-1}). Applied N essentially doubled grain yields. This treatment was 180 kg N ha^{-1} applied preplant, and that resulted in 19.4 kg grain per unit of N applied (after accounting for N in the check). The most efficient treatment in terms of grain produced per unit of N applied was the variable rate applied by-plant (VRBP, treatment 1) with 53 kg grain increase per unit of N. These benefits at the lower rates were expected.

The most efficient treatment in terms of nitrogen use efficiency had a total N rate of 67 kg N ha^{-1} (45 preplant, 22 sidedress N, kg ha^{-1}), and where N was applied variably on a by-plant basis (VRBP). This NUE was 64%. All other treatments had NUE's less than 50. This demonstrated the combined benefits of split applying fertilizer N, and variable rate application on a by-plant basis. When comparing the exact same N rate combination (45 preplant, 22 sidedress N, kg ha^{-1}, but where N was applied using a uniform rate along the entire length of row, a grain yield increase of 1560 kg ha^{-1} was observed (treatment 5 minus treatment 7).

It is important to note that these same advantages of applying N on a by-plant basis were not realized at the higher N rate (90 preplant, treatments 9-11). This is likely because yield maximums were observed when the lower total N rate of 67 kg N ha^{-1} was applied (treatment 5). While smaller increases in yield above the 67 kg N ha^{-1} rate were recorded, they were not significantly higher. It makes intuitive sense that the real benefits of by-plant N fertilization will not be realized unless evaluated at or near the optimum N rate for maximum yield. At N rates higher than that needed for maximum yield, the benefits of by-plant N fertilization would be masked by over application. At rates lower than that needed for maximum yield, improved use efficiency would likely be observed, but the by-plant N benefits would be skewed to the lower end of the N response curve.

Efaw, 2011

Grain yield, NDVI determined at V8, grain N uptake, and NUE results for Efaw, 2011 are reported in Table 4. Average grain yields at this site were 4913 kg ha^{-1}, and having a positive response to preplant N fertilizer. Limited differences were found between any of the sidedress N methods. Yield increases over the check (0 preplant and 0 sidedress, 3906 kg ha^{-1}) approached 2000 kg ha^{-1} (treatment mean of 6102 kg ha^{-1}). When 90 kg N ha^{-1} was applied preplant, it resulted in 24 kg grain per unit of N applied, accounting for N in the check. A yield benefit was noted when N was applied sidedress, by-plant, using a uniform rate, for the 45 kg N ha^{-1} preplant treatment. The most efficient treatment in terms of grain produced per unit of N applied was 2 kg N ha^{-1} applied using a variable rate, on a by-plant basis (VRBP, treatment 1) with 282 kg grain increase per unit of N).

The highest NDVI value was 0.751 at growth stage V8 was recorded for the 90 kg N ha^{-1} preplant and 14 kg N ha^{-1} sidedress applied at a uniform rate to the entire row. The lowest NDVI value (0.639) was recorded when 45 kg N ha^{-1} was applied preplant with 0 kg N ha^{-1} applied sidedress. The check (0 kg N ha^{-1} total) had the second lowest NDVI at 0.642. All treatments receiving a total N rate of 2 kg N ha^{-1}, regardless of sidedress method, had nitrogen use efficiencies that exceeded 100%. The lowest NUE occurred at the 180 kg N ha^{-1} preplant treatment with 17%.

The Efaw 2011 location was under severe heat with water stress throughout the growing season. There were 37 days of greater than 37°C temperatures. This heat stress severely impacted growth during flowering and lowered grain yields. Supplemental water was supplied with surface applied drip tape to counteract the high heat and low rainfall during the summer. Grain yields decreased at the 180 kg N ha^{-1} rate, and the optimum N rate for grain yield was found at 90 kg N ha^{-1}.

Also, corn at this site was under heat and water stress when NDVI data was collected, and this contributed to the low values, even within the N-rich strip. This in turn resulted in low sidedress N recommendations (2, 9, and 14 kg N ha^{-1}). The high NUE's noted when low N rates were applied is a function of how the difference method for estimating NUE is calculated.

