Northern NY Agricultural Development Program
2007-2008 Project Report

ISNT Implementation on NNY Farms and Protected N Sources to Meet N Needs for Corn Where N is Needed

Project Leader:

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Collaborators:

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- Consultants: Peter Barney (Barney Agronomic Services;) Peg Cook, (Cooks Consulting;) Eric Beaver and Mike Contessa, (Champlain Valley Agronomics)

Cooperating NNY Producers:

- Larato Farms, Mooers NY; Swanton Farms, Burke/Chateaugay NY; Darren McIntyre, Watertown NY; Reed Haven Farms, Adams Center NY; Benware Dairy, Madrid NY

Background:

Nitrogen prices have risen to very high levels in recent years. A new soil N test was evaluated for use in New York with several test sites in NNY. This work led to the release of this new test (ISNT) for New York as it was shown to be 83% accurate in identify site responsiveness to additional N. We also successfully calibrated the late season stalk nitrate test. The next step in this work is to do whole farm assessments to determine ISNT and stalk nitrate distribution of corn fields on dairy farms in each of the NNY counties. The greatest benefits of the ISNT are its great compatibility with regular soil testing (8 inch depth) and the ability to determine before the growing season if additional N is needed, enabling early season decision on N use reducing unnecessary N fertilizer additions to field that have sufficient organic N.

New technologies have focused on reducing N volatilization and leaching losses increasing N use efficiencies of fertilizer materials to reduce overall N fertilizer costs and environmental losses. Two such new technologies that have shown promise in resent research trials are: (1) ESN (Environmentally Smart Nitrogen, developed by Agrium Inc.), and (2) NutriSphere-N (by Specialty Fertilizer Products Inc.). ESN is a polymer-coated controlled-release N fertilizer. It has a semi-permeable polymer coating that allows water to enter the urea granule and dissolve the N over time. The N release rate is controlled by soil temperature, which similarly determines plant growth and nutrient demand, thus better synchronizing N release and plant uptake. NutriSphere-N is also a polymer and can be used for urea as well as liquid N sources such as UAN. Especially in situations where N fertilizer demands are high and N cannot be incorporated into the soil (e.g. N application to grasses), the use of polymer-coated controlled-release N fertilizers could possibly reduce both N fertilizer loss and fertilizer costs, and enhance yields. Although research trials indicate benefits of the use of both products over surface application of urea or UAN in various states in the USA, no research has been conducted in New York with the exception of limited field experimentation in western NY that showed promise for ESN as an N source. Research is needed to investigate the potential of both products to reduce overall N fertilizer costs and reduce environmental losses for corn production systems under Northern New York soil and weather patterns.

Methods:

In 2008, we conducted three field trials. Two trials were conducted on research farms in Essex and Cayuga counties. These were harvested for silage. A 3rd on-farm trial in Wayne County was harvested for grain. Characteristics for these trial sites are listed in Table 1. All trials had five treatments:

1. Starter N only
2. Starter N + UAN at sidedress (150 lbs N/Acre)
3. Starter N + Urea at planting (150 lbs N/Acre)
4. Starter N + NutriSphere-N at planting (150 lbs N/Acre)
5. Starter N + ESN at planting (150 lbs N/Acre)

There were 4 repetitions of each treatment. Plots in the silage trials were 8 rows wide and 50 feet long. Plots were 300 feet long and 30 feet wide in the grain trial. On the research farms, N treatments at planting were broadcast and incorporated just prior to planting. The UAN treatment was injected when the corn was between 6 and 12 inches tall (standard starter plus sidedress treatment). Eight inch soil samples were taken at planting, sidedress time and at harvest and analyzed for basic soil fertility and Morgan extractable soil nitrate. At sidedress time, 12 inch PSNT samples were taken and analyzed for Morgan extractable nitrate (PSNT). Basic fertility data at planting are summarized in Table 2. Silage plots were hand harvested (2 rows of 40 feet each) and sub-samples were taken to determine moisture content and silage quality. Late-season-stalk-nitrate samples were also taken in each of the three trials.

In addition, five Northern New York farms (two in eastern NNY and three in western NNY) were sampled for whole farm ISNT. Where possible, corn fields were sampled for stalk nitrate as well (all western NY farms). Farms were given a field history form which was completed with the help of the local collaborator.

