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Evaluation of ESN on Corn and Winter Wheat in Delaware

There are several new fertilizer technologies currently being marketed for agricultural producers. A product developed and marketed by Agrium Corporation called ESN® is a polymer-coated urea fertilizer that is designed to slowly release nitrogen (N) into the soil. The overall goal of the product is to minimize N losses and maximize crop uptake of the N.

Studies were done with winter wheat and corn in 2006. The objective of the winter wheat studies was to compare ESN to normal grower practices and determine if ESN could provide greater yields through greater N efficiencies. For corn, applying N in split applications with most of the N being applied at sidedressing is the standard practice used my most corn growers in this region. Therefore, the main objective of the corn studies was to compare preplant-applied ESN to sidedress-applied UAN fertilizer.

WINTER WHEAT

This wheat project was conducted at three locations in Delaware during the 2006 growing season. Site SI was on a sandy loam soil in Sussex County and was irrigated, while the other two sites were both dryland. Site NCD was located in New Castle County on a silt loam soil; Site SD was in Sussex County on a loamy sand soil. There was no fall N applied at Sites SD and NCD, while Site SI had about 25 lb N/ac applied by the grower in the fall of 2005. Each location utilized a randomized-block design, and each treatment 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 8 at Site SI (at “green-up”), March 7 at Site NCD (shortly before “green-up”), and March 23 at Site SD (shortly after “green-up”). The UAN fertilizer (30-0-0) was applied at four rates (75, 90, 105, and 120 lb N/acre) to quantify the yield response to N at each location. The ESN was applied in two different mixtures and at two N rates (75 and 90 lb N/acre). One mixture (ESN50) was a 50:50 mixture of ESN and ammonium nitrate, while the other mixture (ESN30) was a 30:70 mixture of ESN to ammonium nitrate. These mixture ratios were based on amounts of N, not amounts of fertilizer. All fertilizer treatments were broadcast on the soil surface. Site SI was irrigated frequently by the grower with small amounts of water because the spring of 2006 was extremely dry. Seasonal rainfall amounts are shown in Figure 1.

In 2006, winter wheat yields were excellent at Site SI, above average at Site NCD, and below average at Site SD (Table 1). Visual observations during April and early May showed that the winter wheat was severely drought stressed at Site SD, slightly stressed at Site NCD, and never stressed at Site SI. Winter wheat yields increased linearly with rate of UAN applied at Site SI, while N rate had no significant effect on grain yields at Sites NCD and SD (Figure 2). Because there was no linear effect of UAN rate on grain yields at Sites NCD and SD, there is no need for further discussion of the treatment effects at these locations.

At Site SI, all ESN treatments resulted in better yields than UAN fertilizer applied at the same rate of N. In fact, calculations using the linear model presented in Figure 1 indicate that to achieve the same yield, it would take an average of 19% more UAN fertilizer than it would if using ESN30 fertilizer. Making the same comparison with the ESN50 treatments, indicates that it would take an average of 14% more UAN fertilizer than ESN50 fertilizer to get the same winter wheat yield. These results of the ESN50 and ESN30 treatments are similar to the results obtained in 2005 and suggest that ESN mixed at these ratios with a soluble N source would make a good N fertilizer program for winter wheat. Future studies, however, should evaluate an additional treatment of 100% ammonium nitrate. This additional treatment would quantify the relative benefits of the ESN versus the ammonium nitrate in these mixtures.

CORN

One of the corn projects during 2006 was conducted at five different locations around Delaware (Table 2). Site SI (not the same location as SI wheat study) was an irrigated field in Sussex County, while Sites SND and SSD were both dryland sites in Sussex County. Site NCD was a dryland site in New Castle County, and Site KI was an irrigated site in Kent County. Sites SND and NCD were no-tilled, while the other three sites were conventionally tilled. The soil texture was silt loam at Sites KI and NCD and sandy loam at the other three sites. All five sites were planted by the grower with a small amount of starter fertilizer. Each location utilized a randomized-complete block design with 14 different fertilizer treatments.

