IMPROVING NITORGEN MANAGEMENT IN MANURE AMENDED SOILS WITH REAL-TIME OPTICAL SENSING

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Introduction

As commercial N fertilizer prices climb, alternative sources of N, such as animal manure, become increasingly important sources of N. However, manure management presents producers with a number of challenges, including the variability and uncertainty of: N form and quantity in manure, mineralization of organic N, and effects of application methods on N loss. Producers often top-dress wheat with supplemental in-season N on manure-amended soils; however, additional research is needed to assist in determining the appropriate amount of fertilizer N to add in these situations.

Manure Application

Objectives

- Determine N response of winter wheat on manure-amended soil
- Evaluate N availability calculations recommended by the KSU Extension publications
- Examine application of optical sensors for making in-season N recommendations in manure-amended fields

Materials and Methods

- Field experiments were conducted at six sites: Blaine, Manhattan, and Hays, during 2008-2009 and Ashland 1, Ashland 2, and Leonardville during 2009-2010 winter wheat growing seasons
- A split-plot design was used
- Whole plot treatments were pre-plant N source (manure or fertilizer)
- Sub-plot treatments were top-dress N rates with 28-0-0 fertilizer (0 to 88 kg/ha N) applied in season at Feekes 5 and a reference treatment of 132 kg/ha N were applied at planting
- Nitrogen Rates and manure sources varied slightly at each site (Table 1)
- An active optical remote sensor GreenSeeker RT 200 was used to determine the— NDVI for each plot. Sensing occurred near the Feekes 5 growth stage

Table 1. Summary of material and methods at each site during the 2008-2009 and 2009-2010 seasons.

		Whole-plot pre-plant N			Whole-plot pre-plant P		Sub-plot N
Whole plot†	Soil profile N‡	PAN §	source¶	Application method#	rate	source††	rates
	kg/ha	kg/ha			kg/ha		lb/a
Blaine				2008-2009			
LM	36	29	swine	B/UI	198	Manure	0-88
CF	36	33	UAN/APP	B/UI	55	APP	0-88
Manhattan							
LM	12	92	dairy	B/I	247	Manure	0-88
CF	12	33	UAN/APP	B/I	55	APP	0-88
Hays							
LM	35	24	beef	B/I	77	Manure	0-66
HM	35	70	beef	B/I	231	Manure	0-66
CF	35	33	UAN/APP	B/I	55	APP	0-66
C	35	0	UAN/APP	B/I	55	TSS	0-66
Ashland 1				2009-2010			
LM	12	44	dairy	B/I	299	Manure	0-88
HM	12	88	dairy	B/I	149	Manure	0-88
CF	12	33	UAN/APP	B/I	55	APP	0-88
Ashland 2							
LM	11	44	dairy	B/I	299	Manure	0-88
HM	11	88	dairy	B/I	149	Manure	0-88
CF	11	33	UAN/APP	B/I	55	APP	0-88
Leonardville							
LM	0	44	dairy	B/I	299	Manure	0-88
HM	0	88	dairy	B/I	149	Manure	0-88
CF	0	33	UAN/APP	B/I	55	APP	0-88

† C=control no pre-plant N added, CF=Pre-plant commercial N fertilizer, LM=Pre-plant low rate of manure, HM=Pre-plant high rate of manure,
‡ Soil profile N samples were collected from 0 to 24 inch depth
§ PAN= plant available N
¶ UAN= urea ammonium nitrate, APP= ammonium polyphosphate
# B/UI= broadcast unincorporated, B/I= broadcast incorporated
†† APP= ammonium polyphosphate, TSS= triple superphosphate

Nitrogen Response

The 2008-2009 and 2009-2010 growing sessions had favorable growing conditions. Table 2 and Figure 1 show the significant effect and the yield response to pre-plant N source and in-season N application. At all six sites there was no interaction between pre-plant N source and in-season N rate. This indicates that pre-plant N source did not affect N response function at these locations. All three sites in 2009-2010 had no significant differences between the commercial fertilizer and low rate of manure treatments.

Table 2. Significance of F-tests for fixed effects in the analysis of variance (ANOVA) for pre-plant N source (manure or commercial fertilizer) and in-season N rate effects on winter wheat yield.

