Ketterings, Q.M., G. Godwin, S.N. Swink, J. Foster, E. Hong, K.J. Czymmek, A. Wright, M. Hunter, J. Lawrence, S. Canner, C. Albers, A. Gabriel, E. Young, T. Kilcer, and P. Barney (2011). Can manure replace the need for starter nitrogen fertilizer? What's Cropping Up? 20(2): 14-17.

Can Manure Replace the Need for Starter Nitrogen Fertilizer?

Quirine M. Ketterings, Greg Godwin, Sheryl N. Swink, Joseph Foster, Eun Hong, Karl Czymmek, Alex Wright, Mike Hunter, Joe Lawrence, Stephen Canner, Carl Albers, Aaron Gabriel, Eric Young, Tom Kilcer and Peter Barney

Background

Initial studies at a Western New York State dairy farm showed that for corn fields with a recent manure history, starter nitrogen (N) fertilizer could be eliminated without losing yield or reducing forage quality. Eliminating starter N on corn fields with a manure history has the potential to deliver significant savings of time and money to dairy producers. In 2009, we initiated a 3-yr project to test the need for starter N fertilizer across New York State soil types and growing conditions. The objective of this study is to assess differences in yield and forage quality between corn that receives starter N fertilizer and corn that does not, on fields with varying manure history. Here we report the 2009 and 2010 results.

Materials and Methods

In 2009, seven trials were completed, including three trials at commercial farms and four at the Aurora Research Farm (Sites 1 through 7). In 2010, starter N response trials were established at eleven commercial farm locations and repeated at the Aurora Research Farm (Sites 8-21). Across all trials in 2009 and 2010, a total of four locations were lost due to planter issues, excessive moisture interfering with harvest, bird damage, or weed pressure. All other trials are included in this summary.

Results

Eleven sites had an ISNT-N level classified as "low soil N supply" (>7% below the critical value), three sites were "medium soil N supply" (within 7% of the critical value) while 3 sites were "high soil N supply" (ISNT-N >7% above the critical value).

Of the fields with high soil N supply (sites 19, 20, 21), the manure application alone was sufficient to meet the N needs of the crop; none of these three locations showed a yield increase with starter N use (Table 1). The CSNTs confirmed N was not limiting yield, and reflected for two sites an unnecessary sidedress N application (sites 20, 21). Used in this way, the data suggest that the ISNT can help identify fields that will not benefit from starter or sidedress N.

Of the sites that were classified by the ISNT as medium in soil N supply, all received manure and none responded to starter N. The CSNTs were classified as optimal (site 13) or excess (sites 3, 14) indicating the fields received sufficient or more than sufficient N (Table 2). Thus, manure application can replace starter and sidedress N for soils with a medium soil N supply potential.

The sites classified as low in soil N supply (i.e. soil N alone is not expected to supply sufficient N for the corn crop that year) included the trials at Aurora with no manure history (sites 6 and 11), with limited manure history (sites 4, 5, 7 in 2009, and 9, 10, 12 in 2010) plus three on-farm locations (sites 8, 15, 16). The results of sites 6 and 11 (significantly higher yields in 2010 with starter N and a similar (though not statistically significant) trend in 2009) suggest that starter N is needed for fields that do not have a sufficient soil N supply as measured by the ISNT and are managed without manure.

Table 1. Stand density, percent moisture, and corn yield as influenced by application of 30 lbs of starter N fertilizer/acre at planting in 2009 (Sites 3-7) and 2010 (Sites 8-21).

