Optimum Pre-Plant Nitrogen Placement for Corn Producers With RTK Automatic Guidance Systems

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INTRODUCTION

Recent developments in GPS-guided automatic steering systems have opened up many new management options for corn producers. Automatic guidance devices have provided benefits in terms of improved timeliness of field operations, less operator fatigue, reductions in overlapping applications of pesticides and fertilizers, controlled traffic system opportunities, as well as reduction in capital expenses (such as the possible elimination of row markers on corn planters, or the use of strip tillage tools that are only 1/2 to 2/3 of the corn planter width). The economic merits of automatic steering devices are still being debated, as are the relative merits of automatic guidance systems with various degrees of accuracy.

But until now, there has been very little research or extension emphasis on the possible benefits of automatic steering systems for improved efficiencies in fertilizer application and crop utilization. About the only generalization to have emerged from the discussion thus far is that automatic guidance systems should lessen the total fertilizer applied because of less overlap (associated with more precision of the driving patterns of wide applicators, especially in non-rectangular fields). Clearly, there are many more new opportunities to be explored as possible fertilizer efficiency gains and improved profitability for corn producers who can now purchase various GPS automatic guidance systems for their tractors (and soon for the implements that are pulled behind the GPS guided tractors to correct for side-slopes), and who may also want to be capable of integrating their corn planting row placement with their own, or custom, band fertilizer applications.

Our interest in combining no-till and strip tillage operations with liquid fertilizer banding grew over years of researching and promoting strip tillage and deep banding of dry fertilizers for high yield corn production systems. The objectives of this research were to:

1. Determine the realistic joint benefits associated with automatic guidance systems for both UAN fertilizer banding and planting systems in no-till corn production.
2. Quantify the effects of various degrees of planter precision - relative to pre-planting UAN fertilizer bands - on corn nutrient uptake, growth and yield.
3. Determine whether the combination of automatic guidance systems and pre-plant banded UAN fertilizer application would circumvent the need for liquid starter fertilizer applicators on corn planters.

METHODOLOGY

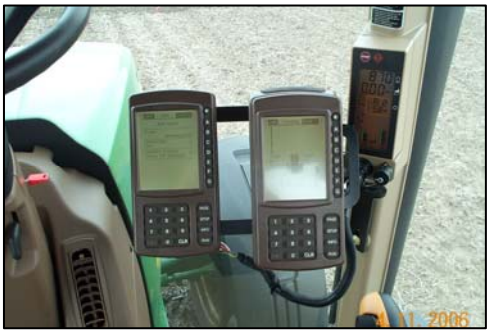
Applying pre-plant treatments with the JD 7920 and DMI 2800 UAN applicator

Equipment and Locations: John Deere loaned us a RTK base station plus a 7920 tractor equipped with Automatic Guidance (RTK) and front-wheel assist for research purposes at the Agronomy Center for Research and Education (referred to as ACRE, and located near West Lafayette, IN) and the Pinney-Purdue Agricultural Center (referred to as PPAC, and located near Wanatah, IN). We used a 7-coulter DMI Nutri-Placr 2800 for pre-plant and side-dress UAN application on our research plots at these 2 locations. We were able to plant corn with 6-row no-till planters at both locations--a JD 1780 planter at ACRE and a JD 1770 planter at PPAC. Both planters have liquid fertilizer attachments for the

traditional 2” x 2” placement. The soil type at ACRE is a Brookston silty clay loam with about 4% organic matter, and the soil type at PPAC is a Raub sandy loam with about 2.5 % organic matter.

Planting at ACRE

Treatments, Experimental Design, and Cultural Practices: Field experiments established as either split-plot (ACRE) or RCB (PPAC) with 6 replications involved no-till corn planting on soybean stubble shortly after (on the same day) pre-plant UAN application in May of 2006. Individual plot lengths were 90 feet at ACRE and 135 feet at PPAC. All plots received the same total rate of N fertilizer (i.e. 200 pounds/acre of actual N as UAN), but the amount of pre-plant UAN varied from 0 to 200 pounds actual N per acre. Pre-plant UAN was banded to a depth of approximately 4”. The side-dress UAN application rates (applied between the corn rows at approximately the V-4 stage) also varied from 0 to 200 pounds N per acre.



RTK and planter displays

Main treatments: Corn Row Proximity to Pre-plant UAN Fertilizer

1. Control (no pre-plant UAN band),
2. Pre-plant UAN at 50 pounds, Planter 0” (on-row)
3. Pre-plant UAN at 50 pounds, Planter ± 5”
4. Pre-plant UAN at 50 pounds, Planter ± 10”
5. Pre-plant UAN at 100 pounds, Planter 0” (on-row)
6. Pre-plant UAN at 100 pounds, Planter ± 5”
7. Pre-plant UAN at 100 pounds, Planter ± 10”
8. Pre-plant UAN at 200 pounds, Planter 0” (on-row)
9. Pre-plant UAN at 200 pounds, Planter ± 5”
10. Pre-plant UAN at 200 pounds, Planter ± 10”

