NORTHEAST AGRICULTURE RESEARCH FOUNDATION

2012 Rates of Seed Placed ESN and Agrotain Treated Urea for Wheat;

2011 and 2012 Reports

Report compiled by: Anne Kirk

ABSTRACT:
Seed placed urea fertilizer causes damage to seeds and seedlings through ammonia toxicity. There are circumstances where producers may want to apply higher rates of N fertilizer than the guidelines for safe application allow. Treated urea products

such as ESN and Agrotain are of interest to producers because they are said to increase the amount of N that can be safely placed with the seed. The objective of this project is to demonstrate the increased safety of ESN and Agrotain treated urea over untreated urea fertilizer when placed with seed. This project took place over a two year period at Scott, Melfort and Swift Current. Untreated urea, ESN treated urea and Agrotain treated urea were placed with the seed at 20 (the maximum recommended safe rate for the equipment used), 40, 80 and 160 lb/ac. Urea was pre-banded on all treatments to bring the combined total N to 160 lb/ac. Increasing the rate of seed-placed N decreased plant density and wheat yield when data from all site years was combined. Increasing rates of seed applied N caused little damage to the wheat seedlings when significant amounts of rain were received shortly after seeding. ESN treated urea increased seed safety over both untreated urea and Agrotain treated urea. It is recommended that producers follow the guidelines for maximum safe rate of seed applied N.

Producer Group Sponsoring the Project:
Western Applied Research Corporation (WARC), Northeast Agricultural Research Foundation (NARF) and Wheatlands Conversation Area Inc. (WCA).

Project locations:
Agriculture and Agri-Food Canada (AAFC) Scott Research Farm, Scott, Saskatchewan; AAFC Melfort Research Farm, Melfort, Saskatchewan; and AAFC Semiarid Prairie Agricultural Research Centre, Swift Current, Saskatchewan.

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Objectives

To demonstrate the increased safety of ESN and Agrotain treated urea over untreated urea fertilizer when placed with seed.

Rationale

There is a wide variety of seeding equipment in use by farmers. Some equipment places seed very well but can only place fertilizer with seed (seed placed). There are limits on how much fertilizer, particularly urea nitrogen (N), that can be seed placed without damaging the seed. There are circumstances where farmers want to place higher rates of N with the seed than the guidelines for safe applicaton rates would allow.

While urea is not damaging to seedlings, urea converts to ammonia and ammonium which can cause severe damage to seedlings if seed-placed levels are too high. Treated urea products are marketed to provide increased seedling safety and may allow producers to place higher rates of N with the seed. Low solubility polymer coated urea or ESN slows the release of urea, decreasing the concentration of fertilizer in contact with the germinating seedling. Another option is to use Agrotain treated urea, which slows the conversion of urea to ammonium. For farmers who use or are contemplating using these products, a demonstartion like this provides a highly visible illustration of the benfits and limitations of the technology without the risk of doing this on a field scale.

Methodology

This project took place at Scott, Melfort and Swift Current in 2011 and 2012. This demonstration was replicated three times at each site and was set up as a factorial randomized complete block design. The two factors are urea type and rate of urea applied with the seed. Treatments included a check treatment with all urea pre-banded, and untreated urea, ESN treated urea and Agrotain treated urea applied at four rates (Table 1). The three types of urea were placed with the seed at 20 lb/ac (the maximum safe rate for the equipment used), 40, 80 and 160 lb/ac. Urea was pre-banded on treatments 1-4, 6-9, and 11-14 to bring the combined total N applied for each treatment to 160 lb/ac. Hard red spring wheat, var. Unity, was seeded at a rate of 330 plants m^{-2} in mid-May, with the exception of Swift Current in 2011 when seeding took place on June 9. Phosphorous was applied according to soil test recommendations and weed control was performed as necessary at each site.

Data collected included plant density two weeks after emergence, photos of treatments at two and five weeks after seeding, days to maturity and grain yield.

Results

Weather Conditions

Mean monthly temperatures and precipitation levels for each site year are reported in Tables 2 and 3. In both years of the trial temperatures in May and June were below normal at all location. Temperatures in July, August and September were normal or above average at all locations in both years. May to September precipitation levels were above average for Melfort in 2012, Scott in both years and Swift Current in 2011. Melfort 2011 experienced lower than normal precipitation and Swift Current 2012 experienced about average precipitation.

Table 1: Amount (lb/ac) of nitrogen fertilizer pre-banded, applied with the seed and urea treatment of the 15 treatments at Scott, Melfort and Swift Current.

