Validation of Ontario's N fertilizer recommendations for corn in high yielding environments: 2012 Summary

Purpose:

With the increase in corn yields over time, more Ontario producers are achieving yields which would not have been well represented in existing nitrogen yield response data. It is unknown how greater yield potential may impact yield response to nitrogen, and as a result the accuracy of current recommendations under these high yielding environments is unknown. In conjunction with calibrating nitrogen recommendations, development of tools which aid in tailoring side-dress nitrogen rates to deliver the maximum economical rates of nitrogen while accounting for changes in nitrogen supply have also been an ongoing effort. In Ontario, validation of these tools is limited, though some are advertised in the marketplace for this purpose. The objective of this research is to calibrate the nitrogen recommendations for corn in high yielding environments, and to evaluate the ability of existing nitrogen management tools such as the SPAD meter, Greenseeker and pre-sidedress soil nitrate tests for their ability to quantify nitrogen requirements at sidedress time.

Methods:

In 2012, nitrogen rate experiments were conducted at six sites. Nitrogen treatments were applied in a strip block design with two randomized replications at each site. Seven nitrogen treatments addressed nitrogen rates and timing, and included a control (no nitrogen except for starter fertilizer), four preplant-only application rates (50, 100, 150 and 200 lb-N/ac), a split application (100 lb-N/ac preplant and 50 lb-N/ac sidedress) and a sidedress only application (150 lb-N/ac). All nitrogen was applied as UAN + Agrotain, with preplant being applied as a top-dress after planting, and side-dress being applied at the 6-8 leaf stage. Both preplant and side-dress applications were completed with a Yetter© toolbar equipped with a 30' spray boom with 3 hole streamer nozzles on 20" centres, and Agsystems coulter injection knives (Fig. 1). Nitrogen management tools were evaluated for their ability to predict optimum nitrogen rates, and included a SPAD meter to measure chlorophyll content, a Greenseeker® to measure NDVI, and a pre-sidedress nitrate test for soil nitrate levels. Plant sampling was conducted during the second week of June and again during the third week of June. Soil nitrate sampling was conducted during the second week of June. Whole plot yields were determined by combine and weigh wagon, while hand harvesting was completed at the flagged "benchmarks" where plant measurements were taken from to overcome field variability. Moistures were taken from samples with moisture meter to correct all yields to 15.5% moisture.

Figure 1. Yetter© toolbar unit used for preplant and sidedress nitrogen applications

Results:

Maximum economic rates of nitrogen (MERN) were successfully determined within the preplant rates applied at all sites except St. Mary's where yields continued to increase for each successive application rate (Table 1). Responses were variable, with MERN ranging from 12 lb-N/ac to 179 lb-N/ac within sites where MERN could be calculated within the preplant rates applied. When investigating yield response to application timing of 150 lb-N/ac, few significant differences in yield were observed except for at Woodstock South where side-dressing yielded 11 bu/ac more and at Ancaster where side-dressing yielded 9 bu/ac less than preplant. These results should be interpreted in context with the environmental conditions experienced during the 2012 growing season.

Table 1. Planter nitrogen rates and average plot yields for seven nitrogen treatments at six sites in Ontario, 2012

		------ Pre Plant Nitrogen (lb-N/ac) ------							
	Planter N	**0**	**50**	**100**	**150**	**200**	**100**	**0**	
		----- Side Dress Nitrogen (lb-N/ac) -----							
Location	**(lb/ac)**	**0**	**0**	**0**	**0**	**0**	**50**	**150**	**MERN**
		---------- yield (bu/ac) ----------							lb-N/ac
Moorefield	12	166	171	169	161	158	157	157	12
St. Mary's	33	157	162	164	173	178	173	174	233
Ilderton	30	165	188	204	202	201	206	203	130
Woodstock North	25	146	188	213	223	228	228	229	172
Woodstock South	3	98	115	134	125	120	121	136	90
Ancaster	23	82	113	136	150	149	158	141	179

Given the positive yield response to increasing rates of nitrogen at certain sites, an effective side-dress nitrogen management tool would be expected to identify differences between nitrogen treatments in attempts to predict yield response potential. At side-dressing time, visual differences in plant colour were not evident at most fields.

Plant measurements and yields are presented as indexes, where values for each nitrogen treatment are expressed relative to the value of the highest (200 lb-N/ac) preplant nitrogen rate (Table 2). Soil nitrate samples are presented as actual ppm values.

SPAD index values appeared to be slightly lower for the zero nitrogen rates at sites where the zero nitrogen rates also had low yield indexes (Ilderton, Woodstock North, Ancaster), suggesting identification of nitrogen deficiency was possible. However, correlation of SPAD index values to yield index at higher application rates was not clear at all sites. Similarly, when looking across sites, yield index values from one field did not appear to correlate to yield index values another when SPAD index values for two nitrogen application rates were similar.