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 when the corn was about 12 inches tall. The other six treatments were three different scenarios of ESN fertilizer. One scenario utilized two rates (90 and 120 lb N/acre) of normal release ESN applied near the time of corn emergence, while the second scenario was the same as the first but a slower release form of ESN was used. In the third scenario, the same two total N rates (90 and 120 lb N/acre) were applied in a 50:50 split application of N with normal ESN applied near the time of corn emergence and UAN applied when the corn was about 12 inches tall. All UAN treatments were applied in a dribble band, while the ESN was broadcast. None of the ESN treatments were incorporated at any of the sites except Site SI, which was row cultivated after the initial application but before the sidedress application. For all corn studies, 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.

Total rainfall was above normal for Delaware in 2006, however, it is important to point out that one rainfall event on June 24 and 25 resulted in anywhere from a few inches to more than 20 inches over a 36-hour period. Nearly 15 inches of rain was measured near Site SI from this event. At Site NCD (no-till field), the rainfall amounts were great enough to move large amounts of wheat and soybean residues and movement of ESN prills did occur at this site.

The corn at Site SND showed visual signs of severe drought stress during the early stages of reproductive growth, while Site SSD showed some visual signs of drought stress. Sites SIZ, SND, and NCD showed visual signs of N stress throughout the growing season, while Site KI showed little, if any, visual signs of N stress during most of the season. Figure 3 shows the yields observed with the eight different rates of sidedressed UAN, while Figure 4 shows the yields of the ESN treatments relative to the QRP (quadratic response and plateau) modeled yields of the UAN sidedress treatments. For all five sites, none of the various ESN treatments were significantly greater yielding than the standard UAN sidedress treatments. At Site NCD (silt loam soil), the normal ESN yields did have greater yields than the UAN treatments, but these differences were not statistically significant. Overall, these results are similar to previous results on sandy soils, which suggest that sidedressed UAN should be considered the best BMP for managing N on these soil types.

