

Corn and Winter Wheat Yield Responses to Products Designed to Improve Nitrogen-Use Efficiencies in 2008

Overall Summary

Studies were conducted in both winter wheat and corn in 2008. The objective of the winter wheat studies was to compare some of the new fertilizer N technologies to normal grower practices and determine if these technologies could provide greater yields by providing greater N efficiencies. Applying N to corn in split applications with most of the N being applied at sidedressing is the standard practice used by most corn growers in this region. Therefore, the main objective of the corn studies was to compare these new fertilizer N technologies to sidedress-applied UAN fertilizer that is applied in a dribble band. The fertilizer technologies being tested in both the winter wheat and corn studies were ESN¹, Agrotain², Agrotain Plus³, and Nutrisphere-N⁴. The winter wheat studies were conducted at two locations (Site W and Site O). At Site W, there were no significant differences among any treatments, while there were significant differences in wheat grain yields among treatments at Site O. None of the fertilizer technologies, however, yielded significantly greater than the standard urea fertilizer treatment. For the corn studies, one study was conducted at two different locations (Sites A and B) and this study involved UAN, ESN, Agrotain, Agrotain Plus, and Nutrisphere-N. Unfortunately, both of these two locations were severely impacted by drought so no differences were found among any fertilizer treatments because the most limiting yield factor was water. An additional irrigated study was conducted at the University of Delaware's Research and Education Center (Site C). In this study, the preemergence N treatments averaged 134 bu/acre, while the sidedress dribble treatments averaged 168 bu/acre. The highest yielding treatment was ESN banded between the rows at sidedressing, and this treatment yielded significantly better than all treatments except the dribble treatment that included a higher rate of N. The ESN preplant treatment yielded 69 bu/acre better than the urea preplant treatment, and this ESN preplant treatment actually yielded the same as the UAN dribble sidedress treatment (Delaware standard). The results showed no yield advantages from Agrotain, Agrotain Plus, or Nutrisphere-N when compared to standard practices.

¹ESN is a polymer-coated urea fertilizer marketed by Agrium Corporation.

²Agrotain is a urease inhibitor marketed by Agrotain International.

³Agrotain Plus is a urease inhibitor and nitrification inhibitor marketed by Agrotain International.

⁴Nutrisphere-N is marketed by Specialty Fertilizer Products as an N fertilizer additive.

Wheat Project for 2008:

This wheat project was conducted at two locations in Delaware during the 2008 growing season. Both sites were located in Sussex County on sandy loam soils. Site W was irrigated and conventionally tilled, while Site O was dryland and no-tilled. There was about 40 lb N/ac applied in the fall by the grower at both sites. Each location utilized a randomized-block design with four replications, and each treatment (i.e., plot) was 15 ft wide and 400 ft long. Grain yields were determined by using a small-plot combine to harvest the center 6.66 ft of each strip and weighing the grain in a weigh wagon.

The fertilizer treatments were applied on March 3rd at Site O and March 4th at Site W, which was at green-up (Zadoks growth stage 25). The split application of UAN was applied on March 24th at both sites. For the split applied treatment, 60% of the N was applied as UAN in the first application and 40% was applied in the second application at Site W, while at Site O the split application was a 50:50 split of urea followed by UAN. The N fertilizer was applied at four rates (Site O = 75, 90, 105, and 120 lb N/acre; Site W = 80, 95, 110, and 125 lb N/acre) to quantify the yield response to N at each location; different N rates were used at each site because of different yield potentials. The main source of N at Site O was urea and was UAN (30-0-0) at Site W.