The NDVI index values did not appear to identify nitrogen deficiencies. At sites with the lowest yield indices for the zero and low nitrogen application rates (St. Mary's, Ilderton, Woodstock North, Ancaster), only the Ancaster site had an NDVI value that was less than the high 200 lb-N/ac preplant treatment. Most sites had NDVI values that were equal to or greater than one across all application rates, demonstrating that no difference was discerned from the high nitrogen application rate at the time of sampling.

Soil nitrates increased with all application rates as expected. When looking across sites, no clear "critical" soil nitrate concentration appeared to exist where the potential for a yield response could be predicted. This could be partially clouded by differences in nitrogen applied as starter fertilizer between sites, and could require further analysis in order to find a meaningful association.

Data for PSNT of the zero nitrogen plots and corresponding trial MERNs for all locations for the past two years of this project are presented in Table 3. While MERN values associated with soil nitrate tests are much higher than existing recommendations (data not shown), a consistent relationship does appear to exist between PSNT and MERN, although outliers do exist, such as St. Mary's in 2012.

Table 2. SPAD, NDVI (values indexed to the high N rate plot) PSNT values (PPM) for the 2nd week of June relative to hand harvested benchmark yields indexed across five nitrogen rates at six locations in Ontario, 2012. The highlighted regions represent the N rate plots that were approximately at the optimum N rate for the site.

		Preplant Rate (lb-N/ac)				
Location	**Measure**	**0**	**50**	**100**	**150**	**200**
Moorefield	SPAD Index	1.03	0.94	1.02	0.97	1.00
	NDVI Index	1.06	1.02	1.09	0.99	1.00
	PSNT (ppm)	36	38	41	54	64
	Yield Index	0.99	1.04	1.03	1.03	1.00
St. Mary's	SPAD Index	1.00	1.05	1.05	0.96	1.00
	NDVI Index	1.03	1.10	1.04	1.06	1.00
	PSNT (ppm)	36	33	42	56	67
	Yield Index	0.83	0.96	0.97	0.93	1.00
Ilderton	SPAD Index	0.95	0.97	0.97	0.96	1.00
	NDVI Index	1.07	1.02	1.02	1.01	1.00
	PSNT (ppm)	21	25	36	39	48
	Yield Index	0.91	1.01	1.15	1.10	1.00
Woodstock North	SPAD Index	0.95	0.97	0.97	0.96	1.00
	NDVI Index	1.06	1.15	1.14	1.13	1.00
	PSNT (ppm)	16	27	27	33	42
	Yield Index	0.62	0.86	0.92	0.98	1.00
Ancaster	SPAD Index	0.92	0.97	0.94	0.91	1.00
	NDVI Index	0.89	1.05	0.94	1.02	1.00
	PSNT (ppm)	17	31	34	41	46
	Yield Index	0.59	0.84	0.96	1.01	1.00
Woodstock South	SPAD Index	0.99	1.02	1.02	1.01	1.00
	NDVI Index	1.00	1.09	1.03	0.99	1.00
	PSNT (ppm)	25	25	29	37	40
	Yield Index	1.09	1.22	1.17	1.04	1.00

Table 3. PSNT and MERN for all nitrogen validation trial sites from 2011 and 2012 in Ontario.

Year	Location	PSNT (ppm)	MERN (lb-N/ac)
2011	Kirkton	14	190
	Ilderton	17	180
	Woodstock - North	15	190
	Woodstock - South	11	190
2012	Moorefield	36	12
	Elora	27	30
	St. Mary's	36	233
	Ilderton	21	130
	Woodstock - North	16	172
	Woodstock - South	25	90
	Ancaster	17	179

Summary:

Yield response to nitrogen was highly variable across all sites. Final MERNs could be calculated within the nitrogen rates that were applied for all sites except for St. Mary's in 2012. No clear advantage to split applying or side-dressing nitrogen was observed in 2012. SPAD appeared to be able to identify nitrogen deficiencies for the low application rates at nitrogen responsive sites, while NDVI measurements did not appear to be correlated with demonstrated N requirements at side-dress time in 2012. Lack of correlation between measurement values and applied nitrogen prevented either tool to predict or fine-tune final nitrogen requirements. Soil nitrate levels increased with N application rate, but did not appear to be able to predict yield response potential to nitrogen when compared across sites. Soil nitrate tests did tend to give some indication as to the amount of N required (i.e. higher PSNT correlated with lower N requirements).

Next Steps:

This was the second year of this project which will be continued for one more year. Next year will be conducted in a similar manner.

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