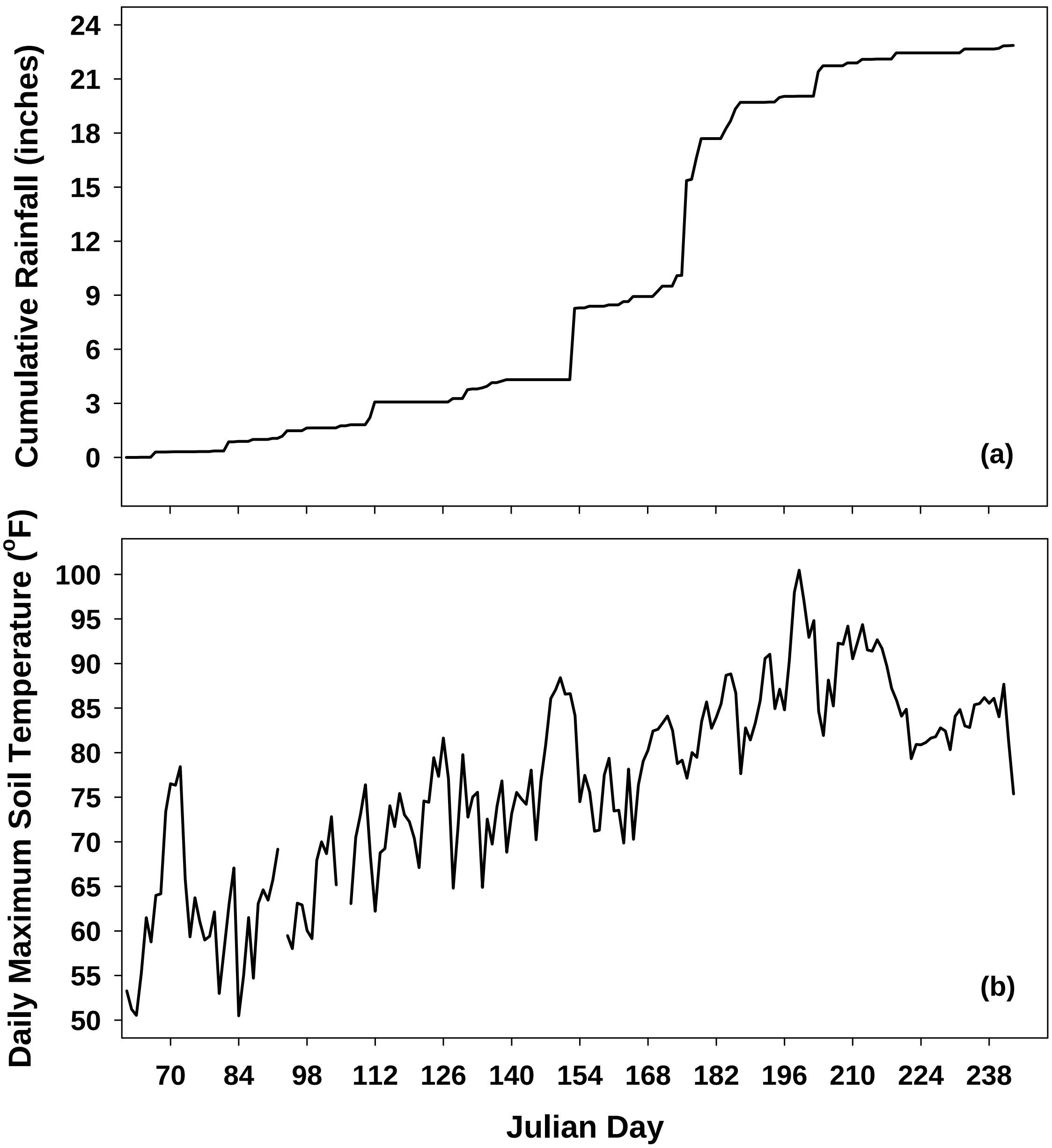

Figure 1. Cumulative rainfall (a) and daily maximum soil temperature (b) at the Research and Education Center near Georgetown, DE from March 1 to August 31, 2006.

Table 1. Grain yields of winter wheat at three Delaware sites in 2006.

		Winter Wheat Grain Yield		
Fertilizer Source[1]	**Nitrogen Rate**	**Site SI**	**Site NCD**	**Site SD**
	Lb N/acre	------------ bu/acre ------------		
UAN	75	116.9	111.3	56.2
UAN	90	126.2	108.7	62.7
UAN	105	136.9	114.5	60.4
UAN	125	146.8	112.7	60.5
50% ESN	75	126.3	108.4	56.6
50% ESN	90	131.7	111.5	54.9
30% ESN	75	125.3	111.7	53.9
30% ESN	90	139.1	109.6	60.6
	STATISTICS			
	P > F	0.0015	0.69	0.049
	CV (%)	4.9	4.5	7.0
	$LSD_{(0.10)}$	9.2	6.1	3.5

[1]**UAN** = 30-0-0 fertilizer; **50% ESN**=50/50 mix of ESN and ammonium nitrate; **30% ESN** = mixture that is 30% ESN and 70% ammonium nitrate

