Northern NY Agricultural Development Program
2008-2009 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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Cooperating Producers:
- Wilson Farm, Hammond NY
- Vincent Farms, LLC, Malone NY
- Graceway Farm, Lowville NY
- Carter Farms, Plattsburgh NY
- Hargrave Farm, Heuvelton NY,
- Clover Crest, Adams NY

Background:

Nitrogen fertilizer sources

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 recent 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. Trials conducted in 2008 showed considerable carryover of the urea that was applied at planting (the cheapest way to apply N) and no yield differences among the four N management strategies. Forage quality was not impacted with the exception of crude and soluble protein content (sites in Essex and Cayuga counties) where N addition resulted in an increase in crude and soluble protein but there was no difference among the different N sources. The increase in protein content did not impact the overall quality of the silage as expressed in estimated milk per ton of silage. A second year of research was needed to investigate the potential of both products to reduce overall N fertilizer costs and reduce environmental losses. In 2009, 2nd year N source trials were conducted in Essex and Cayuga counties and a third site was added in Columbia county.

Nitrogen management tools

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 northern NY. This work led to the release of the Illinois Soil Nitrogen Test (ISNT) for New York as it was shown to be 84% accurate in identifying site responsiveness to additional N. 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 decisions on N use, and thereby reducing unnecessary N fertilizer additions to fields that have sufficient organic N.

We also successfully calibrated the late season corn stalk nitrate test (CSNT) in past years. This test allows us to distinguish between essential and excessive N applications for corn in order to mitigate N loss to the environment. In 2009, we sampled six northern NY dairy farms to determine their whole farm ISNT *and* stalk nitrate distributions. The purpose of this assessment was to determine where, on each farm, manure N could be redistributed and where fertilizer N savings could be made by using the ISNT and CSNT together as a pair of nitrogen management tools.

Methods:

Nitrogen fertilizer sources

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. In 2009, we conducted a second year of N fertilizer testing in Cayuga and Essex counties and added a new site in Columbia County Characteristics for these trial sites are listed in Table 1. All trials had five treatments:

1. Starter N only (30 lbs N/acre)
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 samples were taken and analyzed for Morgan extractable nitrate (PSNT). Basic soil 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.

Nitrogen management tools

In 2009, six Northern New York farms (four in eastern NNY and two in western NNY) were sampled for whole farm ISNT (all fields) and CSNT (all corn fields). Farms were given a field history form which was completed with the help of the local collaborator. Farm characteristics are shown in Table 9. Total acres on these farms range from 244 to 1,143 with the corn acreage ranging from 42% to 73% of the total acreage. Information gathered included soil types, cropping history/rotations, manure and fertilizer application history for each field for the past three seasons, number of cows, animal density, manure storage capacity, total manure generated, and manure analyses. Each field of every farm was analyzed for the Illinois Soil Nitrogen Test (ISNT) (Table 12) and each corn field for the Corn Stalk Nitrate Test (CSNT). Values of the CSNT correspond to three ranges: less than 250 ppm is deficient, between 250 and 2000 ppm is optimal and greater than 2000 ppm is considered excessive. The ISNT and CSNT values were compared to manure and fertilizer application rates in order to identify acreage where N cuts can be made.

Results:

Nitrogen Fertilizer Sources

Sites harvested for silage all showed a yield response to N addition beyond the starter in both years (Table 1). A similar trend was seen in the grain trial in Wayne County, but differences were not statistically significant. There was, however, no difference among N sources or timing of application in any of the sites. The low grain yields in Wayne County in 2008 were due to a combination of heavy insect pest pressure and hail.

In both years, plots that did not receive additional broadcast N at planting were deficient in N at sidedress (PSNTs less than 21 ppm), with the exception of the Cayuga site in 2008 where PSNT levels prior to N addition (i.e. starter N only) averaged 30 ppm. At this site, clover had been planted in fall 2007, killed and plowed under in the spring of 2008. As a result of the clover biomass, this normally N deficient site (and N deficient in 2009) showed high soil nitrate values throughout 2008. The PSNT values of all other sites and years showed a need for additional N beyond the small starter, consistent with the significant yield response to N addition and consistent with the ISNT values for all sites which indicated that a response to N fertilization was expected (i.e. soil organic N mineralization alone would be insufficient for maximum yield). With the exception of the Cayuga site in 2008, all locations had very low soil nitrate levels at harvest.

