Northern New York Agricultural Development Program
2019-2020 Project Report

Evaluation of Variability in Nitrogen Uptake Efficiency across Corn Silage Hybrids in NNY

Also provided to NY Corn Silage Hybrid Evaluation Program

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Cooperating Producers:

- Greenwood Dairy Farm, St. Lawrence County
- Willsboro Research Farm, Essex County

Background:

Understanding corn silage yield potential based on soil type is of great interest to dairy farmers (NNYADP priority #60, 2018-19). Work is ongoing to evaluate corn crop yields of Northern New York soil types with the goal to:

(1) update the corn grain yield potential database that is the basis for the foundational Cornell University guidelines for nitrogen management of corn; and

(2) generate an independent corn silage yield potential database.

While generating a large database with soil type-specific yield distributions (multiple years and multiple farms), it is essential to set new yield potentials to help farmers be more precise in their nutrient/manure/fertilizer applications with the associated benefits

of environmental stewardship and the potential for cost savings. It is recognized that yield can be impacted by factors including hybrid genetics. Understanding of variability in yield, in nitrogen balances, and nitrogen use efficiency of hybrids grown under the same management conditions and on the same soil type is important to help growers achieve efficiency in both crop production and resource stewardship. The NY Corn Silage Hybrid Evaluation Program provides a platform to these comparisons, and so the NNY field trial results were submitted to that program for inclusion.

Methods:

Part A: Evaluate yield and forage quality data from 2016-2018 field trials in NNY.
Corn silage yield, forage quality, and soil and weather data were collected for field trials in Madrid (2016, 2017, 2018, and 2019) and in Willsboro (207, 2018, and 2019) for this project as part of the Corn Silage Hybrid Evaluation Program. Based on yield, crude protein content of yield, soil type, manure and rotation histories, and current year fertilizer use, we derived six different Nitrogen (N) balance indicators. The indicators were:

- A: Basic N balance: lbs N taken up minus lbs N available
- B: lb DM(dry matter) yield per total lb N available
- C: lb N uptake per total lb N as available N
- D: lb N uptake per lb of N added with fertilizer and/or manure only
- E: lb N uptake per lb of N added with fertilizer and/or manure taking into account soil and sod N
- F: N applied with fertilizer and manure per N removed.

Indicator A is a basic N balance that takes into account N removed with yield (yield times N content in the yield) and N supply with fertilizer, manure, soil N supply, and rotation credits. The other indicators are various efficiency indicators. These were calculated per plot, per year, and across varieties, years, and locations.

Part B: Evaluate corn stalk nitrate test levels and yield together
During the 2019 growing season 52 different hybrids, entered by numerous seed companies, were planted in a replicated plot design on a Hogansburg soil at the Greenwood Dairy Farm in St Lawrence County. Nitrogen inputs (manure, fertilizer, sod credits) were documented to assure adequate N inputs for the location. At harvest corn stalk nitrate test (CSNT) samples were collected from each plot and analyzed by the Nutrient Mangement Spear Program laboratory for CSNT-N.

Results:

Part A: Evaluate yield and forage quality data from 2016-2018 field trials in NNY.
Crop N removal varied from site to site and year to year, ranging from a low of 149-169 lbs N/acre for the Willsboro location over three years to a low of 229 lbs N/acre in 2019 and high of 265-268 lbs N/acre in Madrid in 2016 and 2017 (Table 1). The range in crop N uptake was driven primarily by yield differences (yield alone explained 74% of the variability in N uptake across all plots in Willsboro in 2019 and 77% of the variability in N uptake across plots in Madrid that year, across all varieties).

Indicator A: The N balance, defined as N applied with manure and fertilizer minus N removed in harvest across varieties, was negative for five site years, zero for the Willsboro location in 2017, and positive (+26 lbs N/acre) in Willsboro in 2019.

Indicator B: The lb DM yield per total lb N available ranged from 82 to 98 lbs DM per lb of available N in Madrid across the years, and was slightly lower in Willsboro, ranging from 77 to 81 lbs DM per lb of available N.

Indicator C: The N uptake per lb of N available was 1 or higher for all site years except the 2019 growing season in Willsboro.

Indicator D: Three locations showed much higher lb N uptake per lb of N added with fertilizer and/or manure only, reflecting that this indicator does not take into account other N supply (soil and crop rotation credits).

Indicator E: When soil and rotation credits were included, lb N uptake per lb of N added with fertilizer and/or manure ranged from a low 0.75 in 2019 in Willsboro to a high of 2.11 in Madrid in 2016.

Indicator F: The amount of N applied with fertilizer and manure per N removed illustrates the contribution of N from rotations (all three years corn followed sod) and manure history (Table 1).