Results:

Protected N trials

Yield data are shown in Table 3. There was a yield response to N addition beyond the starter in the Essex and Wayne sites and a similar trend in Aurora but for the latter site, differences were not statistically significant due to large variability in the plots. There was, however, no difference among N sources or timing of application in any of the three sites. The low grain yields in Wayne County were due to a combination of heavy insect pest pressure and hail damage (picture included at end of report). At the Cayuga site, clover was planted following wheat in 2007. It was sprayed with Atrazine and Banvel on April 10 and the residue plowed under May 10. As a result of the clover biomass this site, normally N deficient, showed high soil nitrate values throughout the year, with PSNT levels prior to N addition (i.e. starter N only) of 28-31 ppm, indicative of adequate N from the clover cover crop. This could explain the lack of a significant response to the different N sources. The trial will need to be repeated next year (without the carryover of the clover). The Essex and Wayne sites showed N deficiency (PSNTs less than 21 ppm; Table 4), consistent with the significant yield response to N addition. Trends in the soil nitrate data were also visible in the stalk nitrate values (Table 5). The highest levels were seen in the Cayuga site where large PSNT and end of season soil test N values were measured. Addition of N beyond the starter resulted in excessive stalk nitrate levels in Cayuga County. In the Essex county site, all plots had low stalk nitrate values whereas in the Wayne County site side-dressing with UAN and the ESN treatment resulted in optimal stalk nitrate values while in all other treatments, levels were low. The low stalk nitrates in the Cayuga site upon starter N addition only is consistent with low levels found in first year corn sites following sods and most likely reflective of slow release of N over time. These results of the other sites are consistent with N limited sites. Thus, we had ideal conditions to test nutrient use efficiencies among the different N sources and conclude that the 2008 data do not show significant differences in N release from the various N sources. The results also show considerable carryover of the urea that was applied at planting (the cheapest way to apply N). Forage quality was not impacted (Table 6) with the exception of crude and soluble protein content (sites in Essex and Wayne county only; Table 7) where N addition resulted in an increase in crude and soluble protein but there was no difference among the different N sources. This did not impact the overall quality of the silage as expressed in estimated milk per ton of silage (Table 8).

Whole Farm ISNT assessment

Five NNY farms participate in this project. The corn acreage on these farms ranged from 28% of the total acres to 54% (total acres ranging from 295 to 514 for three farms for which field history forms were completed). Samples are being analyzed for ISNT and final field history data are being collected. Results will be summarized once the ISNT assessments have been completed.

Conclusions/Outcomes/Impacts:

An additional year of data is needed for this project but so far, the data do not support the hypothesis that protected N sources increase nutrient use efficiency. The data this year indicate a broadcast incorporation of urea was as effective as application of ESN or NutriSphere on two of the three locations while at the 3rd site, no additional N was needed at all (clover contributions exceeded expectations). We hope to be able to continue the sites to see if under different growing conditions, there will be a difference among the N sources.

Outreach:

Presentations were given on N management for corn (including ISNT and stalk nitrate) at a series of winter meetings in NNY in 2008 (co-presented with CCE field crops extension educators):

1. Determining starter and broadcast fertilizer needs. Presented at: "Making the most of your fertilizer dollars" (2008). Series of 5 meetings in Northern NY, March 17-21, 2008. ~90 people.
2. Tools for N management – what worked, what didn't. Presented at: "Making the most of your fertilizer dollars" (2008). Series of 5 meetings in Northern NY, March 17-21, 2008. ~90 people.

The findings were also presented statewide during the Field Crop Dealer Meetings:
1. Tools for optimizing nitrogen management of corn: ISNT and stalk nitrate tests; a package deal (2008). 2008 Field Crop Dealer Meetings. October 28 (Albany, NY), October 29 (New Hartford, NY), October 30 (Batavia, NY) and October 31 (Auburn, NY). ~240 people.

In addition, the following factsheets relevant to N management of corn were generated:
- # 36: Illinois Soil Nitrogen Test for Corn (1/17/2008)
- # 39: Nitrogen Fixation (4/16/2008)
- # 41: Organic Matter (5/8/2008)
- # 43: Nitrogen Benefits of Winter Cover Crops (11/26/2008)

The ISNT project (including the additional funding sources) resulted in two journal articles:
1. Lawrence, J.R., Q.M. Ketterings, M.G. Goler, J.H. Cherney, W.J. Cox and K.J. Czymmek (2009). Accuracy of the Illinois Soil Nitrogen Test (ISNT) in predicting N responsiveness of corn in rotation. Soil Science Society of America Journal 73(1): (*in press*).
2. Lawrence, J.R., Q.M. Ketterings and J.H. Cherney (2008). Effect of nitrogen application on yield and quality of first year corn. Agronomy Journal 100: 73-79.

In addition, we published a "What's Cropping Up?" article:
1. Lawrence, J.R., Q.M. Ketterings, and K.J. Czymmek (2008). Illinois Soil N Test (ISNT) useful tool for NYS corn producers. What's Cropping Up? 18(3): 4-5.

A Northeast Dairy Business article on ISNT and stalk nitrate assessment will appear in January 2009.