Treatment	Pre-banded N (lb/ac)	N applied with seed (lb/ac)	Urea
1	160	0	untreated
2	140	20	untreated

3	120	40	untreated
4	80	80	untreated
5	0	160	untreated
6	140	20	ESN treated
7	120	40	ESN treated
8	80	80	ESN treated
9	0	160	ESN treated
10	140	20	Agrotain treated
11	120	40	Agrotain treated
12	80	80	Agrotain treated
13	0	160	Agrotain treated

Distribution of spring (May and June) precipitation varied across site years. May precipitation was below normal at Melfort in 2011, average at Scott and Swift Current in 2011 and above average at all sites in 2012. June precipitation was above average for all sites in both years of the study.

Table 2: Mean monthly temperatures for the 2011 and 2012 growing seasons and long-term (1971-2000) normals for Melfort, Scott and Swift Current, Saskatchewan.

Location	Year	May	June	July	August	September	Average
		---------- Temperature (°C)----------					
Melfort	2011	10.1	15.4	17.6	17	13.8	14.8
	2012	9.6	15.2	18.9	17.1	12.4	14.6
	LT[z]	10.8	15.7	17.4	16.4	10.5	14.2
Scott	2011	10.1	14.4	17	16.3	13.7	14.3
	2012	9.7	15.1	18.6	17	12.2	14.5
	LT	10.9	15.2	17	16.3	10.4	14.0
Swift Current	2011	9.5	14.3	11.4	18.4	16.5	14.0
	2012	9.4	15.5	20	19	13.9	15.6
	LT	11.1	15.6	18.1	17.9	11.8	14.9

[z]Long-term normal (1971-2000).

Table 3: Total monthly precipitation amounts for the 2011 and 2012 growing seasons and long-term (1971-2000) normal for Melfort, Scott and Swift Current, Saskatchewan.

Location	Year	May	June	July	August	September	Total
		---------- Precipitation (mm) ----------					
Melfort	2011	10.5	103.5	73.3	10.7	1.1	199.1
	2012	55.2	112.3	97.8	68.1	12.6	346.0
	LT[z]	45.6	65.8	75.7	56.8	39.9	283.8
Scott	2011	30.8	190.2	76.2	51.8	3.8	352.8
	2012	50.6	164.6	56.4	51.4	24.4	347.4
	LT	35.9	62.5	70.9	43.1	29.1	241.5
Swift Current	2011	56.9	117.3	48	45.4	3.9	271.5
	2012	98.3	107	17.2	8.2	6.1	236.8
	LT	49.5	66	52	39.9	27.6	235

[z]Long-term normal (1971-2000).

Plant Population

Increasing the amount of seed placed N decreased plant density for all urea types (Figure 1). ESN provided better seed safety than Agrotain and untreated urea at 20, 80 and 160 lb/ac seed placed N. At 40 lb/ac seed placed N there was no difference between ESN and Agrotain treated urea (Figure 1).

Treatment differences were significant at all locations except Melfort in 2012 where N rate and type of urea did not affect plant density (Table 4). Averaged across seed placed N rates, greater plant densities were achieved with ESN compared to untreated urea at four of the five sites that had significant treatment differences. Agrotain treated urea resulted in a greater plant density than untreated at only one site, and ESN treated urea resulted in greater plant density than Agrotain at three of the five sites. Averaged across all site years, ESN treated urea resulted in a greater plant density than untreated and Agrotain treated urea.

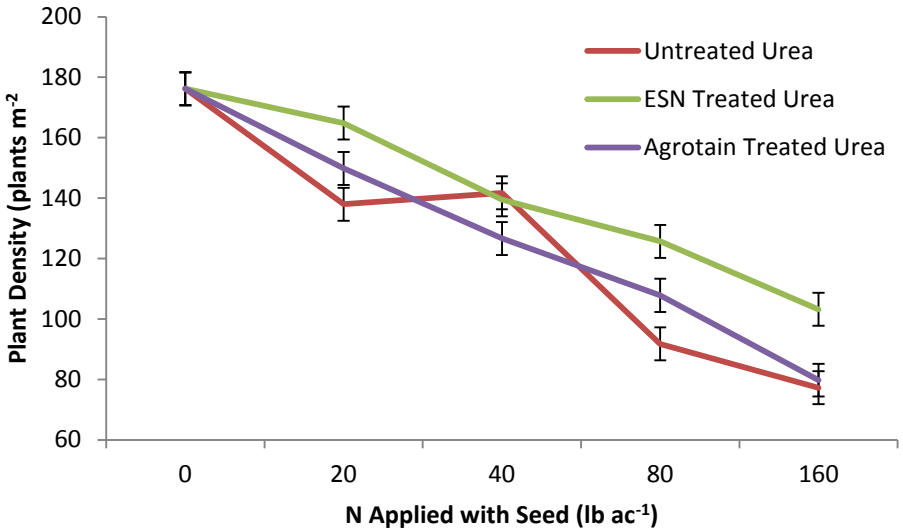

Figure 1: Treatment effects on spring plant density, averaged across six site years.