The ESN was applied in different mixtures with either 34-0-0 or 46-0-0. One mixture (ESN50AN) was a 50:50 mixture of ESN and ammonium nitrate, another mixture (ESN30AN) was a 30:70 mixture of ESN to ammonium nitrate, while a third mixture (ESN30U) was a 30:70 mixture of ESN to urea. These mixture ratios were based on amounts of N, not amounts of fertilizer. The Agrotain, Agrotain Plus, and Nutrisphere-N were mixed with the UAN or urea as recommended by each manufacturer; the highest recommended rate was used for the Agrotain products. All fertilizer treatments were broadcast. Site W was irrigated as needed by the grower with relatively small amounts of water, while Site O was not irrigated. Seasonal rainfall amounts recorded at the University of Delaware's Research and Education Center are shown in Figure 1, as well as the cumulative growing degree days.

On March 5th, both sites received about 0.70 inches of rain and then on March 7th both sites received an additional inch of rain, which would have eliminated any need for a volatilization inhibitor. Most of April was not excessively wet; however, from April 27 through May 12, both sites received about 7.5 inches of rainfall.

The 2008 grain yields were about average for Delaware (Tables 1 and 2). The goal with the N rates used in this study was to compare products at some point just below the optimal N rate. At Site O, statistical analyses showed that there was a significant difference among the treatments and that the treatments were compared at the desired point on the response curve. Even though there was a significant response to N at Site O, there was no significant difference in yield among the various fertilizer treatments. In fact, the urea fertilizer treatment had a greater yield than every treatment, except the ESN30AN, but this difference was not significant and was only 1 bu/ac. At Site W, there was no

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significant difference among the treatments and based on the yields, it appears the treatments were compared a rate that was not below optimal.