Discussion

For the three locations where combinations of preplant, sidedress, and sidedress-methods were evaluated, differing results were the norm. The impact of environmental conditions were clearly different at all three sites. At Lake Carl Blackwell, noting that the highest yields were recorded at the highest preplant N rate of 180 kg N ha^{-1}, somewhat restricted what could be deciphered for the methods of application that were evaluated. It was hoped that the methods of application (variable rate, uniform rate by plant, uniform rate entire row) would be evaluated at or near the maximum yield. This also has implications concerning spatial variability whereby the benefits of by-plant approach might be compromised if inherent variability overrides the ability to recognize scale. Getting the average optimum N rate right will be critical if the benefits of a by plant approach are to be seen.

At Haskell, the average N rate (sidedress) that was identified using the SBNRC was likely correct. As a result the ability to distinguish difference between the sidedress methods was enhanced. At the higher preplant rates, the benefits of the mid-season by-plant approach were more difficult to discern.

CHAPTER V

CONCULSIONS

Over all sites, yields in general increased with increasing preplant N rate. Within preplant N rates applied, sidedress N almost always increased yields. By-plant sidedress N applications increased yields when the preplant N rate was optimized. When preplant N rates exceed the optimum needed for maximum grain yields, no benefits of by-plant N fertilization were observed. For N rates lower than that needed for maximum yield, improved use efficiency was expected, but by-plant N benefits will be noted lower on the N response curve. With the exception of Haskell 2010, heat and water stress severely restricted corn grain yields. Furthermore, the precision at which mid-season prediction of corn grain yields could take place using NDVI, were clearly altered by the early season stress measurements. If mid-season yield prediction is inaccurate, the ability to decipher the correct N rates using in season sensor measurements becomes equally cumbersome.

TABLES

Table 1. Preplant nitrogen, planting, seeding rate, maize hybrid, sidedress nitrogen, and harvest date for Lake Carl Blackwell 2010, Haskell 2010, and Efaw 2011.

Location	Preplant N	Planting	Population (seeds ha^{-1})	Hybrid	Sidedress N	Harvest
LCB 2010	April 15	May 25	86,500	Dekalb DKC52-59	June 30	Sept 16
Haskell 2010	May 4	May 4	61,700	Dekalb DKC52-59	June 29	Aug 17
Efaw 2011	April 6	May 4	56,800	Pioneer P0902XR	June 13	Aug 9

Table 2. Analysis of variance and treatments means for corn grain yield, NDVI collected at V8, grain nitrogen uptake, and nitrogen use efficiency with different preplant nitrogen rates and methods of sidedress nitrogen fertilization, Lake Carl Blackwell, 2010.

		Yield	NDVI	Grain N Uptake	NUE≠
Source of Variation	df	(mean squares)			
Replication	2	930142	0.003	83	27258**
Preplant N	2	8819540**	0.033**	1475**	12979*
Sidedress Method	3	178739	0.004	35	151
Preplant * Sidedress Method	6	234428	0.003	52	84
Error	22	4551123	0.002	89	2771

Treatment Preplant N kg N ha^{-1}	Sidedress N kg N ha^{-1}	Method	Yield kg ha^{-1}	NDVI	Grain N Uptake kg ha^{-1}	NUE %
0	42	VRBP	3300	0.613	40	-63
0	42	URBP	3483	0.643	41	-60
0	42	URER	3767	0.621	45	-51
0	0	None	3496	0.655	43	---
45	51	VRBP	3870	0.761	46	-3
45	51	URBP	4072	0.709	49	0.1
45	51	URER	4162	0.675	50	3
45	0	None	3865	0.678	45	5
90	51	VRBP	5048	0.730	61	12
90	51	URBP	5687	0.790	71	19
90	51	URER	4747	0.701	56	8
90	0	None	5231	0.715	65	25
180†	0	None	6586	0.765	87	25
SED			550	0.036	7	43
r^2			0.68	0.70	0.64	0.61
CV, %			15.9	6.4	18.6	-553

SED – standard error of the difference between two equally replicated means.
VRBP – variable rate of N applied on a by-plant basis.
URBP – uniform rate of N applied on a by-plant basis.
URER – uniform rate of N applied along entire length of row.
None – no sidedress N was applied.
† - not included in complete factorial arrangement of treatments.
*, ** significant at the 0.05 and 0.01 probability level, respectively.
≠ df computed using one less treatment (0-N check)

