UW Extension
Ashland/Bayfield County
Research Bulletin
No. 7
Date: Dec 2009

Nitrogen Fertilization of Corn Silage in Ashland County, WI

Jason Fischbach, UW-Extension Agriculture Agent
jason.fischbach@ces.uwex.edu

Introduction

Although corn silage is an excellent feeds for livestock, it is expensive to produce. Optimizing nitrogen fertilization is important to capturing the highest return on your investment. In cooperation with three producers in Ashland County, a nitrogen fertilization trial was conducted during the 2009 growing season. The goal of the trial was to use all available tools for determining nitrogen needs of the corn crop and to validate standard corn fertilization recommendations.

Methods

The corn nitrogen fertilization trial was established in the spring of 2009 at three locations between Sanborn and Marengo. Details of each site are shown in Table 1. Manure and starter were applied by the producers as they normally would. At each site there were three replications of each of 5 fertilization rates. Each plot was 15 ft long by 4 rows wide. One week prior to top-dressing fertilizer, a pre-sidedress nitrate test (PSNT) was conducted by pulling soil samples from each location and testing for nitrate levels. The PSNT provides a measure of how much nitrogen is in the soil and can be used to validate calculated nitrogen availability based on legume and manure credits. If the PSNT value is greater than 21 ppm than adding additional nitrogen is highly unlikely to increase corn yields. The PSNT for all three sites was well above 21 ppm and no additional nitrogen was necessary (Table 1).

To validate the PSNT test, urea was top-dressed at a rate of 0, 43, 87, 131, and 174 lbs urea/ac for actual N rates of 0, 20, 40, 60, 80 lbs N/ac, respectively, to each plot. There were 3 replications per treatment at each location. The urea was applied when the corn was about 1 foot high on July 6. The corn was harvested from a portion of each plot on September 18 and dried and weighed to determine a per acre corn silage yield for each fertilization rate. Corn ears were harvested on October 12 from two of the sites to determine ear yields.

Trial Results

Table 1 shows the amount of N from urea that should have been top-dressed based on the calculated manure and legume credits for each site. The calculations used the book-values for manure and legume nitrogen. Based on the calculations, Site 1 needed 30lbs N/ac, Site 2 needed 10lbs N/ac, and Site 3 needed no additional nitrogen due to the large legume credit from the 2008 alfalfa plow-down. The PSNT showed that no additional nitrogen was needed for either site, suggesting that the calculated values were underestimating the actual nitrogen availability.

Table 2 shows the corn silage yield in tons per acre on

Table 1. Calculated nitrogen needs for the 2009 corn silage crop at three locations near Sanborn, WI.

	Site 1	Site 2	Site 3
Field Location	town hall	Stork road	Home farm
2008 Crop	corn silage	corn silage	alfalfa
2008 Post-Harvest Manure (Fall)			4000 gal/ac
2009 Pre-Plant Manure (Spring)	7000 gal/ac	7000 gal/ac	2000 gal/ac
Corn Plant Populations (plants/ac)	27,878	26,136	27,181
Corn Nitrogen Need (lbs N/ac)	120	120	120
Legume Credit (lbs N/ac)	0	0	90
Manure Credit (lbs N/ac)	70	70	60
Adjusted Corn N Need (lbs N/ac)	50	50	0
Nitrogen From Starter* (N lbs/ac)	20	40	40
Additional Nitrogen Needed from Urea	**30**	**10**	**0**
Pre-Sidedress Nitrate Test (ppm)	36	45	77

* Starter: Site 1-100lbs/ac 20-10-26; Site 2-200lbs/ac 20-10-26; Site 3-200lbs/ac 20-10-26

a dry matter and 65% moisture basis. There was no statistically significant difference in silage yield among the urea treatments at any of the locations, validating the PSNT. In addition, there was no statistically significant difference in ear yield among the urea treatments (Table 3).

Based on the results of this trial, the pre-sidedress nitrate test can be used by corn silage producers in the region to more accurately determine how much, if any, nitrogen should be applied with a topdress or sidedress application of urea. Furthermore, nutrient crediting using book values should be done by corn silage producers to avoid over-application of manure or fertilizer, particularly in the year after a stand of legumes is incorporated.

Table 3. Corn ear yield (cob and kernal) in tons/acre at two locations in response to five rates of top-dressed urea.

Lbs actual N/acre	Site 1	Site 3
	----tons as is/ac----	
0	9.2	6.5
20	9.5	6.7
40	9.4	6.8
60	9.5	7.6
80	9.7	6.7

Table 2. Silage yield (9/18 harvest) in tons/ac at three locations in response to five rates of top-dressed urea.