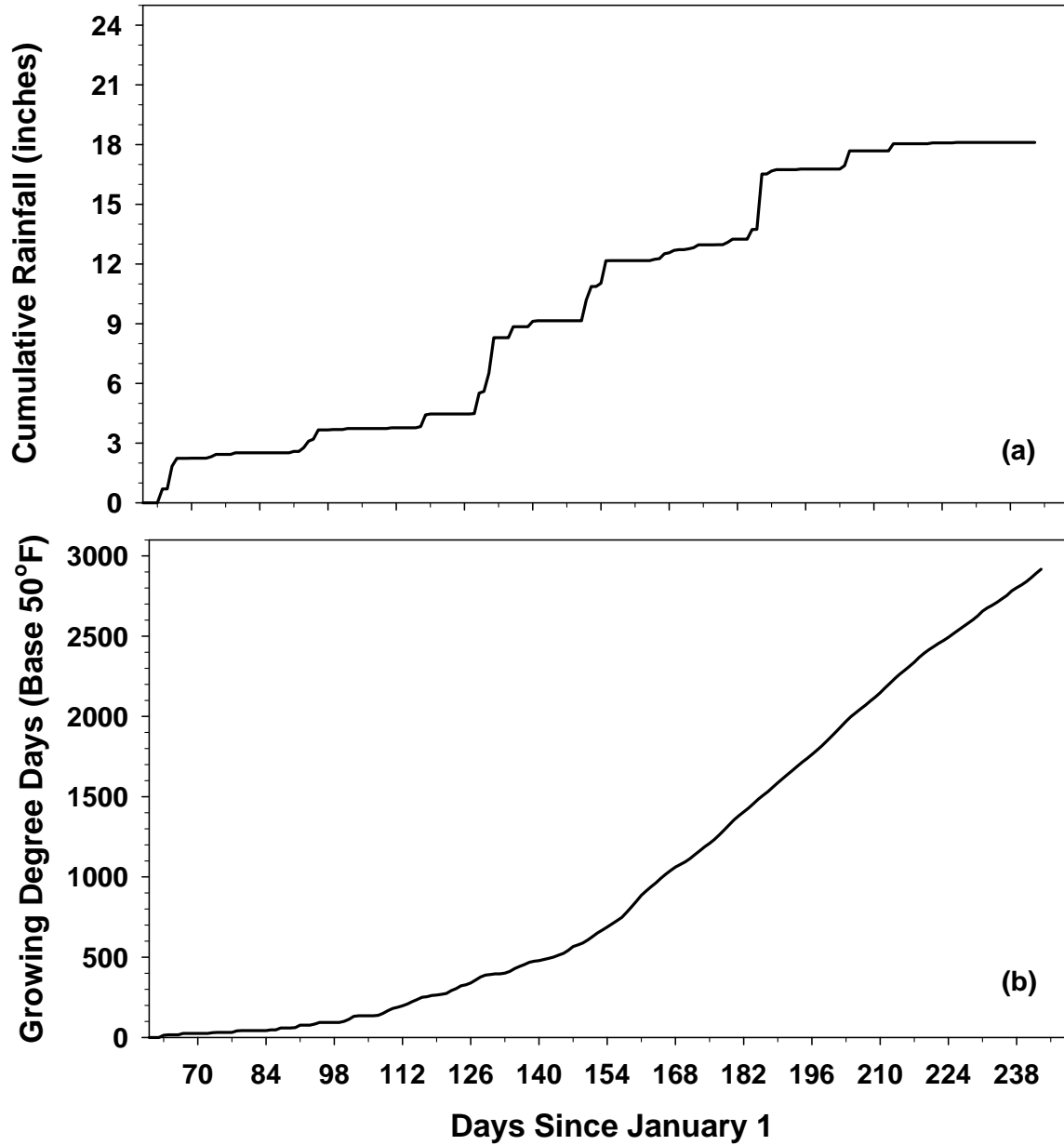


Figure 1. Cumulative rainfall (a) and growing degree days (b) since January 1, 2008 at the Research and Education Center near Georgetown, DE.

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Table 1. Winter wheat grain yields at Site O.

Trt	N Source¹	N Rate	Grain Yield	Grain Moisture
		lb/ac	bu/ac	%
1	Super U	90	87.3	14.9
2	Nutrisphere-N	90	87.3	14.7
3	Agrotain	90	89.9	14.7
4	ESN30U	90	87.5	15.0
5	ESN30AN	90	93.2	14.8
6	34-0-0	90	91.4	14.6
7	Urea	75	85.1	14.9
8	Urea	90	92.1	14.8
9	Urea	105	98.8	14.8
10	Urea	120	102.0	14.6
11	Urea/UAN Split	90	84.6	15.0
<u>Statistics</u>				
	CV		7.6%	1.5%
	P > F		0.02	0.25
	LSD(0.10)		9.9	N.S.

¹Agrotain and Nutrisphere-N applied on Urea fertilizer

¹ESN30U = 30% of N as ESN; 70% as urea

¹ESN30AN = 30% of N as ESN; 70% as 34-0-0

¹50% of N applied at Zadoks growth stage 25 and 50% applied at Zadoks growth stage 30

Table 2. Winter wheat grain yields at Site W.

Trt	N Source ¹	N Rate	Grain Yield	Grain Moisture
		lb/ac	bu/ac	%
1	ESN50AN	95	103.6	15.1
2	ESN30AN	95	101.0	15.0
3	Agrotain	95	100.7	15.1
4	Agrotain Plus	95	101.5	15.0
5	Nutrisphere-N	95	106.1	14.9
6	UAN/UAN Split	95	96.3	15.0
7	UAN	80	96.3	14.9
8	UAN	95	99.6	15.0
9	UAN	110	103.2	14.9
10	UAN	125	99.4	14.9
11	34-0-0	95	103.2	15.1
Statistics				
	CV		5.0%	1.6%
	P > F		0.21	0.95
	LSD(0.10)		N.S.	N.S.

¹Agrotain, Agrotain Plus and Nutrisphere-N applied in UAN

¹ESN50AN = 50% of N as ESN; 50% as 34-0-0

¹ESN30AN = 30% of N as ESN; 70% as 34-0-0

¹60% of N applied at Zadoks growth stage 25 and 40% applied at Zadoks growth stage 30

Corn Projects in 2008:

Corn projects in 2008 were conducted at three locations in Delaware. Sites A and B had the same treatments and were both dryland sites located on silt loam soils in Northern Delaware. Site C was located at the Research and Education Center in Georgetown and was an irrigated site. Sites A and B were both planted by the cooperating growers and some N was applied with the planter as a starter fertilizer (Table 3), while Site C was planted by the farm staff at the University of Delaware. All fertilizer treatments were applied by the University of Delaware, and the sidedress treatments were applied when the corn was between 10 to 12 inches tall.