Table 3. Analysis of variance and treatments means for corn grain yield, nitrogen uptake, and nitrogen use efficiency with different preplant nitrogen rates and methods of sidedress nitrogen fertilization, Haskell, 2010

Source of Variation	df	Yield	Grain N Uptake	NUE≠
		(mean squares)		
Replication	2	86663	29	7254**
Preplant N	2	16943963**	3608**	2553
Sidedress Method	3	689562	129	294
Preplant * Sidedress Method	6	1383921	337	506
Error	22	851162	180	824

Treatment Preplant N kg N ha^{-1}	Sidedress N kg N ha^{-1}	Method	Yield kg ha^{-1}	Grain N Uptake kg ha^{-1}	NUE %
0	19	VRBP	4731	45	30
0	19	URBP	3569	35	-5
0	19	URER	4284	41	15
0	0	None	3720	40	---
45	22	VRBP	6737	81	64
45	22	URBP	5867	66	44
45	22	URER	5177	59	41
45	0	None	5560	62	50
90	22	VRBP	5694	63	21
90	22	URBP	6569	75	33
90	22	URER	7148	90	46
90	0	None	5947	64	28
180†	0	None	7214	92	29
SED			753	11	23
r^2			0.70	0.71	0.65
CV, %			17.0	22.3	85.9

SED – standard error of the difference between two equally replicated means.
VRBP – variable rate of N applied on a by-plant basis.
URBP – uniform rate of N applied on a by-plant basis.
URER – uniform rate of N applied along entire length of row.
None – no sidedress N was applied.
† - not included in complete factorial arrangement of treatments.
*, ** significant at the 0.05 and 0.01 probability levels, respectfully.
≠ df computed using one less treatment (0-N check)

Table 4. Analysis of variance and treatments means for corn grain yield, NDVI collected at V8, grain nitrogen uptake, and nitrogen use efficiency with different preplant nitrogen rates and methods of sidedress nitrogen fertilization, Efaw, 2011.

		Yield	NDVI	Grain N Uptake	NUE[≠]
Source of Variation	df	(mean squares)			
Replication	2	3171006*	0.003	605**	256
Preplant N	2	4248514**	0.0006	1317**	51902**
Sidedress Method	3	428443	0.005	41	7657**
Preplant * Sidedress Method	6	960059	0.005	160	8762**
Error	22	772994	0.002	125	339

Treatment

Preplant N kg N ha^{-1}	Sidedress N kg N ha^{-1}	Method	Yield kg ha^{-1}	NDVI	Grain N Uptake kg ha^{-1}	NUE %
0	2	VRBP	4471	0.692	59	403
0	2	URBP	4293	0.723	58	101
0	2	URER	4336	0.668	55	242
0	0	None	3906	0.642	50	---
45	9	VRBP	4461	0.685	64	24
45	9	URBP	5594	0.746	76	45
45	9	URER	4610	0.652	63	24
45	0	None	4660	0.639	63	29
90	14	VRBP	4636	0.658	67	17
90	14	URBP	5141	0.675	71	21
90	14	URER	5888	0.751	84	33
90	0	None	6102	0.689	82	36
180†	0	None	5771	0.650	80	17
SED			718	0.036	9	15
r^2			0.56	0.55	0.64	0.97
CV, %			18.2	6.5	16.9	34.8

SED – standard error of the difference between two equally replicated means.
VRBP – variable rate of N applied on a by-plant basis.
URBP – uniform rate of N applied on a by-plant basis.
URER – uniform rate of N applied along entire length of row.
None – no sidedress N was applied.
† - not included in complete factorial arrangement of treatments.
*, ** significant at the 0.05 and 0.01 probability level, respectively.
≠ df computed using one less treatment (0-N check)