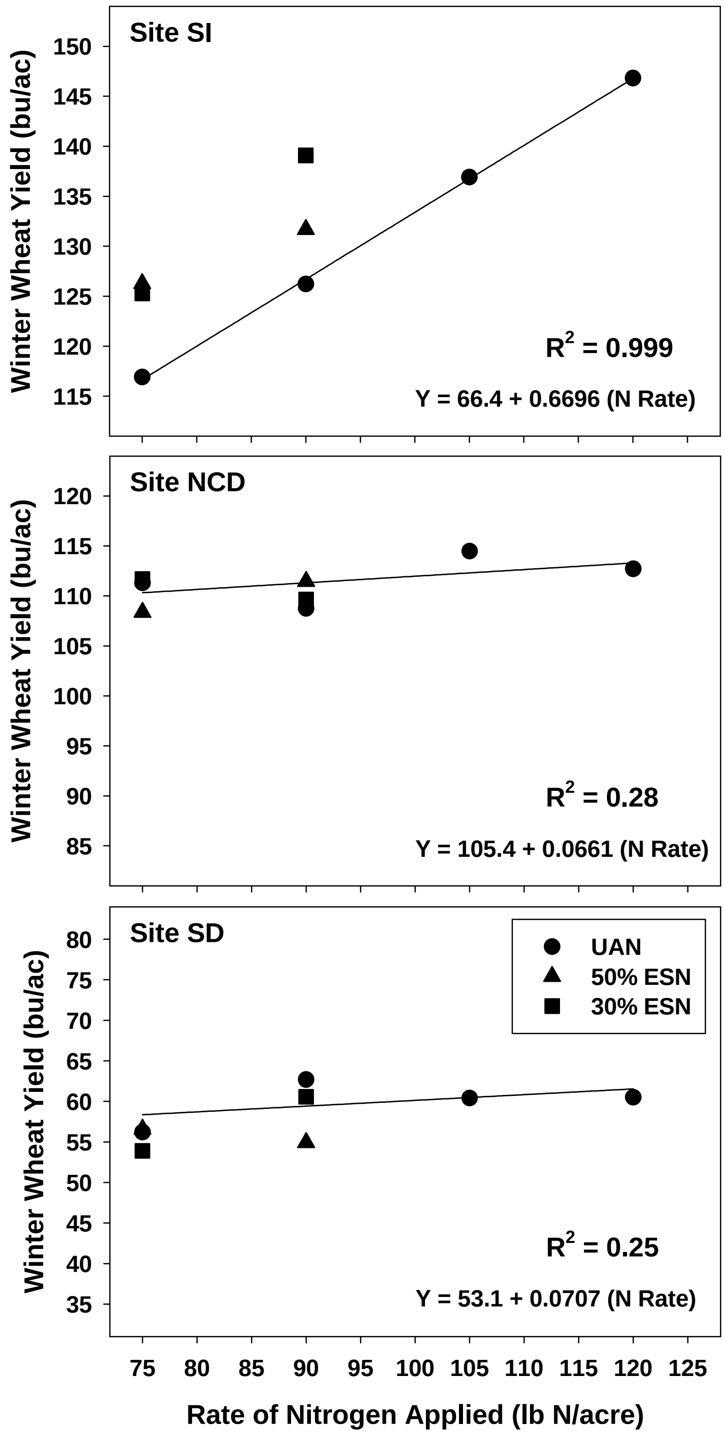

Figure 2. Grain yields of winter wheat for different N rates and N sources. The 50% ESN was 50:50 ratio of ammonium nitrate to ESN, while the 30% ESN was 30% ESN and 70% ammonium nitrate.

Table 2. Grain yields of corn at five Delaware sites in 2006.

Fertilizer Source[1]		Fertilizer Rate		Corn Grain Yield				
PP	SD	PP	SD	Site SI	Site NCD	Site KI	Site SSD	Site SND
		lb N/acre		-------------------- bu/acre --------------------				
None	UAN	0	0	130.5	137.9	174.3	94.1	71.0
None	UAN	0	30	141.9	171.8	189.1	103.6	88.7
None	UAN	0	60	186.7	186.3	189.7	108.0	96.1
None	UAN	0	90	184.4	192.8	192.8	116.2	123.6
None	UAN	0	120	192.8	199.1	193.5	114.8	143.9
None	UAN	0	150	194.3	204.1	195.9	121.5	113.0
None	UAN	0	180	191.1	212.1	200.0	126.3	126.0
None	UAN	0	210	195.3	204.2	193.5	118.9	134.0
ESNstd	None	90	0	176.7	199.8	188.1	105.5	115.3
ESNstd	None	120	0	161.3	213.1	187.2	112.5	93.9
ESNstd	UAN	45	45	183.1	193.3	191.3	121.3	109.0
ESNstd	UAN	60	60	192.7	193.8	185.5	119.8	86.1
ESNslow	None	90	0	178.1	205.6	196.5	109.6	75.5
ESNslow	None	120	0	178.8	197.1	190.1	113.2	83.4
				STATISTICS				
			P > F	0.0001	0.0001	0.0771	0.0004	0.0061
			CV (%)	8.0	8.2	4.8	7.5	25.8
			$LSD_{(0.10)}$	18.4	18.9	10.8	10.1	32.0
			Parameters for the QRP Model for UAN Response					
			Intercept	126.2	141.8	175.7	94.6	67.1
			Linear	1.061	0.894	0.387	0.286	0.860
			Quad	-0.00418	-0.00314	-0.00192	-0.00074	-0.00303
			Plateau	193.5	205.4	195.2	122.1	128.2
			N Max	126.9	142.3	100.8	192.7	142.1
			Ec Opt[2]	116.4	128.4	78.0	133.7	127.6