Table 3. Site descriptions for the three corn study sites in Delaware.

Site	Soil Type	Tillage ¹	Planting		Previous Crop ²	Starter
			Date	Hybrid		Fertilizer ³
A	Silt Loam	TT	1-May	P36W66	W/DS	50-40-0
B	Silt Loam	NT	25-Apr	NKN58	W/DS	15-38-0
C	Sandy Loam	CT	25-Apr	P33N58	Corn	25-25-0

¹NT = No-Till; TT=Turbo Till; CT = Conventional Till

²W/DS = winter wheat followed by soybeans

³Pounds per acre of N - P₂O₅ - K₂O

At Sites A and B, eight of the treatments were different rates (0, 30, 60, 90, 120, 150, 180, & 210 lb N/acre) of UAN (30-0-0) fertilizer applied as a sidedressing dribbled on the soil surface between the rows of corn. The other treatments included UAN mixed with Agrotain or Agrotain Plus, UAN mixed with Nutrisphere-N, and ESN. All UAN treatments were dribbled at sidedressing; however, the ESN treatments were applied broadcast when the corn was in the V1 growth stage and were not incorporated. All fertilizer technologies were applied at three rates of N (30, 60, and 90 lb N/acre).

Site C had 14 treatments. Treatments 1 and 2 were applied and incorporated on April 22 prior to planting, while all other treatments were applied after planting. Treatments 11 through 14 were broadcasted as preemergence treatments on May 1. All other treatments were applied when the corn was about 10 inches tall the first week of June. For the ESN banded treatment (Trt 7), a hoe was used to develop a small trench between the rows and the ESN was banded in this trench and the trench was filled with soil so that the fertilizer was covered with soil.

At all three sites, individual plots were 15 ft wide (six rows) and 100 ft long. Corn yields were determined by harvesting the three center rows of each plot with a plot combine equipped with on-board weigh buckets. The SAS system was used for all statistical analyses.

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The 2008 season had a severe drought in the northern half of Delaware. The yield potential at Sites A and B is around 200 bu/acre in a normal year, so the low yields observed in 2008 demonstrate the severity of the drought at these two locations (Table 4). Because water was so limiting, there is really no need to discuss the impact of the treatments at these two sites because any differences among N treatments were masked by drought effects.

At Site C, there was a highly significant impact of treatment on corn grain yields (Table 5). The lowest yielding treatment was the urea preplant treatment (i.e., Trt 2). The UAN preemergence treatments were significantly lower yielding than all sidedress treatments, however, there was no significant difference among any of the UAN preemergence treatments (Trts 11 through 14). The preemergence treatments were applied on the morning of May 1st and the site did not receive any rainfall until May 9th when an inch of rain was received. From the last week of April through the month of May, this site received nearly 7 inches of rainfall. This amount of rain likely resulted in leaching losses of N, which explains the lower yields of the preemergence and the urea treatments. The grain yield of the ESN preplant (Trt 1) treatment was much greater than the urea preplant and the UAN preemergence treatments. In fact, the ESN preplant treatment had a higher yield than the UAN sidedress treatment, although this difference was not statistically significant. It is important to point out that in previous research in this region, the ESN preplant treatment has often yielded significantly less than the UAN sidedress treatment on sandy soils.

The highest yielding treatment in this study was the ESN sidedress banded treatment. In fact, this treatment resulted in a significantly greater yield than all treatments, except Treatment 10, which was a higher rate of sidedress N. Treatment 10 suggests that the rate used for testing treatments was slightly below optimal, which was the reason this treatment was included in the study. About 0.5 inches of rainfall occurred at this site on the evening that the sidedress treatments were applied, which again should have eliminated any potential responses from urease inhibitors.