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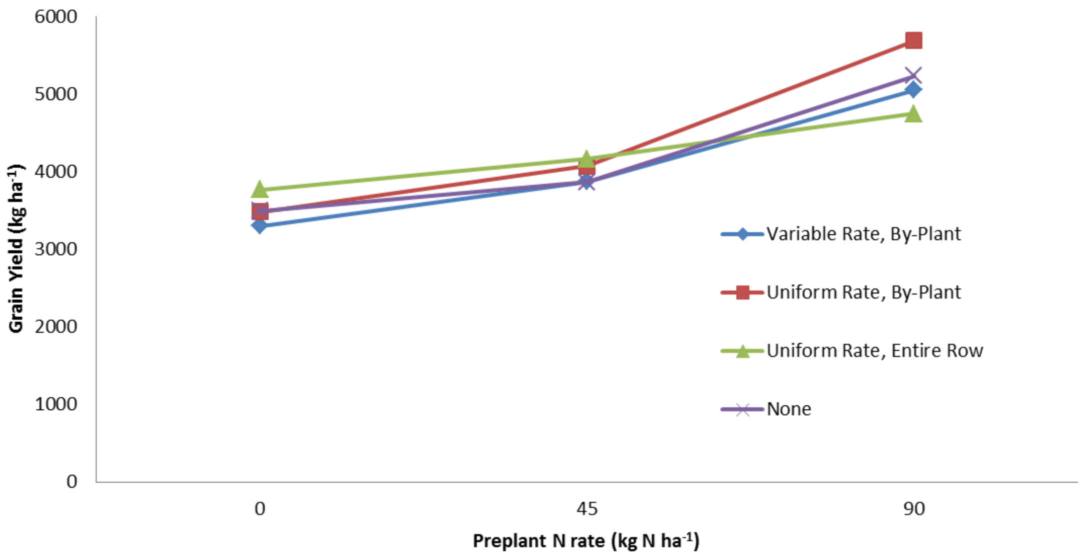
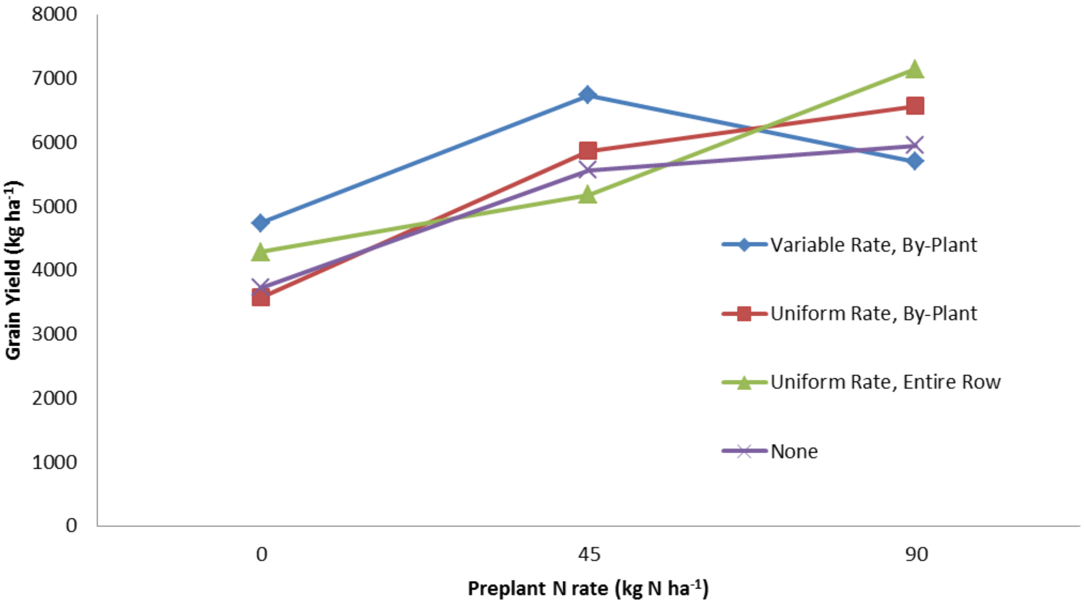
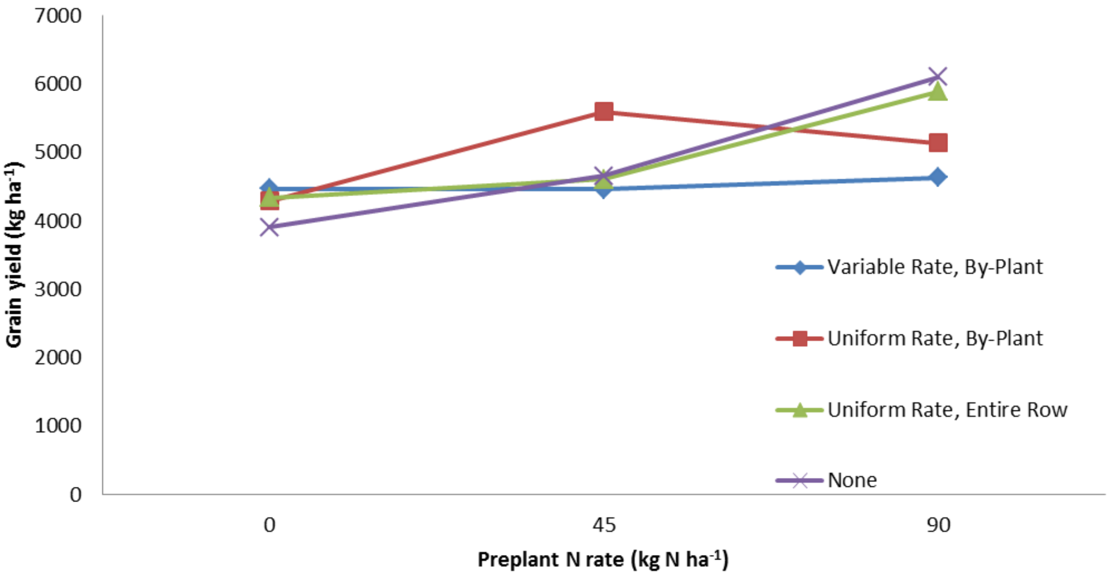
APPENDICES