Table 4: Treatment effects on spring plant density at each of the site years and when site years are combined.

Treatment			Site						
	Nitrogen applied with		Scott		Melfort		Swift Current		All Sites
No.	seed (lb/ac)	Type	2011	2012	2011	2012	2011	2012	
			---------- plants m^{-2} ----------						
1	0	Untreated	172a[y]	196a	165a	187[z]	151a	186a	176a
2	20	Untreated	145bc	123cde	141abc	159	103bc	158abc	138bc
3	40	Untreated	89d	105de	152abc	236	110b	159abc	142b
4	80	Untreated	33ef	28gh	132bcd	186	28e	143bcd	92ef
5	160	Untreated	21ef	11h	91e	163	9e	168ab	77f
6	20	ESN	163ab	175ab	171a	214	142a	125cd	165a
7	40	ESN	126c	110de	169a	194	103bc	134bcd	139bc
8	80	ESN	98d	83ef	154abc	198	109b	112d	126c

9	160	ESN	42e	60fg	161ab	159	86c	112d	103de
10	20	Agrotain	141bc	157abc	144abc	192	115b	150abcd	150b
11	40	Agrotain	76d	138bcd	123cd	180	100bc	141bcd	127c
12	80	Agrotain	39e	87ef	128cd	191	55d	147abcd	108d
13	160	Agrotain	11f	17h	106de	171	22e	152abcd	80f
Contrasts[1]			---------- p-value ----------						
Untreated vs ESN			***	***	***	n.s.	***	**	***
Untreated vs Agrotain			n.s.	***	n.s.	n.s.	n.s.	n.s.	n.s.
ESN vs Agrotain			***	n.s.	***	n.s.	***	*	***

[y]Means within the same site year followed by the same letter within a column are not significantly different (P>0.05) according to Fischer's protected LSD.
[z]Means are not significantly different (P>0.05) according to Fischer's protected LSD.
[1]Contrasts: n.s. (not significant at P<0.05), *(P<0.05), **(P<0.01), ***(P<0.001)

Days to Maturity

Days to maturity were measured at Scott in both years and at Swift Current in 2012. Scott 2012 days to maturity data was not completed due to hail. There was no effect on days to maturity for any of the urea treatments or fertilizer rates at Scott in 2011 and Swift Current in 2012 (data not shown).

Grain Yield

Increasing the amount of seed placed N to two times the recommended safe rate did not result in a yield loss when data was combined across locations (Figure 2). At 80 lb/ac seed placed N untreated urea yielded significantly less than treated urea. At 160 lb/ac seed placed N the ESN treated urea yielded significantly greater than untreated and Agrotain treated urea. While yield declined as N rate increased for all treatments, the rate of decline was lessened with ESN treated urea (Figure 2).

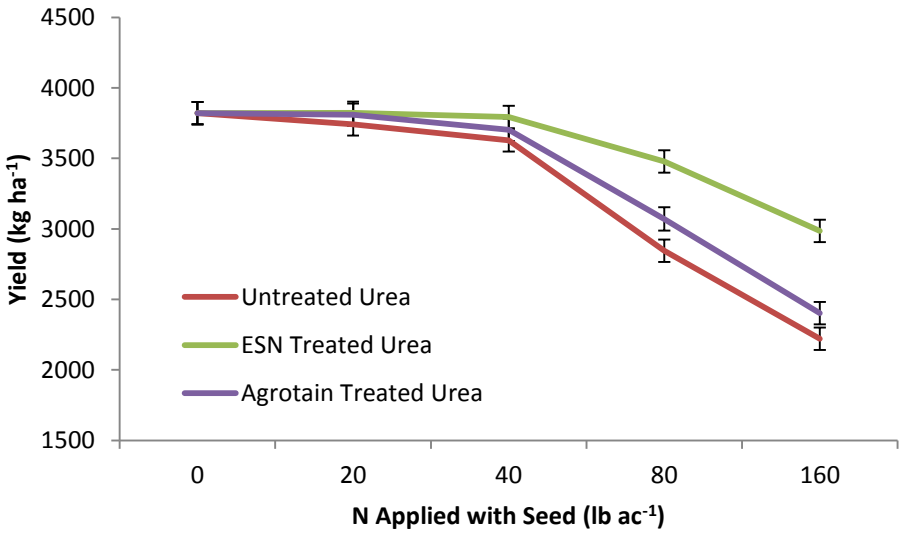

Figure 2: Treatment effects on grain yield, averaged across six site years.

Treatment differences were only significant at Scott and Swift Current in 2011, there was no significant yield difference between treatments at Melfort in both years and Swift Current in 2012 (Table 5). In 2012 the Scott site was unable to be harvested due to hail shortly before maturity. A substantial amount of rain was received shortly after seeding at Melfort in both years of the trial and at Swift Current in 2012. Nitrogen is very mobile in the soil, therefore a large amount of rain would flush N out of the seed row and reduce the damaging effects of seed placed N on the germinating wheat seed.