[1]PP=preplant, SD=sidedress; ESNstd=standard ESN; ESNslow=slower releasing ESN
[2]Ec Opt=Economic optimum using a corn price of $4/bu and fertilizer N price of $0.35/lb

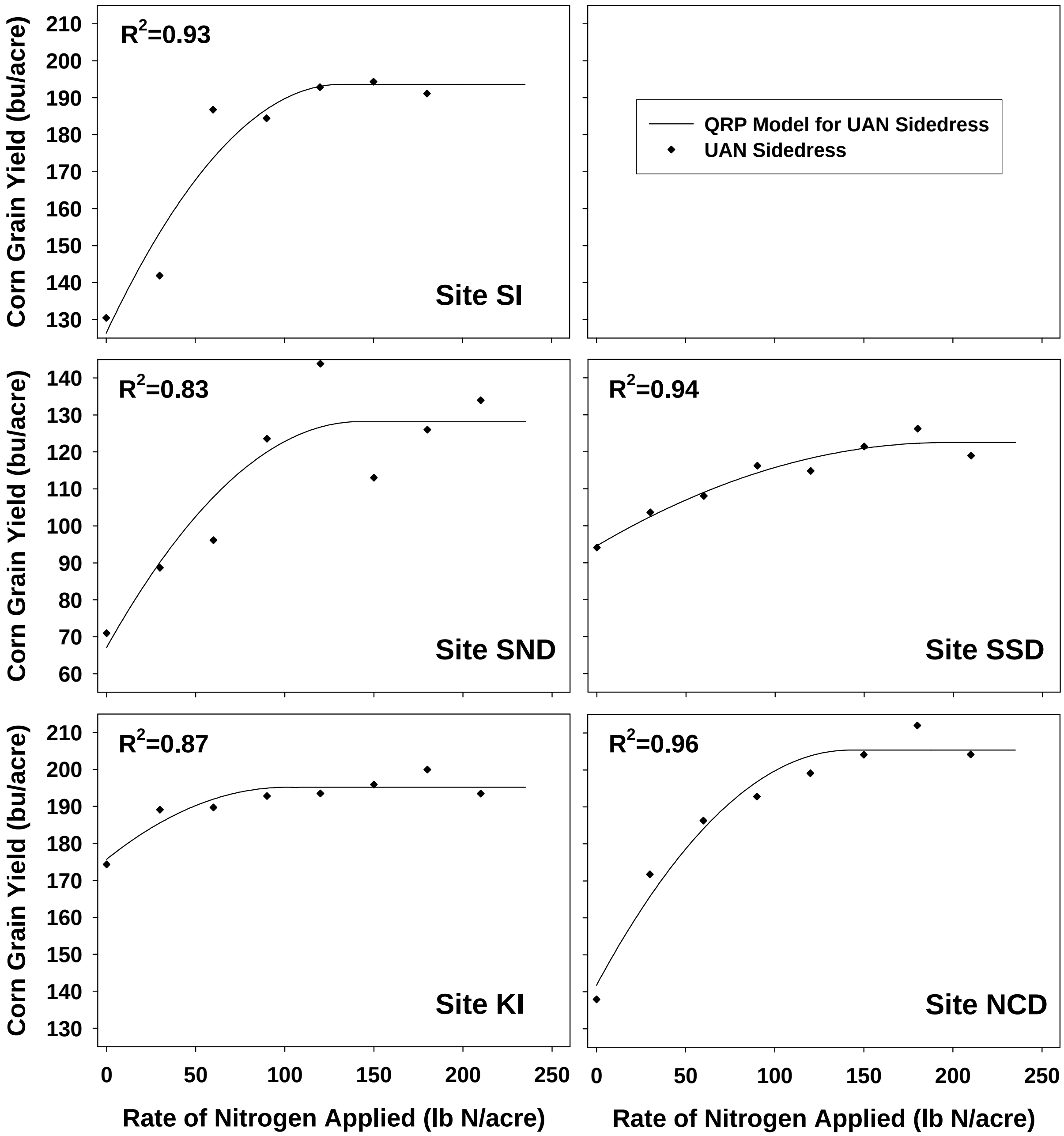

Figure 3. Grain yields observed for each rate of sidedress UAN applied at five sites in Delaware in 2006. The curve and R-square values are for the quadratic-response-and-plateau (QRP) model.