Appedix 1. Grain yield response to different methods of mid-season sidedress nitrogen determined by NDVI and plant height, Lake Carl Blackwell, 2010.



Appendix 2. Grain yield response to different methods of mid-season sidedress nitrogen determined by NDVI and plant height, Haskell, 2010.



Appendix 3. Grain yield response to different methods of mid-season sidedress nitrogn determined by NDVI and plant height, Efaw, 2011.

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VITA

Jeremiah Lee Mullock

Candidate for the Degree of

Master of Science

Thesis: BY-PLANT SIDEDRESS NITROGEN IN CORN (ZEA MAYS L.) BASED ON PLANT HEIGHT AND NORMALIZED DIFFERENCE VEGETATION INDEX

Major Field: Plant and Soil Science

Biographical:

Education:

Completed the requirements for the Master of Science in your major at Oklahoma State University, Stillwater, Oklahoma in July, 2012.

Completed the requirements for the Bachelor of Science in Agronomy at Northwest Missouri State University, Maryville, Missouri in 2009.

Experience: Raised and worked on a corn and soybean farm in Northern Missouri. Started working as a graduate research assistant in January 2010 at Oklahoma State. Currently serving as Senior Agriculturalist for the Soil Fertility project, whereby maintain 50+ field trials a year and manage 8 fellow graduate students.

Professional Memberships: American Society of Agronomy, Soil Science Society of America, and Crop Science Society of America.

Name: Jeremiah Lee Mullock Date of Degree: July, 2012

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: BY-PLANT SIDEDRESS NITROGEN IN CORN (ZEA MAYS L.) BASED ON PLANT HEIGHT AND NORMALIZED DIFFERENCE VEGETATION INDEX

Pages in Study:23 Candidate for the Degree of Master of Science

Major Field: Plant and Soil Science

Scope and Method of Study: Current methods of applying nitrogen (N) fertilizer do not treat small scale variability that is known to exist. Variations in corn grain yield can be found from one plant to the next. With knowledge that yield potential can be predicted by-plant, this in turn can be used to adjust fertilizer N rates for individual plants. This study was conducted in 2010 and 2011 to evaluate by-plant sidedress N using plant height and normalized difference vegetation index (NDVI) sensor readings. Treatments included pre-plant N rates of 0, 45, 90, and 180 kg N ha-1 with 180 kg N ha-1 as a reference strip. Sidedress N was applied as a variable rate on a by-plant basis, uniform rate on a by-plant basis, and uniform rate on the entire row with a non-fertilized check included.

Findings and Conclusions: By-plant sidedress N applications increased yields when the preplant N rate was optimized. When preplant N rates exceeded the optimum needed for maximum grain yields, no benefits of by-plant N fertilization were observed.

ADVISER’S APPROVAL: Bill Raun