Sub-treatments: Starter at planting (at ACRE only)

1. Without 2” x 2” starter-band placement of 10-34-0 at 20 gallons/acre
2. With 2” x 2” starter band placement of 10-34-0 at 20 gallons/acre

RESULTS and DISCUSSION

ACRE, West Lafayette

The overall negative effects of on-row fertilization on early plant establishment after pre-plant UAN banding at high N rates were less than anticipated at this location. Corn plant populations were not significantly affected by pre-plant UAN rate or by row placement with either starter treatment (Table 1). This location was planted just before a 10-day consecutive period of precipitation (May 10 to 20), and it is quite possible that precipitation patterns following corn planting were crucial in preventing toxicity to corn seedlings from high rates of UAN application. From May 10 to May 20, this site received a total of 3.7” of rain. Both corn row position and starter affected corn plant heights. Following pre-plant UAN, corn plant heights at V-6 stage were lowest with the 200 pound N rate whether or not starter was applied at planting. However, corn plant heights were even lower for the Control treatment versus the 200 pound on-row treatment, as well as all other treatments, when no starter 10-34-0 was applied. Planting row position had little influence on relative plant heights when starter was applied. Early corn growth was very responsive to starter fertilizer at this site; plant heights with starter averaged 4.4 inches taller than those without starter.

Corn row position compared to pre-plant UAN bands had large impacts on grain yields, but not on grain moisture contents at harvest. Corn yields were highest when the rows were planted directly over the 50 pound N rate, whether or not starter was applied (Table 1). Planting directly on-row after a UAN band application never lowered yields significantly at this location. In fact, sometimes there was a significant yield benefit from being on-row versus 10" away from the UAN band (for instance, when pre-plant UAN was banded at the 50 and 100 pound rates and when no starter was applied at planting). Average corn yields were increased about 13 bushels per acre by the starter application; corn moisture contents were decreased by 1.3% when starter was applied. It is interesting to note that corn yields responded most positively to starter when pre-plant UAN was banded 10" away from the row.

For this environment and year, it seems that there was a particular benefit to planting directly over a pre-plant UAN band, and a yield disadvantage associated with planting 10" away from the UAN band - especially when starter was not applied - even though on-row planting caused some stunting of early plant growth at the highest UAN rate.

Table 1. Corn response to pre-plant banded UAN application and RTK-guided corn row placement at ACRE, 2006. Average of six replications. Means with the same letter are not significantly different.

Starter Fertilizer?	Pre-plant N rate and Placement	Stand 4 weeks	Plant Height V6	Harvest Moisture	Yield @ 15.5%
		plants/acre	in	%	bu/acre
No Starter	0 pre-plant UAN	30556	27.0d‡	30.5	200.4abc
	50 lbs on row	30111	31.8ab	29.3	208.0a
	50 lbs 5 inches	30889	31.8ab	29.4	200.9abc
	50 lbs 10 inches	30167	30.3bc	30.2	186.8cd
	100 lbs on row	31333	32.1a	29.3	205.7ab
	100 lbs 5 inches	30278	30.4abc	30.6	193.7bcd
	100 lbs 10 inches	30278	31.1abc	28.9	199.4abc
	200 lbs on row	31500	29.8c	30.1	198.8abc
	200 lbs 5 inches	30556	31.6ab	30.1	193.9abcd
	200 lbs 10 inches	30167	30.5abc	30.1	183.7d
	Mean of 10 treatments		**30.6**	**29.8**	**197.1**
	LSD (5%)	*1763*	*1.73*	*1.78*	*14.3*
Starter	0 pre-plant UAN	30111ab	34.7ab	28.8	205.2
	50 lbs on row	29667b	35.5ab	28.2	216.7
	50 lbs 5 inches	31500a	35.9ab	27.9	207.7
	50 lbs 10 inches	30222ab	35.6ab	28.8	207.5
	100 lbs on row	30667ab	34.9ab	28.2	213.3
	100 lbs 5 inches	31056ab	35.3ab	28.6	210.8
	100 lbs 10 inches	30389ab	36.2a	28.3	213.5
	200 lbs on row	30444ab	34.3b	29.0	208.6
	200 lbs 5 inches	30500ab	34.9ab	28.5	211.0
	200 lbs 10 inches	30055ab	35.1ab	28.9	205.7
	Mean of 10 treatments		**35.2**	**28.5**	**210.0**
	LSD (5%)	*1566*	*1.80*	*1.92*	*11.8*

PPAC, Wanatah

In contrast to the results at the first location (ACRE), corn plant establishment at PPAC was very negatively affected by placing corn rows on directly over some pre-plant UAN bands. Considerable plant death occurred with on-row planting at N rates of 100 pounds and 200 pounds per acre, but not with on-row planting at the 50 pound rate (Table 2). Only 71% of the plants survived with on-row planting at 100 pounds N, and less than 40% of the plants survived at the 200 pound rate of N. Corn plants were also severely stunted in these same two treatments (note that plant heights at V-8 for on-row planting at 200 pounds were just half as tall as those in comparable treatments planted 5" to 10" away). At the same time, there was no deleterious impact to plant populations or to early plant heights when corn rows were planted just 5" away from the UAN band at even the highest N rate. This marked suppression of early plant growth was exacerbated by dry conditions following planting at this location. Although there was a small rain of 0.44" just 2 days after planting, there were almost 13 consecutive days of no rain following that precipitation event (data not shown). The first substantial rainfall (cumulative of 1.40") did not occur until 18 days after planting. Soil nitrogen levels can be found in Table 3.