Significant treatment differences were seen when all site years were combined. Averaged across seed placed N rates, treated urea yielded significantly higher than untreated urea, and ESN yielded higher than Agrotain treated urea (Table 5).

In 2011 this project was presented at the Scott Field Day held on July 13 and approximately 200 people were in attendance. Due to poor weather we were not able to take the attendees to the location of the demonstration, but an indoor presentation on this project was done. The 2011 results of this project were written up in a WARC research update in the fall 2011 issue of the CCSA Prairie Steward Newsletter, presented at the Agronomy Research Update in Saskatoon in December 2011 and presented at the Crop Opportunity and Scott Research Update on March 8, 2012.

The 2012 Swift Current field day, held on July 12, had approximately 110 people in attendance. Although an official stop at this demonstration was not made, attendees were able to view the demonstration. Stops were made at the Swift Current site as part of the Patterson Grain field tour held on July 13 (25 people in attendance) and at the Viterra Diagnostic School held on July 17 and 23 (26 people in attendance). An official stop at this demonstration was not made at the 2012 Scott Field Day due to flooding around the trial area, but a small group of people that were interested in this demonstration were taken to the trial location after the field day.

Table 5: Treatment effects on grain yield at each of the site years and when site years are combined.

Treatment			Site						
	Nitrogen applied with		Scott		Melfort		Swift Current		All Sites
No.	seed (lb/ac)	Type	2011	2012	2011	2012	2011	2012	
			---------- kg ha^{-1} ----------						
1	0	Untreated	4973ab	-	5278	3030	3617a	2208	3821a
2	20	Untreated	4841abc	-	5415	2921	3421a	2108	3741a
3	40	Untreated	4436c	-	5051	2941	3351a	2362	3628ab
4	80	Untreated	2094e	-	5022	3149	1799c	2156	2844d
5	160	Untreated	409g	-	5215	3121	345e	2016	2221e
6	20	ESN	5018a	-	5258	2857	3584a	2401	3824a
7	40	ESN	5028a	-	5289	2998	3352a	2300	3793a
8	80	ESN	3794d	-	5037	3064	3447a	2050	3478b
9	160	ESN	1532f	-	4955	3130	3360a	1947	2985cd
10	20	Agrotain	5001a	-	5251	3185	3373a	2234	3809a
11	40	Agrotain	4459bc	-	5371	2988	3470a	2220	3702a
12	80	Agrotain	1820ef	-	5479	3187	2592b	2273	3070c

13	160	Agrotain	525g	-	5267	3155	1137d	1924	2402e
Contrasts[1]				---------- p-value ----------					
Untreated vs ESN			***	-	n.s.	n.s.	***	n.s.	***
Untreated vs Agrotain			n.s.	-	n.s.	n.s.	***	n.s.	*
ESN vs Agrotain			***	-	n.s.	n.s.	***	n.s.	***

[y]Means within the same site year followed by the same letter within a column are not significantly different (P>0.05) according to Fischer's protected LSD.
[z]Means are not significantly different (P>0.05) according to Fischer's protected LSD.
[1]Contrasts: n.s. (not significant at P<0.05), *(P<0.05), **(P<0.01), ***(P<0.001)

Conclusions and Recommendations

Increasing rates of seed applied N resulted in decreased plant populations and yield when data from all site years was combined. The different responses to rate of seed placed N and urea products across sites can be explained by the different environmental conditions at each site. Increasing rates of seed applied N caused little damage to the wheat seedlings when significant amounts of rain were received shortly after seeding. Excess moisture would flush soluble N away from the root zone of the seedling, preventing the urea from becoming extremely toxic and reducing plant stands and yields drastically.

ESN treated urea increased seed safety over both untreated urea and Agrotain treated urea. The magnitude of the effect of ESN varies between site years and may be dependent on temperature and moisture conditions at each site. ESN fertilizer has a polymer coating that allows water to enter the urea granule and dissolve the N. Soil temperature and moisture control the release of N from ESN. When precipitation levels are high after seeding it is expected that N would be released faster from the polymer coating.

It is recommended that producers follow the guidelines for maximum safe rate of seed applied N. Although treated urea products can provide increased seed safety, environmental conditions will largely affect release of N and seed and seedling damage. The sites included in this demonstration experienced higher than average spring precipitation in both years of the study. When spring conditions are dry the toxicity of seed placed urea will increase.

Acknowledgements

We would like to express our gratitude to the Ministry of Agriculture for the funding support for this project. To recognize the ADOPT program and the Ministry each organization had a sign in front of the plot demonstration. When this project is presented at meetings and included in newsletters the funding from the ADOPT program is acknowledged.