Across varieties, years, and sites, the comparison of N in yield and the ratio of N uptake per lbs of N available (Figure 1) suggests that the highest yielding crops are produced with the highest N efficiency. Nitrogen rate studies or corn stalk nitrate test results are needed to evaluate if the crop was N limiting, correctly fertilized, or over-fertilized. However, these initial results suggest that higher yielding crops are more efficient in N uptake than lower yielding crops.

Table 1: Calculated Nitrogen Balances for corn silage trials at Madrid and Willsboro, 2016-2019. Columns reflect six different analyses of N uptake and use efficiency based on N inputs from soil, crop rotation, manure, and fertilizer. A: Basic N balance: lbs N taken up minus lbs N available; B lb DM yield per total lb N available; C: lb N uptake per total lb N available N; D: lb N uptake per lb of N added with fertilizer and/or manure only; E: lb N uptake per lb of N added with fertilizer and/or manure taking into account soil and sod N; F: N applied with fertilizer and manure per N removed.

Location	Soil type	Year	Total N uptake (lbs N/acre)	A	B	C	D	E	F
Madrid	Kalurah	2016	268	-44	89	1.20	6.80	2.11	0.15
Madrid	Stockholm	2017	265	-37	98	1.16	1.68	1.23	0.60
Madrid	Hogansburg	2018	246	-2	82	1.01	4.20	1.04	0.24
Madrid	Hogansburg	2019	229	-24	93	1.12	4.84	1.51	0.21
Willsboro	Stafford	2017	165	0	81	1.00	1.57	1.00	0.65
Willsboro	Stafford	2018	169	-4	78	1.02	1.61	1.04	0.63
Willsboro	Cosad	2019	149	26	77	0.85	1.41	0.75	0.72

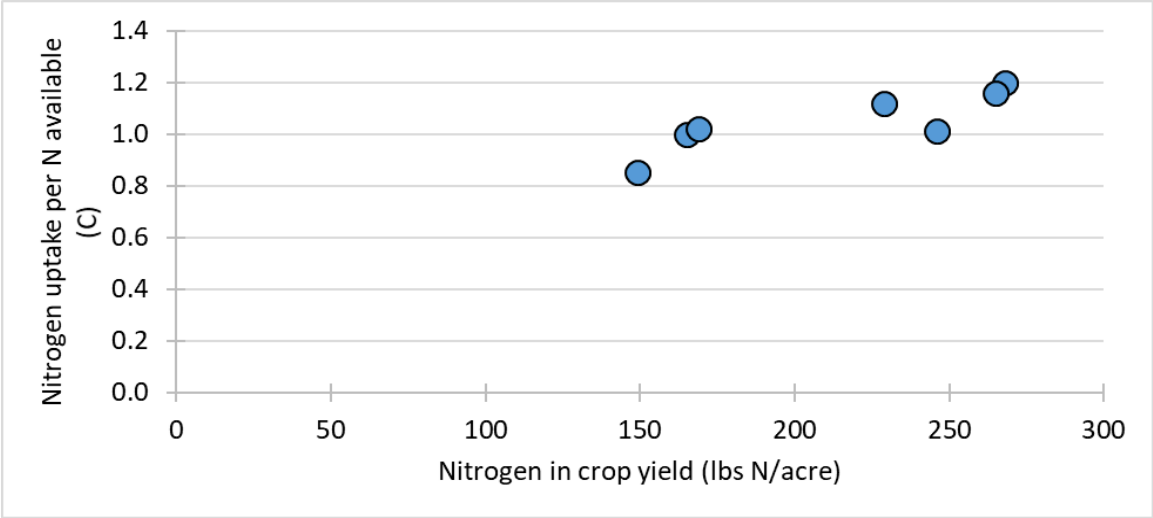

Figure 1: As crop yield increased, the N uptake per lb of N available increased as well.

Part B: Evaluate corn stalk nitrate test levels and yield together

The 2019 yields at Madrid were very competitive, despite a challenging growing season that included an excessively wet spring that delayed planting followed by a relatively cool growing season that slowed crop maturation. While the average whole plant dry matter at the location was lower than desired due to slow maturation of the crop and increased fall rainfall at harvest, the mean yield for the location was 27.4 tons/acre when corrected to 35% dry matter (Table 2)

Table 2: Yield and key forage quality values for 2019 Madrid location.

Relative Maturity Group	Growing Season	Location	Yield, 35% DM	Dry Matter	Starch	Crude Protein	Lignin	aNDFom	30 hr NDFDom	240 hr uNDFom
			tons/acre	%	% DM	% DM	% DM	% DM	% NDF	% DM
96-110	2019	Madrid, NY	27.4	28.6	30.7	7.5	2.7	38.0	58.4	12.1

The CSNT-N results showed that all plots at the 2019 Madrid location were in the optimal range (750-2000 ppm) or greater and a large majority were in the excess range (>2000 ppm), suggesting that the N applied and N available met and exceeded crop N needs.