Lbs actual N/acre*	Site 1		Site 2		Site 3	
	DM	65%	DM	65%	DM	65%
	---------- tons/acre ----------					
0	6.95	19.88	6.81	19.48	6.43	18.36
20	7.07	20.21	7.26	20.76	6.33	18.11
40	7.33	20.97	6.76	19.34	6.86	19.61
60	7.80	22.32	6.95	19.88	7.06	20.21
80	7.76	22.19	7.13	20.38	6.44	18.42
Pr>F	0.41	0.41	0.95	0.95	0.68	0.68

* Nitrogen was applied in the form of urea on July 6 at a rate of 0, 43, 87, 131, 174 lbs urea/acre, respectively

Calculating How Much Nitrogen To Apply To Your Corn

Step 1: Determine the Corn Nitrogen Need
How much nitrogen the corn silage needs to maximize production depends primarily on the yield potential of the soil and the maximum return to nitrogen. The soils of the Lake Superior counties are almost all Medium yield potential soils and, thus, the corn requires between 100-140 lbs of actual N per acre. For corn silage a Maximum Return to Nitrogen (MRTN) ratio of 0.05 is used. An MRTN table can be looked up in most corn fertilization publications. For each of the trial sites in this study, the corn nitrogen need was 120 lbs N per acre.

Step 2: Determine the Legume Nitrogen Credit
When legumes die and decompose the nitrogen in the root nodules and foliage becomes available to plants around them. When a stand of alfalfa or mixed forage is tilled-in, a significant quantity of nitrogen becomes available for the next crop. The amount of N available depends on the amount of legume that is plowed-in and the soil type. The amount of legume is a function of plant density and plant height at the time of tillage. The legume credit can vary from 190 lbs per acre when a good (70-100% alfalfa) alfalfa stand is tilled into clay soils to 40 lbs per acre when a poor (0-30% alfalfa) is tilled into sandy soils. If legumes are in the crop rotation it is important to determine the legume credit from a legume credit table and use that value when planning manure and fertilizer applications.

Step 3: Determine the Manure Nitrogen Credit
Manure is an important source of nitrogen for corn. On average, one ton of solid dairy manure has 4 lbs of nitrogen available in the first year and 1000 gallons of liquid dairy manure has 10 lbs available if it's incorporated within 3 days after spreading. If it's not incorporated, some of the nitrogen is lost via volatilization and the available nitrogen is reduced to 3 lbs/ton and 7 lbs/1000 gallons, respectively. These values are average values and can change considerably from farm-to-farm and year-to-year. Knowing exactly how much nitrogen is available from your manure requires that you send in a sample of the manure prior to spreading. Likewise, knowing how much nitrogen is being applied from the manure requires knowing how many gallons or tons are being applied to each acre.

In our region, manure is not typically used as the sole source of nitrogen for the corn. Starter and topdressed urea are often added to spread out the availability of N during the growing season.

Step 4: Determine the Adjusted Corn Nitrogen Need
The adjusted corn nitrogen need is the amount of additional nitrogen to add after accounting for the nitrogen from legumes and manure. The adjusted need is calculated by subtracting the legume and manure nitrogen from the total corn nitrogen need.

Step 5: Account for the Starter
Regardless of how much nitrogen is available from legumes or manure, a starter fertilizer with some nitrogen is recommended for corn. The current recommendation is to add 10lbs N per acre at the time of planting. This amount should be accounted for when determining how much additional nitrogen to add after planting.

Step 6: Apply Additional Fertilizer
If nitrogen from legumes, manure, and starter is insufficient, a topdress of urea or other N fertilizer may be necessary to fully meet the needs of the corn crop. The pre-sidedress nitrate test should be used to validate the calculated values and determine exactly how much additional nitrogen is necessary.

		Lbs actual N/ac
	1. Corn Nitrogen Need	
–	2. Legume Credit (Nitrogen from legumes)	
–	3. Manure Credit (Nitrogen from manure)	
=	4. Adjusted Corn Nitrogen	
	5. Nitrogen From Starter	
	6. Nitrogen From Topdress	

Summary

This study suggests the PSNT combined with nutrient crediting could be used by corn silage producers in the region to potentially save fertilizer expenses and avoid loss of nitrogen to surface and groundwater. For example, assuming urea cost \$372/ton (\$0.19/lb), a producer would spend roughly \$19/acre to topdress urea at 100lbs/ac. If the PSNT indicated no additional nitrogren was necessary, this is money that could be saved or spent elsewhere.

Assistance is available from UW-Extension Agriculture Agents for corn silage producers that would like to use the PSNT and nutrient crediting to maximize the return on their fertilizer investment.

Thanks to Bob Reimer, Todd Berweger, and Brian Anderson for use of their corn fields and thanks to Dick Wolkowski, UW-Extension Soil Scientist, for assistance with experimental design, corn silage sampling, and statistical analysis.