ID	Treatment	Density	MC	Corn yield		Manure history and ISNT** values
		pl/acre	%	ton/acre	bu/acre	
4	Starter	28,579 *	18.2 a	.	112 a	Manure aerator-incorporated in spring at ~8,000 gal/acre (5 yrs). ISNT=261 ppm (L).
	No Starter	28,579 *	17.4 a	.	109 a	
5	Starter	29,513 *	18.3 a	.	119 a	Manure chisel-incorporated in spring at ~8,000 gal/acre (5 yrs). ISNT=252 ppm (L).
	No Starter	29,513 *	17.6 a	.	105 b	
6	Starter	29,394 *	18.1 a	.	144 a	No manure history. Sidedressed. ISNT=224 ppm (L).
	No Starter	29,394 *	19.0 a	.	126 a	
7	Starter	28,885 *	18.5 a	.	103 a	Manure surface applied in spring at ~8,000 gal/acre (5 yrs). ISNT=253 ppm (L).
	No Starter	28,885 *	18.2 a	.	91 a	
9	Starter	27,885 a	16.6 b	.	150 a	Manure aerator-incorporated at ~8,000 gal/acre (6 yrs). ISNT=257 ppm (L).
	No Starter	24,640 b	17.2 a	.	138 b	
10	Starter	29,124 a	16.6 a	.	160 a	Manure chisel-incorporated at ~8,000gal/acre (6 yrs). ISNT=248 ppm (L).
	No Starter	27,863 a	16.9 a	.	151 a	
11	Starter	27,576 a	16.9 b	.	173 a	No manure history. Sidedressed. ISNT=230 ppm (L).
	No Starter	24,107 b	17.3 a	.	147 b	
12	Starter	27,683 a	16.7 a	.	141 a	Manure surface applied at ~8,000 gal/acre (6 yrs). ISNT=245 ppm (L).
	No Starter	26,208 a	17.0 a	.	125 b	
8	Starter	25,706 a	67.1 a	19.2 a	.	Manure chisel-incorporated at 5,000 gal/acre each spring. ISNT=235 ppm (L).
	No Starter	25,626 a	67.0 a	20.0 a	.	
16	Starter	29,442 a	68.3 a	18.0 a	.	Manure surface applied 12,000 gal/acre per year. ISNT=247 ppm (L).
	No Starter	29,186 a	67.7 a	19.1 a	.	
15	Starter	37,897 a	60.1 a	24.7 a	.	Manure chisel-incorporated at 4,000 gal/acre in 2010; 20 tons/acre before. ISNT=216 ppm (L). Sidedressed.
	No Starter	37,571 a	61.2 a	24.9 a	.	
13	Starter	32,390 a	65.0 a	19.1 a	.	4,000 gal/acre incorporated 2008 (1st yr corn); 10,000 gal/acre in 2009. ISNT=290 ppm (M).
	No Starter	31,097 a	65.8 a	20.0 a	.	
3	Starter	25,134 a	67.3 a	25.4 a	.	Winter manure additions plus 6,000 gal/acre before planting. ISNT=341 ppm (M).
	No Starter	25,014 a	65.6 a	24.9 a	.	
14	Starter	37,952 a	59.6 a	21.2 a	.	Manure surface applied winter and spring at 8,000-9,000 gal/acre. ISNT=315 ppm (M).
	No Starter	37,952 a	57.9 a	20.6 a	.	
19	Starter	30,492 a	49.8 a	30.3 a	.	Injected 11,400 gal/acre 2010; no manure 2009; 7,400 gal/acre 2008. ISNT=334 ppm (H).
	No Starter	30,982 a	50.1 a	29.5 a	.	
20	Starter	30,546 a	67.9 a	20.0 a	.	Chisel-incorporated 2,000 gal/acre 2009, 2010; surface applied 6,000 gal/acre June/Aug 2008. ISNT=344 ppm (H). Sidedressed.
	No Starter	33,106 a	66.5 a	21.1 a	.	
21	Starter	31,908 a	67.9 a	23.8 a	.	Surface applied 17 tons/acre Dec 2009; 16,000 gal/acre 2008; 5 tons/acre 2007. ISNT=344 ppm (H). Sidedressed.
	No Starter	31,581 a	68.9 a	23.6 a	.	

*Only one stand density (mean of reps) available for combined starter/no starter at this site, no statistical analysis possible. ** Illinois Soil Nitrogen Test – (L, M, H) indicates the soil N supply was low (L, yellow), medium (M, orange), and high (H, green) for corn.

Table 2. Soil nitrate (NO_3^-) (0-8 and 0-12 inch depths), presidedress nitrate test (PSNT), and corn stalk nitrate test (CSNT) as influenced by the amount of banded N fertilizer at planting (0 versus 30 lbs N/acre) in corn trials conducted in 2009 (Sites 3-7) and 2010 (Sites 8-21). Stalks in the grain trials (4-7 and 9-12) were sampled at a whole plant moisture content of 35%.

