Evaluating Nitrogen Stabilizers for More Efficient Nitrogen Use when Growing Corn on Sandy Soil

RFR-A1602

Vince Lawson, farm superintendent

Introduction

Producing field corn on a coarse sandy soil with low organic matter presents several challenges to farmers. One of the biggest is applying nitrogen (N) efficiently. The low water-holding capacity of a sandy soil and the soluble nature of most N fertilizers create a situation where N is easily leached below the crop root zone during high rainfall or excessive irrigation events. The purpose of this trial was to examine different N stabilizers for their ability to limit leaching and increase N use efficiency in this type of production system. Products evaluated included ESN (Agrium U.S., Inc.), Instinct II (Dow AgroSciences), Agrotain Dri-Maxx (Koch Agronomic Services), and SuperU (Koch Agronomic Services).

Materials and Methods

The trial was conducted on a coarse textured Fruitfield sand soil with 1.5 percent organic matter and cation exchange capacity of 8.2 meq/100g. Total water holding capacity of soil was calculated to be approximately 1 in. and plant available water 0.5 to 0.75 in./ft Pioneer 1443AM corn was planted April 23 and plant counts after emergence identified a final stand of 31,240 plants/acre. Overhead irrigation was supplied as needed to supplement rainfall and prevent drought stress. The center two rows of each plot were harvested September 29 for yield determination.

Trial fertilization included broadcasting 150 lb/acre of potash (0-0-60) and 175 lb/acre of calcium sulfate (17% sulfur), which were incorporated before planting. A soil test indicated very high levels of phosphorous so none was applied. N stabilizer treatments are listed in Table 1. Agrotain Dri-Maxx is a dry fertilizer additive that was mixed with urea at the rate of 2.5 lb/ton. Instinct II was applied to urea in an amount that would equal 35 fl oz/acre when spread in the field. A drying agent (calcium bentonite) also was added to the urea to reduce wetness and facilitate spreading. SuperU is a manufactured product consisting of urea granules treated with both NBPT (n-butyl-thiophosphoric triamide) and DCD (dicyandimide) N stabilizers. ESN is a manufactured product of polymer-covered urea granules that allow slow diffusion of water in and urea out of the granule. Because it provides slow release of N, 25 percent of the N in the ESN treatment was supplied as straight urea for immediate crop availability. The preplant incorporated (PPI) N treatments were applied April 20 by spreading uniformly over the plot area and then chisel plowing and disking. Sidedress treatments were applied May 27 and June 24 by banding between the rows and incorporating with a half inch of irrigation water.

Results and Discussion

The 2016 growing season provided plenty of opportunities for N leaching. Figure 1 shows rainfall plus irrigation totals for 3-day intervals during the growing season. There were several periods when rainfall exceeded the water holding capacity of the soil and probably leached soluble N. Evidence of leaching can be seen in Table 2, which reports soil N concentration at two soil depths (0-8 in. and 16-24 in.) on two dates (June 6 and 30) from the treatments receiving all of their N preplant (PPI). As expected, N concentrations in the 0-8 in. depth were elevated due to fertilizer incorporation on April 20. But most telling were the elevated N concentrations at the deeper 16-24 in. soil depth indicating fertilizer leaching had occurred. By June 30, soil N concentrations at both depths were reduced due to crop use and leaching. It is interesting to note the ESN + Urea PPI treatment had slightly higher soil N concentrations at the 0-8 in. depth than the other treatments at both sampling dates.

Table 1 presents treatment descriptions and grain yields at harvest. Although all treatments received a total N application of 200 lb/acre during the season, there still were large yield differences. Yields ranged from 102 to 216 bushels/acre. Comparing yield of treatments where all N was applied, PPI gave the best indication of how well the N stabilizers improved N use efficiency. The ESN product, which is a polymer coated urea providing slow release of N, produced highest yield in the PPI group. Both Instinct II and SuperU PPI produced lower yield than the ESN treatment. It is possible they did not perform as well due to the frequent rainfall causing N leaching when it wasn't in a protected form. Both of these products utilize a nitrification inhibitor that provides leaching protection by keeping N in the ammonium form that binds to soil sites. However, leaching is still possible, and probably occurred in this study, while the applied N was in the water soluble urea or nitrate form.

