The Potential of the Pre-sidedress Nitrate Test and Variable Rate Application to Improve Nitrogen Utilization in Corn

UNIVERSITY OF MINNESOTA | EXTENSION

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Introduction

In Minnesota there is considerable interest in using split applications of nitrogen (N) in corn (Zea mays L.) to better manage N fertilizer and enhance profitability. A recent survey of farmers in Minnesota (Carlson, unpublished) found 38% intend to split apply N fertilizer and 37% intend to adopt variable rate (VR) technology. The question is what tool should be used to base these VR sidedress N rates. The objective of this on-farm research was to determine the potential of the pre sidedress soil nitrate test (PSNT) as the tool for determining sidedress N rates in corn.

Methods

An on-farm research study was conducted at four sites in Southern Minnesota on glacial till soils. Fertilizer N treatments were applied to field length strips in a randomized complete block design with four replications. Crop rotation varied by site; BP14 and WA15 sites were corn following soybean (Glycine max L.), and NF15 and CG15 were corn following corn.

Treatments

- FIX: split application of 70% preplant (PP) and 30% at sidedress (SD)
- VAR: split application about 70% PP and a variable rate at sidedress
- UM: a single spring PP application based on Univ. of Minnesota guidelines

Total N rates varied among treatments and crop rotations but were constant at each research site for the UM and FIX treatments; whereas, the SD rate in the VAR treatment varied across the landscape based on PSNT and a productivity zone factor (Table 1). Preplant applications were generally applied a few days prior to planting and SD applications were applied at about the V6 growth stage of corn.

Table 1. Preplant and sidedress nitrogen rates for each treatment and site.

	BP14		WA15		NF15		CG15	
	PP	SD	PP	SD	PP	SD	PP	SD
	---------- kg ha^{-1} ----------							
FIX	118	52	112	45	168	56	168	56
VAR	112	135†	112	113†	168	72†	168	127†
UM	135	0	135	0	185	0	185	0

† Average rate across variable rate area

Soil samples were taken at V2 and again at V5 (PSNT) to a 30 cm depth. The PSNT sample locations for the VAR treatment were determined by soil types and productivity zones, while other treatments were sampled at regular distance intervals. After collection, field moist soil samples were stored at 5° C. until analyzed for NO_3-N using Solum's No-Wait Nitrate™ test. After sieving, soil is made into a moisture corrected slurry. The slurry is filtered and extract is scanned by an optical sensor to measure NO_3-N. Corn grain yields were determined both by combine yield monitor and weigh wagon. Partial factor productivity (PFP) was calculated using the following equation: Yield (kg) ÷ N rate (kg).

Results

Table 2. Soil nitrate-N (0-30 cm depth) as affected by treatment and sampling time.

	------ BP14 ------			------ WA15 ------			------ NF15 ------			------ CG15 ------		
	Sample Time			Sample Time			Sample Time			Sample Time		
	V2	V6	Ave	V2	V6	Ave	V2	V5	Ave	V2	V5	Ave
	---------- mg kg^{-1} ----------											
FIX	10.2	4.1	7.2 a†	25.3	18.1	21.7 a	18.5	29.0	23.7 a	28.3	20.9	24.6 a
VAR	6.7	3.7	5.2 b	18.5	15.2	16.8 a	22.1	31.7	26.9 a	37.0	23.7	30.3 a
UM	11.1	4.7	7.9 a	25.7	19.5	22.6 a	19.8	31.3	25.5 a	32.5	27.0	29.7 a
Ave	9.3 A	4.2 B		23.1 A	17.6 B		20.1 B	30.7 A		32.6 A	23.9 B	

† Numbers within a column followed by the same uppercase letter and numbers within a row followed by the same lowercase letter are not significantly different (*P* ≤ 0.10)

- At BP14 NO_3-N concentrations at V6 sampling were very low. Suggesting considerable N loss due to leaching and/or denitrification which likely occurred during an exceptionally wet period in mid June.
- At WA15, NO_3-N concentrations were less at the V6 sampling time than at V2, when averaged across N treatments, suggesting some N loss or movement below 30-cm had occurred.
- NF15, NO_3-N was considerably greater at the V5 sampling time than at V2, suggesting significant N mineralization from soil organic matter and very little N loss during this period.
- CG15, nitrate was considerably less at the V5 sampling time than at V2, suggesting some N loss or movement below 30-cm during this period.
- At 3 of 4 sites soil NO_3-N concentrations were not affected by treatments, which is expected as PP N rates were similar among treatments.

Table 3. Corn grain yields as affected by N treatments.

	BP14	WA15	NF15	CG15
	----- Mg ha^{-1} -----			
FIX	9.4 b†	13.1 b	13.4 a	13.6 a
VAR	10.0 a	13.8 a	13.8 a	13.6 a
UM	8.5 c	12.9 b	13.3 a	13.3 b

† Numbers within a column followed by the same letter are not significantly different (P ≤ 0.10)

- At BP14, grain yields ranked VAR > FIX > UM.
- At WA15, grain yield with VAR was greater than FIX and UM.
- At NF15, grain yields were not different among treatments.
- At CG15, VAR and FIX had equal grain yield and were slightly greater than UM.

Table 4. PFP as affected by N treatments.

	BP14	WA15	NF15	CG15
	----- kg grain per kg N -----			
FIX	56.0 b†	84.0 b	59.9 b	61.0 b
VAR	40.8 c	61.6 c	58.2 b	44.2 c
UM	63.2 a	95.7 a	72.2 a	72.2 a

† Numbers within a column followed by the same letter are not significantly different (P ≤ 0.10)

- At BP14, PFP ranked UM > FIX > VAR
- At WA15, PFP ranked UM > FIX > VAR
- At NF15, PFP with UM was greater than FIX and VAR
- At CG15, PFP ranked UM > FIX > VAR

Discussion

Treatments significantly affected corn grain yields at three of the four sites. The VAR treatment had 2, 7 and 18% greater yields than the UM treatment at these three sites; however, the VAR treatment received 59, 68 and 83% more fertilizer N, respectively. Generally, the FIX treatment had equal or slightly less yields than the VAR treatment with considerably less fertilizer N. At all sites Partial Factor Productivity (PFP) was greatest with the UM treatment. Ultimately, the potential of the PSNT for improving N utilization in corn remains unclear. While yields were increased there were added costs for soil sampling, soil testing and additional fertilizer. In addition, the short period of time available for soil sampling, testing and fertilizing was a significant logistical challenge.