			At Sidedress Time			At Harvest			
Site	ISNT	Treatment	Nitrate-N	PSNT		Nitrate-N	Nitrate-N	CSNT	
			0-8 inch	0-12 inch		0-8 inch	0-12 inch		
			lbs/acre	ppm		lbs/acre	ppm	ppm	
4	0.91	Starter	11 b	7 a	Deficient	23 b	5 a	94 a	Deficient
	L	No Starter	17 a	8 a	Deficient	27 a	7 a	90 a	Deficient
5	0.90	Starter	18 a	12 a	Deficient	22 b	6 a	94 a	Deficient
	L	No Starter	21 a	9 a	Deficient	28 a	7 a	105 a	Deficient
6	0.88	Starter	4 b	6 a	Deficient	16 a	4 a	160 a	Deficient*
	L	No Starter	11 a	4 a	Deficient	18 a	5 a	208 a	Deficient*
7	0.90	Starter	14 a	9 a	Deficient	20 a	5 a	104 a	Deficient
	L	No Starter	14 a	7 b	Deficient	25 a	6 a	94 a	Deficient
9	0.88	Starter	67 a	55 a	Sufficient	21 a	15 a	182 a	Deficient
	L	No Starter	74 a	56 a	Sufficient	20 a	17 a	99 a	Deficient
10	0.86	Starter	63 a	61 a	Sufficient	22 a	18 a	80 a	Deficient
	L	No Starter	67 a	51 a	Sufficient	21 a	15 a	89 a	Deficient
11	0.82	Starter	36 a	29 a	Sufficient	18 a	16 a	827 a	Optimal*
	L	No Starter	36 a	26 a	Sufficient	18 a	14 a	669 a	Optimal*
12	0.85	Starter	57 a	47 a	Sufficient	21 a	15 a	129 a	Deficient
	L	No Starter	64 a	50 a	Sufficient	22 a	15 a	83 a	Deficient
8	0.84	Starter	84 a	57 a	Sufficient	13 a	7 a	1,661 a	Optimal
	L	No Starter	79 a	54 a	Sufficient	10 a	5 b	463 b	Optimal
16	0.81	Starter	66 a	33 a	Sufficient	40 a	33 a	2,552 a	Excess
	L	No Starter	66 a	31 a	Sufficient	31 a	25 a	1,174 a	Optimal
15	0.81	Starter	130 a	52 a	Sufficient	158 a	44 a	7,838 a	Excess*
	L	No Starter	142 a	45 a	Sufficient	131 a	53 a	5,938 a	Excess*
13	1.01	Starter	96 a	31 a	Sufficient	20 a	10 a	1,225 a	Optimal
	M	No Starter	76 a	33 a	Sufficient	24 a	9 a	818 a	Optimal
3	1.07	Starter	60 a	34 a	Sufficient	63 a	27 a	5,154 a	Excess
	M	No Starter	52 a	30 a	Sufficient	47 a	27 a	5,017 a	Excess
14	1.05	Starter	124 a	55 a	Sufficient	42 a	18 a	10,135 a	Excess
	S	No Starter	117 a	53 a	Sufficient	25 b	11 a	9,164 a	Excess
19	1.10	Starter	80 a	59 a	Sufficient	30 a	14 a	4,817 a	Excess
	H	No Starter	81 a	66 a	Sufficient	32 a	16 a	4,164 a	Excess
20	1.13	Starter	54 a	25 a	Sufficient	38 a	16 a	4,484 a	Excess*
	H	No Starter	57 a	27 a	Sufficient	38 a	16 a	4,599 a	Excess*
21	1.12	Starter	42 a	24 a	Borderline	67 a	24 a	9,326 a	Excess*
	H	No Starter	50 a	23 a	Borderline	90 a	33 a	10,051 a	Excess*

*Sidedressed in addition to receiving manure (sites 15, 20, 21) or without manure history (6, 11).

At the other 3 sites at the Aurora Research Farm (4, 5, 7 in 2009; 9, 10, 12 in 2010), liquid manure had been applied at a rate of ~8,000 gallons/year over the past 5/6 years. Manure application increased ISNTs over time (compare values to sites 6 and 11) but after 5-6 years of manure application, the ISNT of these sites was still classified as low. Of these six site*years, three showed a significant yield increase with starter N addition while for the other three sites, a similar trend was seen (Table 1). These same sites exhibited deficient CSNTs, suggesting that the specific manure history was not enough to increase soil N supply to levels high enough to supply the N needed by the crop and that the current year manure applications were also insufficient to meet N needs of the crop. Under these conditions, the starter N application was needed.