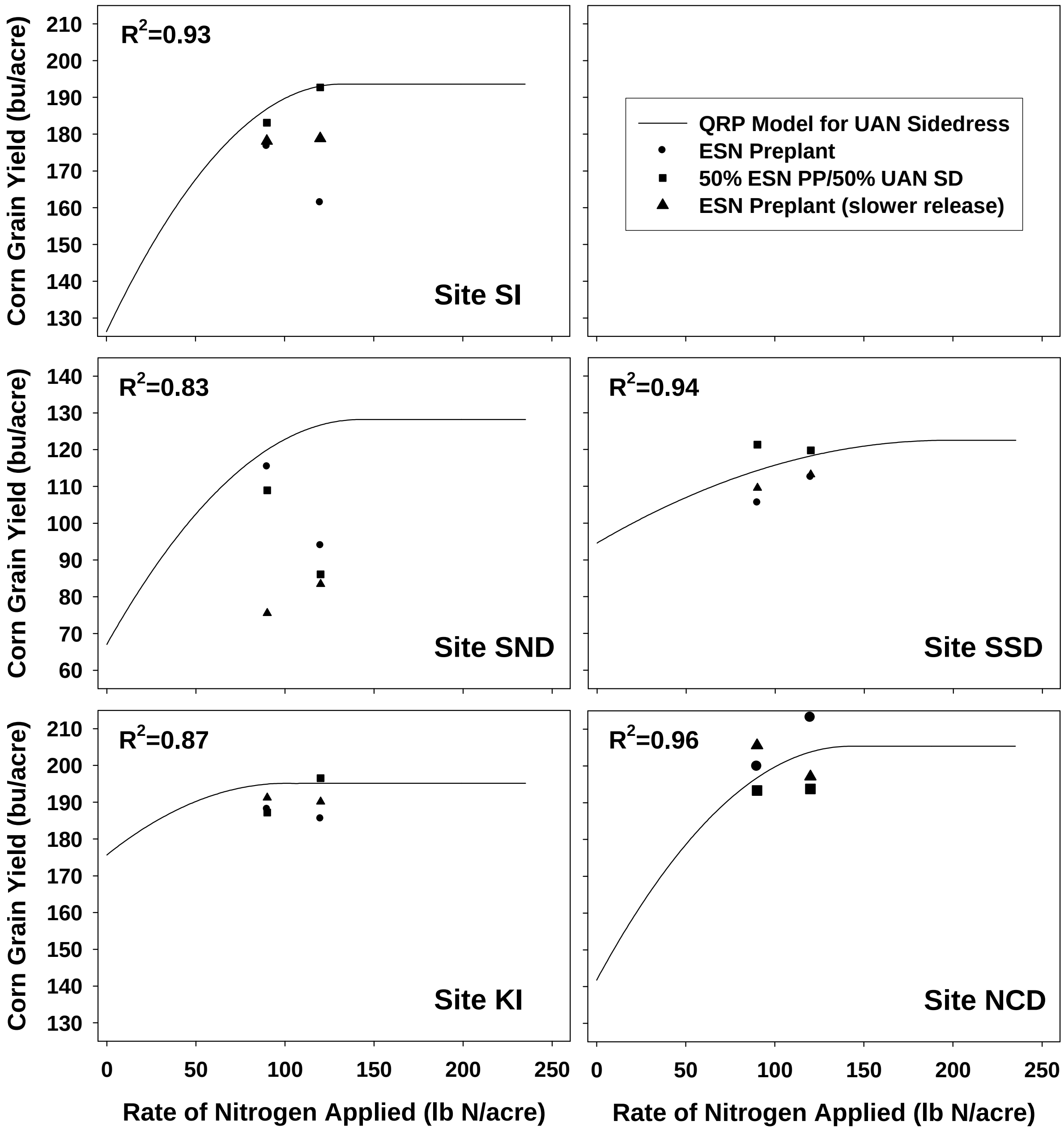

Figure 4. Grain yields observed for two rates and various combinations of ESN fertilizer and UAN fertilizer at five sites in Delaware in 2006. The curve and R-square values are for the quadratic-response-and-plateau (QRP) model of grain yield versus rate of sidedressed UAN (i.e., from the yield data shown in Figure 3).