Agrotain Dri-Maxx PPI was included in this study for observational purposes. Its active ingredient, NBPT, is a urease inhibitor and protects mainly against volatilization losses. As such, it was not expected to prevent leaching and, in fact, its yield was not significantly different from that of the Urea PPI treatment with no stabilizer additive.

Yield data in Table 1 clearly show that split applications of N, no matter which stabilizer used, provided better N efficiency than a single PPI application. These results confirm what has been recommended all along for sandy soils; mainly, N leaching from unpredictable rainfall can be reduced by applying N in small, multiple applications. Although this approach provides more N for crop use, the reliance on multiple applications also increases labor and input costs.

These trial results demonstrate better N use efficiency can be obtained when growing corn on a coarse sandy soil by using a slow release N stabilizer product like ESN. What still needs to be determined is how consistently this response would occur and the optimum application timings. Under the conditions of this study (which included frequent rainfall) there was a clear advantage to dividing N into three split applications. A followup question is whether or not N use efficiency could be maintained, when using ESN, if the N applications were reduced to just two (preplant followed with one sidedress after corn emergence).

Table 1. Nitrogen stabilizer treatment descriptions, timing of N application, and grain yield.

Treatment	N Stabilizer	N Rate lb/acre[1] April 20	May 27	June 24	Yield bu/acre[2]
Preplant Incorporated (PPI)					
Urea PPI	---	200	-	-	102.2
Urea + Instinct II PPI	nitrapyrin	200	-	-	116.6
Urea + Agrotain PPI	NBPT	200	-	-	120.5
SuperU PPI	DCD + NBPT	200	-	-	129.8
ESN + Urea PPI	polymer coated	200	-	-	152.0
Split Application					
Urea Split	---	67	66	66	182.8
Urea + Instinct II Split	nitrapyrin	67	66	66	190.1
SuperU Split	DCD + NBPT	67	66	66	192.1
ESN + Urea Split	polymer coated	67	66	66	216.4

[1]Total N application for all treatments was 200 lb/acre. PPI = preplant incorporated on April 20. Split = 1/3 of total N applied PPI on April 20, 1/3 of total N sidedressed May 27 when corn at V4 growth stage, and 1/3 of total N sidedressed June 24 when corn at V12-V14 growth stage.
[2]Yield differences less than 22.3 bu/acre were not significant at LSD of 5%.

Table 2. Soil N concentration (ppm of NH_4^+-N plus NO_3^--N) at soil depths of 0-8 and 16-24 in. on June 6 and 30.

N stabilizer treatment	June 6 0–8 in.	June 6 16–24 in.	June 30 0–8 in.	June 30 16–24 in.
No fertilizer	4.9	4.6	2.6	2.0
Urea PPI	12.1	9.5	3.7	3.8
Urea + Instinct II PPI	16.0	9.6	4.5	4.2
Urea + Agrotain PPI	9.6	10.2	3.1	3.5
SuperU PPI	11.6	8.2	4.4	3.2
ESN + Urea PPI	22.9	7.2	7.7	4.8

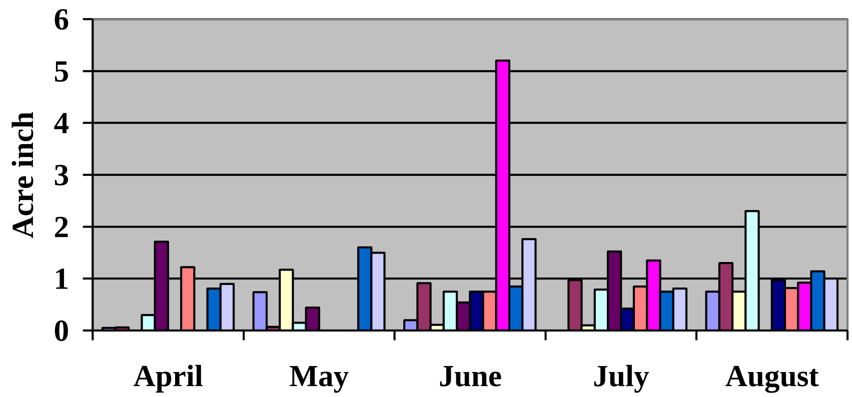

Figure 1. Rainfall and irrigation amounts (3 day intervals) during the season.