Table 1: Silage and grain yields and moisture content for six N source trials in 2008 and 2009. The UAN was sidedressed. All other N sources were applied at planting and incorporated. Each plot received 30 lbs N/acre in the starter band.

	Essex		Cayuga		Wayne		Essex		Cayuga		Columbia		Average	
	2008		2008		2008		2009		2009		2009			
Treatment	Silage yield				Grain yield		Silage yield							
	(tons/acre 65% moisture)				(bu/acre)		(tons/acre 65% moisture)							
Starter Only	18.8	b	24.6	a	35.8	b	11.3	b	15.9	b	13.8	b	15.1	b
Starter + UAN	21.6	a	25.6	a	86.4	a	20.5	a	23.3	a	22.8	a	21.4	a
Starter + Urea	23.5	a	25.5	a	86.3	a	22.0	a	25.9	a	24.7	a	22.7	a
Starter+ NutriSphere	24.1	a	26.2	a	87.0	a	21.9	a	23.5	a	23.8	a	22.4	a
Starter + ESN	22.6	a	27.2	a	86.6	a	23.8	a	26.5	a	25.0	a	23.3	a

Forage quality parameters of NDF, starch and lignin were not impacted by any of the N treatments in 2008. The data showed variability in dNDF for the Essex site with lower dNDF for the Nutrisphere and UAN sidedress treatments and the sidedress N application at the Columbia site decreased NDF but there was no difference among the four N applications. Nitrogen application also decreased dNDF at this location from 69% of NDF with a starter N application only to 64-65% with N addition, independent of N source of time of application. Lignin and starch contents were not impacted. At the Cayuga site in 2009, the protected N treatments and the urea treatment had significantly lower values of dNDF as compared to the control and the UAN sidedress treatments. None of the other quality parameters were impacted by N source or application time. At the Essex site, the urea application increased lignin content although differences were only significant in comparison with the starter only treatment. Crude and soluble protein content increased where N was applied beyond the starter, but there was no difference among the N sources. None of the forage quality parameters significantly impacted the overall quality of the silage as expressed in estimated milk per ton of silage (Table 8). Differences in milk per acre were attributed to yield.

Whole Farm ISNT and CSNT assessment

A total of 109,324 lbs of fertilizer were applied to the six farms as a whole. The CSNT values ranged from low to excessive, presenting an opportunity for each farm to decrease fertilizer use while reallocating manure N across the farm. For example, at one of the farms, a total of 47,697 lbs of N fertilizer was applied in 2009. Only one field had a low CSNT, while 4 fields were in the optimal range. Every other field tested excessive in CSNT, representing 750 acres. If fertilizer N (beyond a starter) was eliminated on all fields with a CSNT value greater than 5000 ppm, over 8,000 lbs of N (17% for this farm).

Fields that are excessive in CSNT and sufficient in ISNT offer the lowest risk and greatest options for N fertilizer savings. The other five farms showed potential for N fertilizer savings as well and the need for reallocation of some of the manure to meet soil N, P, and K needs and reduce P and K fertilizer needs.

Conclusions/Outcomes/Impacts:

Protected N trials 2008 and 2009

Our data show no justification for use of either of the two protected N sources; broadcast incorporation of urea was as effective as application of ESN or NutriSphere on five of the six locations while at the remaining site, no additional N was needed at all (clover contributions exceeded expectations). It should be noted that the spring of 2008 was relatively dry (reducing mineralization) while the 2009 growing season was very wet (also reducing mineralization) and that the urea was broadcast and incorporated, allowing for carryover of the N as long as nitrification is reduced early season (presidedress time).

Whole Farm ISNT and CSNT assessment

On every farm there is an opportunity for a decrease in fertilizer use and/or a redistribution of manure to fields with a lower CSNT value and those that are show a low soil N supply potential (low ISNT). It would not only save each of these farmers money, but would also help mitigate N loss to the environment. A total of 1,084 acres of corn (57% of the total corn acreage) were excessive in CSNT across the six farms. If all fertilizer N were eliminated from fields with a CSNT greater than 5000 ppm and reduced from first year corn to 30 lbs/acre, fertilizer use could be reduced with more than 20,000 lbs of N (about 18% reduction across all six farms). Manure reallocation to low P and K fields (if feasible) could result in even greater savings in fertilizer costs.