Next steps

The next steps are to (1) continue the protected N sources trials for an additional year (second year of a two-year project); and (2) complete the 2008 assessment and work with additional producers to do whole farm ISNT and stalk nitrate assessment. We plan to generate three additional factsheets: "N fertilizers", "Protected N sources", and "Optimizing N management with ISNT and CSNT". Farmer impact stories are planned for 2009 once full assessments have been completed and given to the farms.

Acknowledgments:

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Reports and/or articles in which results of this project have already been published.

For Agronomy Fact Sheets: http://nmsp.css.cornell.edu/publications/factsheets.asp. The "What's Cropping Up?" article can be downloaded from the CSS extension website: http://css.cals.cornell.edu/cals/css/extension/upload/wcu_vol18no3_2008a3isnt.pdf. The harvest pictures of the Essex County site are included in this report.

For more information:

The initial trials were conducted at the Willsboro Farm, the Aurora Research Farm, and on a farm in Wayne County. Participating consultants include Peter Barney (St Lawrence County farm) and Eric Beaver (two eastern NNY farms). Mike Hunter (Jefferson County CCE) collected samples on a farm in Jefferson County while Joe Lawrence (Lewis County CCE) worked with Peg Cook to collect ISNT samples on a farm in Lewis County.

Table 1: Site characteristics for the 3 Protected Nitrogen studies in 2008.

	Essex	Cayuga	Wayne
	Stafford fine sandy loam	Kendaia fine loam	Wallington silt loam
Planted	5/2/2008	5/7/2008	5/14/2008
Sidedressed	6/12/2008	6/11/2008	6/24/2008
Harvested	9/3/2008	9/8/2008	11/12/2008
	Cropping History (Dry Matter Yield)		
2007	Corn (6.5 tons/acre)	Wheat (NA)	Soybean
2006	Corn (7.8 tons/acre)	Soybean (NA)	Corn
2005	Corn (7.8 tons/acre)	Corn (NA)	NA
2004	Grass (NA)	Corn (NA)	NA
	Fertilizer Addition at Planting (2008)		
lbs N/acre	15	20	17
lbs P_2O_5/acre	60	20	23
lbs K_2O/acre	60+60[1]	20	0+200[1]

[1]. Additional K_2O broadcast and incorporated prior to planting at the Essex and Wayne County sites.

Table 2: Soil management groups (SMG), soil series and general soil fertility data at planting for the 3 Protected Nitrogen studies in 2008. L=low; M=medium, H=high, VH=very high, N=normal, E=excessive.

	Essex	Cayuga	Wayne
	Stafford fine sandy loam	Kendaia fine loam	Wallington silt loam
SMG	4	2	3
pH	6.6	8.1	6.4
OM (%)	1.6 (2.7% LOI)	1.8 (2.9% LOI)	4.1 (2.6% LOI)
P (lbs/acre)	22 H	9 H	16 H
K (lbs/acre)	62 L	56 L	154 H
Mg (lbs/acre)	77 M	480 VH	182 H
Ca (lbs/acre)	1964	5003	1922

Table 3: Silage and grain yields and moisture content for 3 protected N trials in 2008.

Treatment	Silage Yield (tons/acre 65% moisture)				Grain Yield (bu/acre)	
	Essex		Cayuga		Wayne	
Starter Only	18.8	b	24.6	a	35.8	b
Starter + UAN	21.6	a	25.6	a	86.4	a
Starter + Urea	23.5	a	25.5	a	86.3	a
Starter + NutriSphere	24.1	a	26.2	a	86.9	a
Starter + ESN	22.6	a	27.2	a	86.6	a
	Moisture Content at Harvest (% moisture)					
Starter Only	59.7	a	64.7	a	18.1	a
Starter + UAN	57.8	a	65.7	a	18.1	a
Starter + Urea	58.0	a	66.6	a	17.8	a
Starter + NutriSphere	58.9	a	66.5	a	18.0	a
Starter + ESN	58.9	a	66.4	a	18.2	a

†Average values with different letters (a,b,c) are statistically different ($\alpha = 0.05$)

Table 4: Soil nitrate values for samples taken at planting, sidedress and harvest from the Protected N trials in 2008. The Essex and Wayne sites are 4th year corn site. The Cayuga site followed a clover cover crop.