Grain yields were dramatically affected by corn row position relative to the pre-plant UAN bands. At the 100 pound N rate, planting on-row reduced corn yields by an average 38 bushels per acre relative to planting 5" or 10" from the pre-plant UAN bands. At the 200 pound N rate, planting on-row reduced corn yields by an average 79 bushels per acre relative to planting 5" or 10" from the pre-plant bands. There was no negative effect of on-row planting on corn growth at the 50 pound N rate.

Grain moisture concentrations were highest with on-row planting at the 200 pound N rate, and this probably reflected delayed development of these stunted corn plants (Table 2). Grain moisture concentrations were lowest when corn rows were positioned 10" away from the 100 pound pre-plant N rate, but corn in this treatment was significantly drier than just two other treatments (the 100 and 200 pound N rates with on-row planting).

For this environment and year (sandy loam soil plus relatively dry conditions after planting), the best corn row positions were either 5" or 10" away from pre-plant UAN bands whenever the N rate was above 50 pounds per acre. Perhaps because starter fertilizer was applied to all treatments in this trial, there was no yield advantage to pre-plant banded applications of UAN.

Table 2. Corn response to pre-plant banded UAN application and RTK-guided corn row placement at PPAC, 2006.

Pre-plant N rate and Placement	Stand 4 weeks	Plant Height V8	Harvest Moisture	Yield @ 15.5%
	Plants/acre	in	%	bu/acre
0 pre-plant UAN	34306a	17.3a	24.9abc	171.6a
50 lbs on row	32833a	16.9a	24.5bc	169.2a
50 lbs 5 inches	34417a	17.8a	24.6bc	171.6a
50 lbs 10 inches	34500a	17.5a	24.6bc	168.3a
100 lbs on row	24417b	14.0b	25.5ab	135.4b
100 lbs 5 inches	33861a	17.0a	24.7bc	174.0a
100 lbs 10 inches	33944a	17.5a	23.9c	173.2a
200 lbs on row	13306c	9.9c	26.3a	92.6c
200 lbs 5 inches	34556a	17.1a	24.8abc	172.0a
200 lbs 10 inches	34472a	18.5a	24.4bc	170.8a
LSD (5%)	*3809*	*2.2*	*1.5*	*17.8*
Significance Level	.01	.01	NS	.01

* Values followed by different letters are significantly different at P=0.05.

Table 3. Soil nitrogen concentrations at 2 depth intervals, in row samples approximately 1 month after planting, PPAC, 2006. Average of three replications.

Depth of soil sample	Pre-plant N rate and Placement	NO_3N	NH_4N
0-8 inches	0 pre-plant UAN	20c	5c
	50 lbs on row	63a	99b
	50 lbs 5 inches	22c	8c
	50 lbs 10 inches	19c	8c
	100 lbs on row	84a	204a
	100 lbs 5 inches	20c	7c
	100 lbs 10 inches	23c	9c
	200 lbs on row	82a	206a
	200 lbs 5 inches	24c	8c
	200 lbs 10 inches	20c	7c
	Mean of 10 treatments	**38**	**56**
	LSD (5%)	*10*	*57*
8-16 inches	0 pre-plant UAN	9c	3c
	50 lbs on row	16b	12b
	50 lbs 5 inches	9c	4c
	50 lbs 10 inches	8c	4c
	100 lbs on row	19a	14ab
	100 lbs 5 inches	9c	3c
	100 lbs 10 inches	10c	4c
	200 lbs on row	22a	19a
	200 lbs 5 inches	9c	3c
	200 lbs 10 inches	8c	4c
	Mean of 10 treatments	**12**	**7**
	LSD (5%)	*4*	*5*

SUMMARY

The most precise GPS-controlled automatic guidance system currently available for agricultural equipment is the RTK system. This tool provides new opportunities for varying crop row position relative to recent (or older) nutrient bands and prior crop rows. With one year of testing concluded, we tentatively conclude that RTK guidance is advantageous when planting corn soon after banded UAN application, and that the optimum corn row position for a “safe” response shortly after UAN application at high rates is about 5 inches from, and parallel to, the UAN band.

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Waters Agricultural Laboratories agreed to analyze some of our plant samples at no cost, and these will improve our interpretation of the results from this experiment. Mr. Keith Dominey is our contact person at this laboratory in Camilla, GA.

Pioneer Hi-Bred (Dupont) donated seed for this and other cropping systems experiments in 2006.

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