Varieties varied in CSNT-N results across relative maturities with a slight hint of a trend toward lower CSNTs for higher relative maturity. Additional CSNT-N assessments are needed, across a larger number of sites and years to draw further conclusions.

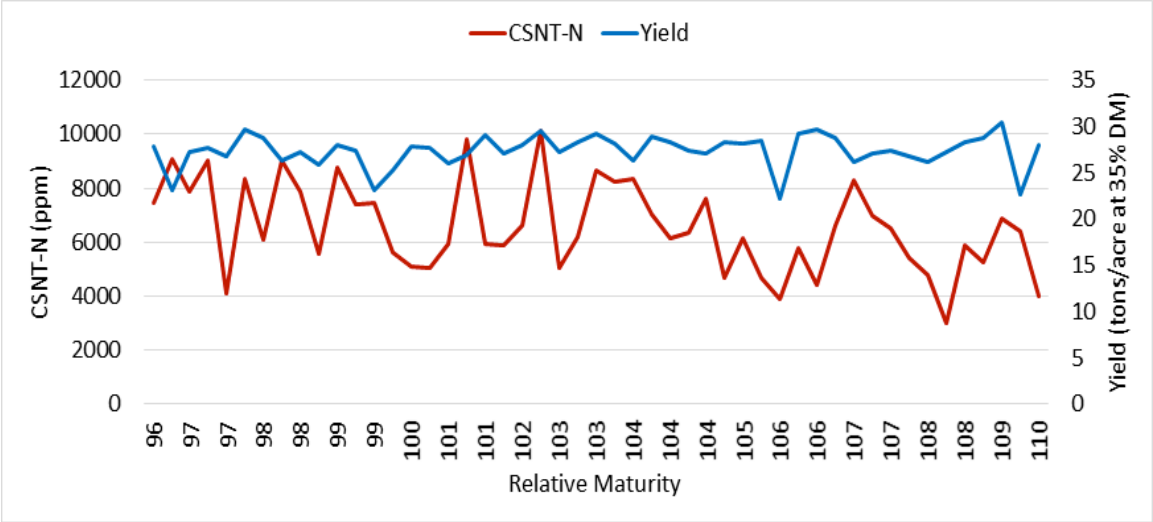

Figure 2: Crop Yield and Corn Stalk Nitrate Test (CSNT) values sorted by hybrid relative maturity for Madrid 2019.

Conclusions/Outcomes/Impacts:

With yield data and forage quality data, and information on soil type, manure management, and fertilizer decisions, N balances can be derived. Six balances, each showing a different aspect of N efficiency, were derived. Additional site evaluations and N rate studies are needed to determine ranges in balances from site to site, but initial assessments here show site-to-site differences are much larger than variety-to-variety differences within a site, suggesting overall growing conditions and field management play a larger role than genetic differences between hybrids. The yield-to-CSNT-N ratio should be explored, in combination with field balances, as a means to evaluate N efficiency.

Outreach:

Preliminary data were presented at two North Country Crop Congress (Canton and Chazy) as well as at the Central NY Winter Crop Meeting, all in January 2020. Currently, additional opportunity to present the data will include the Lowville Farmers Co-op Forage Forum (in NNY) and the Delaware County Crop School. Project leaders welcome additional opportunities to share results.

Next Steps:

Given that multi-years assessments are important to evaluating nitrogen use efficiency for corn production and resource stewardship, we hope to continue to utilize the Corn Silage Hybrid Evaluation program as a platform for this work. A grant proposal was submitted to the New York Corn Growers in the fall of 2019 to support this work in 2020. At this time no announcement has been made on funding.

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Valley Agronomics for assistance in documenting the souces and quantities of nitrogen inputs for each year evaluated. Thank you to Willsboro Research Farm Manager Michael Davis for assistance in documenting the souces and quantities of nitrogen inputs for each year evaluated.

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

We plan to proceed with additional data analysis for the four (NNYADP) sites and from trials funded elsewhere (NY Corn Growers) for which hybrid evaluations were conducted in 2019. Once the combined data are analyzed, an article will be generated and shared through Cornell Cooperative Extension newsletters and Cornell Field Crops "Wha'ts Cropping Up?" newsletter on N balances, N efficiency indicators, and the yield/CSNT-N ratio.

For More Information:

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PHOTO:

2019 Northern New York Agricultural Development Program corn silage research trial plot at Madrid, NY. Photo: Joe Lawrence