Of the remaining three on-farm sites with low soil N supply potential, two sites had CSNTs in the optimal range (without starter). A lack of a yield response to starter N illustrated that for these locations, the current year manure supplied sufficient N and starter N was not needed. The very high CSNT of site 15 (>5000 ppm) illustrates that the sidedress N application was not needed.

Of the silage trials, two locations showed a significant increase in crude protein and/or soluble protein with starter N addition (Table 3). Only one site showed a change in NDF (decrease, site 21) with starter N addition. Lignin and starch were not impacted. Elimination of starter N did not result in significant differences in milk per ton or per acre estimates (results not shown) suggesting omission of starter N is more likely to impact yield than quality.

Table 3. Crude protein, soluble protein, neutral detergent fiber (NDF), digestible NDF (dNDF), lignin, and starch as influenced by 30 lbs/acre of starter N fertilizer. In grey background are sites where starter N increased quality parameters with a P value of 0.05 (95% certainty level).

Site	Treatment	Crude protein	Soluble protein	NDF	dNDF	Lignin	Starch
		------------% of dry matter-----------			% NDF	---% of dry matter---	
8	Starter	8.0 a	1.6 a	46.4 a	67.6 a	3.5 a	29.3 a
	No Starter	7.9 a	1.6 a	43.8 a	66.5 a	3.3 a	31.4 a
16	Starter	8.3 a	2.0 a	39.3 a	70.2 a	2.8 a	34.5 a
	No Starter	7.8 a	1.9 b	37.5 a	70.2 a	2.7 a	37.2 a
15	Starter	8.3 a	2.2 a	47.0 a	61.2 a	3.6 a	28.7 a
	No Starter	8.3 a	2.4 a	46.1 a	60.6 a	3.5 a	30.0 a
13	Starter	7.8 a	1.8 a	40.5 a	69.8 a	2.8 a	34.6 a
	No Starter	7.9 a	2.0 a	39.6 a	67.3 a	2.7 a	35.6 a
3	Starter	8.3 a	2.4 a	42.2 a	65.2 a	3.2 a	33.6 a
	No Starter	7.3 b	2.1 b	42.5 a	64.1 a	3.0 a	34.7 a
14	Starter	7.8 a	2.1 a	40.0 a	64.3 a	3.1 a	40.4 a
	No Starter	7.7 a	2.2 a	41.1 a	64.7 a	3.1 a	38.6 a
19	Starter	8.1 a	1.7 a	36.4 a	74.8 a	2.4 a	43.6 a
	No Starter	8.1 a	1.8 a	34.2 a	72.1 a	2.4 a	46.1 a
20	Starter	7.9 a	2.1 a	46.1 a	64.6 a	3.5 a	30.8 a
	No Starter	7.6 a	2.0 a	46.0 a	63.1 a	3.3 a	31.7 a
21	Starter	9.2 a	2.5 a	35.9 b	77.5 a	2.4 a	37.9 a
	No Starter	8.9 b	2.5 a	39.6 a	77.0 a	2.5 a	34.1 a

Preliminary Conclusions

Results to date suggest a new twist to the ISNT: on fields where P and K fertility are high, and manure is applied, no starter or sidedress N is required when soil N supply potential is high as measured by the ISNT. Fields without a manure history (past and current year) and low soil N supply require starter N addition for optimal yield. Where soil N supply alone is insufficient to meet crop N needs (ISNT=low) manure could replace the need for starter N but sufficient N will need to be supplied one way or another; use the CSNT to adjust rates over time. In 2011, the final year of this project, we hope to add another 15-20 locations to this dataset before drawing final conclusions.

Acknowledgments

The project was funded with federal formula funds and Northern New York Agricultural Development Program (NNYADP) funds. We thank LaGrange Brothers Farm, Musgrave (Aurora) Research Farm, Ooms Farm, Shimel Farm, Thunder Lane Dairy, Walnuthof Farm, Hargrave Farm, Mapleview Dairy, Cannon Farm, Mapledale Farm, Brown Farms, Heritage Hill Farm, Woody Hill Farm for participating in the project.

For Further Information

Questions about this project? Contact: Quirine M. Ketterings at 607-255-3061 or qmk2@cornell.edu, and/or visit the Nutrient Management Spear Program website at: http://nmsp.cals.cornell.edu/.