Site	Pre-plant N Source	In-season N Rate	Interaction Pre-plant N Source / In-season N Rate
Blaine	***0.004***	***<0.001***	0.181
Manhattan	***0.029***	0.170	0.058
Hays	0.578	***0.014***	0.766
Ashland 1	***0.011***	***0.002***	0.874
Ashland 2	***0.003***	0.714	0.135
Leonardville	***0.024***	***<0.001***	0.801

*Bold indicates significance at the 0.05 probability level

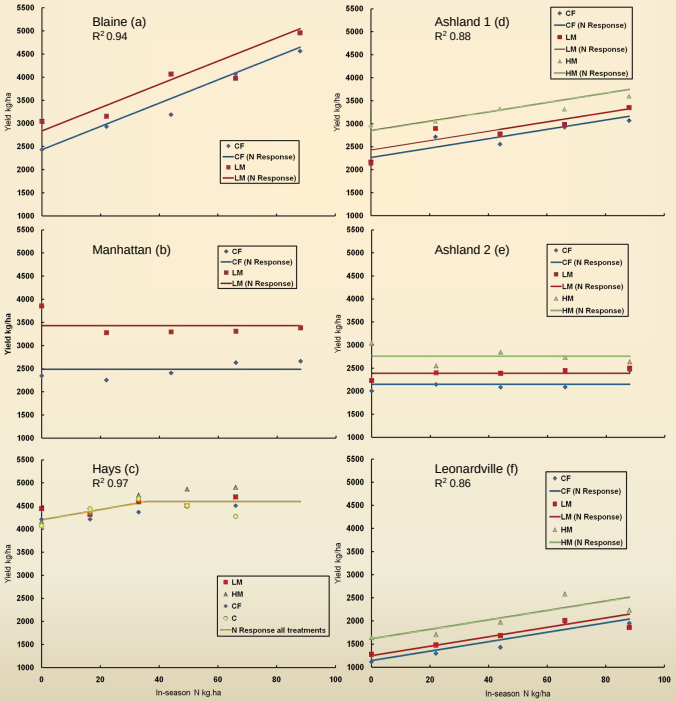

Figure 1. Wheat yield response to in-season N applications on soils receiving pre-plant manure or commercial fertilizer at Blaine (a), Manhattan (b), Hays (c) Ashland 1 (d) Ashland 2 (e) and Leonardville (f) Kansas. Lines in (a) , (b), (d), and (e) represent the N response functions for commercial fertilizer or manure treatments. The line in (c) represents the N response function averaged over all treatments.

N Recommendation Comparison

The optimum in-season N rates were compared to N recommendations calculated based on KSU extension publications (KSU recommendation) and the GreenSeeker (GreenSeeker recommendation). This comparison can be seen in Table 3 and table 4.

- KSU recommendation performed well at the Blaine and Ashland 1 sites
  The Greenseeker performed well at the Manhattan, Ashland 1, and Leonardville sites
- Neither recommendation tool performed well at the Hays and Ashland 2 sites

Table 3. Comparison of two methods for making in-season N recommendations on manure and commercial fertilizer whole plots against actual field observations of N response to in-season N application.

C	3026	63	2623	0	4640	33
Ashland 1				2009-2010		
LM	3363	63	4708	58	3352	88
HM	3363	19	4708	46	3605	88
CF	3363	74	4708	74	3068	88
Ashland 2						
LM	3026	44	4708	45	2393	0
HM	3026	0	4708	22	2764	0
CF	3026	55	4708	44	2157	0
Leonardville						
LM	3363	72	3228	59	1862	88
HM	3363	28	3430	67	2235	88
CF	3363	83	2892	34	1949	88

C	3026	63	2623	0	4640	33
Ashland 1				2009-2010		
LM	3363	63	4708	58	3352	88
HM	3363	19	4708	46	3605	88
CF	3363	74	4708	74	3068	88
Ashland 2						
LM	3026	44	4708	45	2393	0
HM	3026	0	4708	22	2764	0
CF	3026	55	4708	44	2157	0
Leonardville						
LM	3363	72	3228	59	1862	88
HM	3363	28	3430	67	2235	88
CF	3363	83	2892	34	1949	88

† C=control no pre-plant N added, CF=Pre-plant commercial N fertilizer, LM=Pre-plant low rate of manure, HM=Pre-plant high rate of manure,
‡At the Blaine and Hays sites, actual yields corresponding to the maximum and optimum N rates respectively. At the Manhattan site, yields are averaged across all treatments

Table 4. Observed differences between recommended N and actual in-season N need.

Pre-plant N source†	KSU Method	GreenSeeker Method
	kg/ha	
LM	3 (a)	-19 (a)
HM	-38 (b)	-22 (a)
CF	9 (a)	-18 (a)

* Letters indicate statistical difference at the 0.05 probability level
† CF=Pre-plant commercial N fertilizer, LM=Pre-plant low rate of manure, HM=Pre-plant high rate of manure,

- This comparison indicate a significant interaction between pre-plant N source and the KSU recommendation
- The GreenSeeker recommendation performed uniformly regardless of pre-plant N source

Conclusions

- Winter wheat responded to in-season N application on manure-amended soils
- At all six sites there was no interaction between pre-plant N source and in-season N rate. This indicates that pre-plant N source did not affect N response function at these locations
- KSU recommendation accuracy was affected by pre-plant N Source.
- GreenSeeker recommendation had equal performance on manure-amended soil as it did on commercial fertilized soils

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