Economic Potential for a Pre-sidedress Soil Nitrate Test Based Variable Rate Nitrogen Application in Corn

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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 A recent survey of farmers in Minnesota (Carlson, unpublished) found 38% intend to split apply N fertilizer and 37% intend to adopt variable rate (VR) technology.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 economic 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 seven 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, CG15, NF16, CG16, and WA16 were corn following corn.

<u>Treatments</u>

- 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. 30 cm PSNT soil samples were collected at V2 and V6 growth stages.

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

	BP14		WA15		NF15		CG15		NF16		CG16		WA16	
	PP	SD	PP	SD	PP	SD	PP	SD	PP	SD	PP	SD	PP	SD
	------------ kg ha^{-1} ------------													
FIX	118	52	112	45	168	56	168	56	168	56	168	56	168	56
VAR	112	135†	112	113†	168	72†	168	127†	168	60†	168	74†	168	85†
UM	135	0	135	0	185	0	185	0	185	0	185	0	185	0

† Average rate across variable rate area

<u>Economic Analysis</u>

Input costs were provided by Central Farm Service, the industry provider/supplier, and the University of Minnesota Extension Ag Business Management Team (Table 2). Net returns were calculated from yield, crop price, and input costs.

Table 2. Input costs

Input	Price
PSNT soil sampling on 1.8 hectare grids	\$16.05 ha^{-1}
Sidedress application with high clearance applicator	\$22.23 ha^{-1}
Variable rate sidedress application with high clearance applicator	\$23.47 ha^{-1}
Preplant N	\$0.99 kg^{-1}
Sidedress N (urea with NBPT)	\$1.10 kg^{-1}
Grain handling (field to farm)	\$3.94 Mg^{-1}
Grain drying	\$0.98 %$^{-1}$Mg^{-1}
Corn price	\$157.48 Mg^{-1}

Results

Table 3. Corn grain yields as affected by N treatments

	BP14	WA15	NF15	CG15	NF16	CG16	WA16
	------------ Mg ha^{-1} ------------						
FIX	9.4 b†	13.1 b	13.4 a	13.6 a	12.0 a	12.6 a	12.8 a
VAR	10.0 a	13.8 a	13.8 a	13.6 a	12.1 a	12.6 a	13.1 a
UM	8.5 c	12.9 b	13.3 a	13.3 b	12.0 a	12.7 a	11.8 b

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

- At NF15, NF16, and CG16 grain yields were not different among treatments.
- At BP14, grain yields ranked VAR > FIX > UM.
- At WA15, grain yield with VAR was greater than FIX and UM.
- At CG15 and WA16 VAR and FIX had equivalent grain yield and were slightly greater than UM.

Table 4. Net returns and ranking for N treatments

	BP14†		WA15†		NF15		CG15†		NF16		CG16		WA16†	
	\$ ha^{-1}	Rank	\$ ha^{-1}	Rank	\$ ha^{-1}	Rank	\$ ha^{-1}	Rank	\$ ha^{-1}	Rank	\$ ha^{-1}	Rank	\$ ha^{-1}	Rank
FIX	1,235	1	1,820	3	1,811	3	1,839	2	1,595	2	1,694	2	1,686	1
VAR	1,227	2	1,829	2	1,820	2	1,744	3	1,586	3	1,651	3	1,683	2
UM	1,164	3	1,836	1	1,857	1	1,868	1	1,654	1	1,782	1	1,602	3

† sites where yields were significantly different (P ≤ 0.10)

- At BP14 and WA16 net returns ranked FIX ≈ VAR > UM
- At WA15 and NF15 net return was greatest with UM followed by VAR and then FIX
- At CG15, NF16, and CG16 net return was greatest with UM followed by FIX and then VAR

The UM treatment had the greatest returns in 5 of 7 site years. BP14 and WA16 had greater than normal precipitation (data not shown), illustrating the potential value of split applications although the FIX and VAR treatments were similar in their net returns. The VAR treatment in BP14, WA15, CG15, and WA16 had 50% to 160% more sidedress fertilizer applied compared to the FIX sidedress treatment; this highlights the issues with using a 0-30 cm PSNT soil test to variable rate on high rates of N fertilizer. For example, at BP14, WA15, and WA16 PSNT values were concernedly low (Table 5), but returns for VAR and FIX were essentially the same at these sites.

Table 5. Soil nitrate-N (0-30 cm depth) at V5-V6 timing

	BP14	WA15	NF15	CG15	NF16	CG16	WA16
	------------ mg kg^{-1} ------------						
FIX	4.1	18.1	29.0	20.9	29.7	19.2	13.7
VAR	3.7	15.2	31.7	23.7	32.6	22.1	14.6
UM	4.7	19.5	31.3	27.0	36.8	24.3	15.1

Discussion

Treatments significantly affected corn grain yields at four of the seven sites, and at all four of these sites the split application treatments had yields greater than the UM treatment. The VAR treatment had 2, 7, 12 and 18% greater yields than the UM treatment at these four sites; however, the VAR treatment received 59, 68, 37 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. In only 2 of the 7 site-years did the added input costs associated with split application treatments result in greater net returns then the UM single preplant application. For these 2 years with greater net returns the split applications had \$160 ha^{-1} more combine net profit than the UM treatment; whereas, for the other 5 site-years the UM treatment had \$303 ha^{-1} more net profit than the average of the split applications. Without the proper rate calibration of the PSNT based sidedress approach it is unlikely that this approach will increase net return.