Outreach:

Presentations were given on N management for corn (including ISNT and stalk nitrate) at a number of Northern NY events and during the Field Crop Dealer Meetings:

- Late season stalk nitrate test (2009). Corn silage management field day. September 10, 2009. Hi-Hope Farm, Woodville, NY. ~250 people.
- NNY nutrient management projects. Eastern NY NNYADP meeting. Chazy, NY, February 20, 2009. ~35 people.
- NNY nutrient management projects. Western NY NNYADP meeting. Watertown, NY, January 30, 2009. ~15 people.
- Ketterings, Q.M. Enhanced efficiency fertilizers and research update (2009). 2009 Field Crop Dealer Meetings. October 27 (Latham, NY), October 28 (New Hartford, NY), October 29 (Batavia, NY) and October 30 (Auburn, NY). ~240 people.

In addition, the following factsheets relevant to N management were generated:

- # 44: Nitrogen Sources (8/23/2009).
- # 45: Protected Nitrogen Sources (8/23/2009).

The ISNT project (including additional funding sources) resulted in a 2009 journal articles with Joe Lawrence of CCE of Lewis County as lead author (his thesis work which included many NNY sites).

- 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 J. 73(1): 303-311.

We also published "What's Cropping Up?" articles:

- Ketterings, Q.M., J. Lawrence, G. Godwin, N. Glazier, P. Barney, and K.J. Czymmek (2009). Evaluation of ISNT-based nitrogen management for multi-year corn sites. What's Cropping Up? 19(3): 10-11.

A Northeast Dairy Business article appeared in January 2009:

- Czymmek, K. and Q.M. Ketterings (2009). A one-two punch for corn N management. The Manager. Eastern DairyBusiness 1(1): 22-23.

Next steps

The next steps for the ISNT and CSNT include spatial variability assessment of both tools ("How many samples do we need to take?") and to continue work with farms for on-farm implementation. We will meet with the participating producers to discuss the results and quantify potential fertilizer savings in February/March of this year (2010). We also need to investigate both tools in cropping systems that include cover crops. Farmer impact stories are planned for 2010 once full assessments have been completed and What's Cropping Up? articles will follow (N source study is scheduled for publication in February 2010).

Acknowledgments:

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

For Agronomy Fact Sheets: http://nmsp.css.cornell.edu/publications/factsheets.asp. For the "What's Cropping Up?" article: http://css.cals.cornell.edu/cals/css/extension/cropping-up-archive/wcu_vol19no3_20095isnt.pdf. The harvest pictures of the Essex County N trial site are included in this report.

For more information:

The N fertilizer trials were conducted at the Willsboro Farm, the Aurora Research Farm, on a farm in Wayne County, and on the Valatie Research Farm in Columbia County. Whole farm ISNT and CSNT assessment was done in collaboration with Cornell Cooperative Extension educators Mike Hunter (Jefferson County CCE), Stephen Canner (St Lawrence County CCE), Joe Lawrence (Lewis County CCE), and agricultural consultants Peg Cook, Peter Barney, and Eric Beaver. Participating consultants in the project include Peter Barney (St Lawrence County farm), Eric Beaver (eastern NNY farm), and Peg Cook (Lewis County farm). For more information, contact Quirine Ketterings (qmk2@cornell.edu; 607-255-3061).

Photos

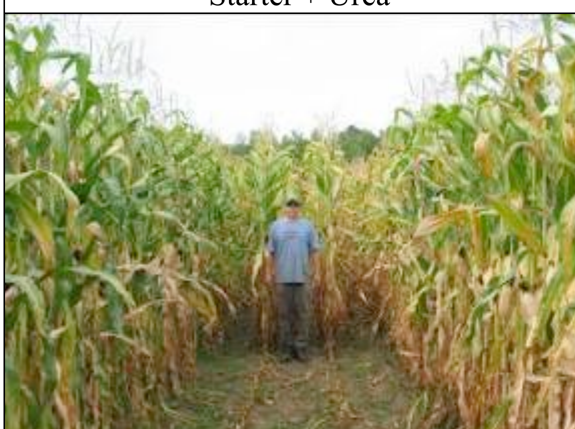
Silage harvest and sidedressing at E.V. Baker Research Farm, Willsboro NY, 2009.

Starter Only

Starter + UAN

Starter + Urea

Starter + NutriSphere



Starter + ESN

Starter Only at Sidedress