Table 4. Corn grain yield and moisture at Sites A and B in 2008.

N Rate	Source ¹	Grain Yield		Grain Moisture	
		Site A	Site B	Site A	Site B
lb N/ac		----- bu/ac -----		----- % -----	
0	None	105.2	92.0	14.0	14.9
30	UAN	117.6	107.6	14.1	15.3
60	UAN	118.1	117.6	14.2	15.4
90	UAN	120.0	116.2	14.1	15.2
120	UAN	111.5	100.4	14.0	15.7
150	UAN	117.7	109.8	14.2	15.8
180	UAN	114.4	116.9	14.1	15.0
210	UAN	112.9	123.4	14.1	15.0
30	Agrotain	106.4	95.5	14.2	15.8
60	Agrotain	110.1	118.8	14.3	14.7
90	Agrotain	107.6	113.4	14.0	15.3
30	Agrotain Plus	110.8	101.5	14.0	14.3
60	Agrotain Plus	105.8	104.3	14.0	14.2
90	Agrotain Plus	108.1	113.7	14.3	15.6
30	ESN	103.8	94.2	14.2	15.9
60	ESN	103.5	103.0	13.9	14.9
90	ESN	107.1	120.3	14.0	14.9
30	Nutrisphere-N	110.3	100.7	14.1	15.1
60	Nutrisphere-N	104.6	99.1	14.2	15.5
90	Nutrisphere-N	108.4	105.1	14.3	15.9
Mean					
	UAN (30, 60, 90)	118.6	113.8	14.1	15.3
	Agrotain	108.0	109.3	14.2	15.2
	Agrotain Plus	108.2	106.5	14.1	14.7
	ESN	104.8	105.8	14.0	15.2
	Nutrisphere-N	107.7	101.6	14.2	15.5
Statistics					
	CV	9.4%	13.4%	1.7%	6.0%
	P > F	0.51	0.06	0.68	0.29

¹Agrotain, Agrotain Plus, and Nutrisphere-N were mixed with UAN

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Table 5. Corn grain yields and moisture for various N treatments at Site C in 2008.

Trt # ¹	Preplant Source	Preplant N Rate - lb/ac -	Preplant Method	Sidedress Source ²	Sidedress N Rate - lb/ac -	Sidedress Method ³	Total N Rate - lb/ac -	Grain Yield bu/ac	Grain Moisture - % -
1	ESN	155	Broadcast	None	0		155	171.1	18.6
2	Urea	155	Broadcast	None	0		155	101.8	19.5
3	None	0		UAN +NSN	155	Dribble	155	165.6	18.0
4	None	0		UAN +AT	155	Dribble	155	173.6	18.7
5	None	0		UAN +ATP	155	Dribble	155	173.4	18.5
6	ESN	77.5	Broadcast	UAN	77.5	Dribble	155	163.6	18.6
7	None	0		ESN	155	BAND	155	190.7	18.6
8	None	0		UAN	155	Dribble	155	165.5	18.3
9	None	0		UAN	155	Knife	155	173.1	18.4
10	None	0		UAN	185	Dribble	185	184.5	18.8
11	None	0		UAN +NSN	155	Broadcast	155	129.4	18.9
12	None	0		UAN +AT	155	Broadcast	155	138.9	18.2
13	None	0		UAN +ATP	155	Broadcast	155	132.5	18.5
14	None	0		UAN	155	Broadcast	155	136.8	18.3
Statistics									
CV								7.0%	2.8%
P > F								<0.0001	0.57
LSD (0.1)								16	0.76

¹Trts 1 and 2 were applied preplant and incorporated

¹Trts 11 to 14 were applied preemergence on May 1

²NSN = Nutrisphere-N, AT = Agrotain, ATP = Agrotain Plus

²AT and ATP were applied at the 14-day rate

³Sidedress treatments (dribble, band, and knife) were applied on June 4