Treatment	Soil Nitrate at Planting - 8" depth (ppm)					
	Essex		Cayuga		Wayne	
Starter Only	3.2	a	4.0	a	9.4	a
Starter + UAN	3.7	a	2.5	a	9.8	a
Starter + Urea	2.0	a	4.0	a	10.0	a
Starter + NutriSphere	2.3	a	1.7	a	11.5	a
Starter + ESN	2.3	a	1.5	a	10.8	a
	Soil Nitrate at Sidedress - 8" depth (ppm)					
Starter Only	5.9	b	28.9	b	15.3	a
Starter + UAN	5.9	b	33.4	b	17.9	a
Starter + Urea	10.7	b	97.9	a	34.9	a
Starter + NutriSphere	19.5	a	80.3	a	39.2	a
Starter + ESN	10.8	b	81.0	a	26.2	a
	PSNT at Sidedress - 12" depth (ppm)					
Starter Only	8.2	bc	30.7	b	12.9	a
Starter + UAN	5.4	c	27.6	b	16.8	a
Starter + Urea	22.5	a	74.2	a	23.4	a
Starter + NutriSphere	29.7	a	67.4	a	42.2	a
Starter + ESN	18.6	ab	73.8	a	21.9	a
	Soil Nitrate at harvest - 8" depth (ppm)					
Starter Only	0.0	a	1.3	a	0.0	a
Starter + UAN	1.4	a	30.9	a	0.0	a
Starter + Urea	2.2	a	27.5	a	0.0	a
Starter + NutriSphere	1.3	a	22.4	a	3.2	a
Starter + ESN	1.0	a	34.2	a	1.2	a

†Average values with different letters (a,b,c) are statistically different ($\alpha = 0.05$)

Table 5: Late Season Stalk Nitrate Test results for 3 Protected N Trials in 2008. L = Low (less than 250 ppm N), O = Optimal (250 to 2000 ppm N) and E = Excess (greater than 2000 ppm N). The Essex site is a 4th year corn site. The Cayuga site followed a clover cover crop.

Treatment	Essex			Cayuga			Wayne		
	Stalk Nitrate Test (ppm)								
Starter Only	35	a	L	144	b	L	33	b	L
Starter + UAN	142	a	L	3058	a	E	1446	a	O
Starter + Urea	128	a	L	3536	a	E	115	b	L
Starter + NutriSphere	57	a	L	3177	a	E	74	b	L
Starter + ESN	39	a	L	3147	a	E	444	b	O

†Average values with different letters (a,b,c) are statistically different ($\alpha = 0.05$)

Table 6: Impact of N source on NDF, dNDF, starch and lignin for 2 sites in 2008. The Essex site is a 4th year corn site. The Cayuga site followed a clover cover crop. The UAN was sidedressed. All other N sources were applied at planting.

Treatment	Essex		Cayuga		Essex		Cayuga	
	NDF (% of DM)				dNDF (% of DM)			
Starter Only	44.4	a	39.9	a	64.9	a	64.6	a
Starter + NutriSphere	43.4	a	39.9	a	62.4	a	64.8	a
Starter + ESN	40.4	a	39.3	a	64.3	a	65.0	a
Starter + Urea	41.5	a	38.1	a	62.4	a	65.6	a
Starter + UAN	41.7	a	39.4	a	64.9	a	66.3	a
	Starch (% of DM)				Lignin (% of DM)			
Starter Only	35.1	a	37.1	a	2.9	a	2.8	a
Starter + NutriSphere	33.7	a	35.4	a	3.1	a	2.8	a
Starter + ESN	36.9	a	35.8	a	2.8	a	2.8	a
Starter + Urea	35.7	a	37.0	a	2.9	a	2.7	a
Starter + UAN	35.1	a	36.6	a	2.8	a	2.7	a

Table 7: Impact of N source on crude protein and soluble protein for 2 sites in 2008. The Essex site is a 4th year corn site. The Cayuga site followed a clover cover crop. The UAN was sidedressed. All other N sources were applied at planting.

Treatment	Essex		Cayuga	
	Crude Protein (% of DM)			
Starter Only	5.2	b	6.2	b
Starter + UAN	6.6	a	6.8	a
Starter + Urea	6.3	a	7.1	a
Starter + NutriSphere	6.4	a	6.9	a
Starter + ESN	6.2	a	7.0	a
	Soluble Protein (% of DM)			
Starter Only	1.3	b	1.6	b
Starter + UAN	1.6	a	1.7	ab
Starter + Urea	1.6	a	1.8	a
Starter + NutriSphere	1.5	a	1.7	ab
Starter + ESN	1.5	a	1.8	a

Table 8: Impact of N source on estimated milk per ton and milk per acre using Milk2006 in 2008. The UAN was sidedressed. All other N sources were applied at planting.

Treatment	Essex		Cayuga		Essex		Cayuga	
	Milk per ton (lbs/ton)				Milk per acre (lbs/acre)			
Starter Only	3427	a	3514	a	22497	b	30292	a
Starter + UAN	3491	a	3569	a	26418	a	31957	a
Starter + Urea	3435	a	3576	a	28280	a	31854	a
Starter + NutriSphere	3386	a	3506	a	28506	a	32108	a
Starter + ESN	3514	a	3529	a	27858	a	33714	a

†Average values with different letters (a,b,c) are statistically different ($\alpha = 0.05$)