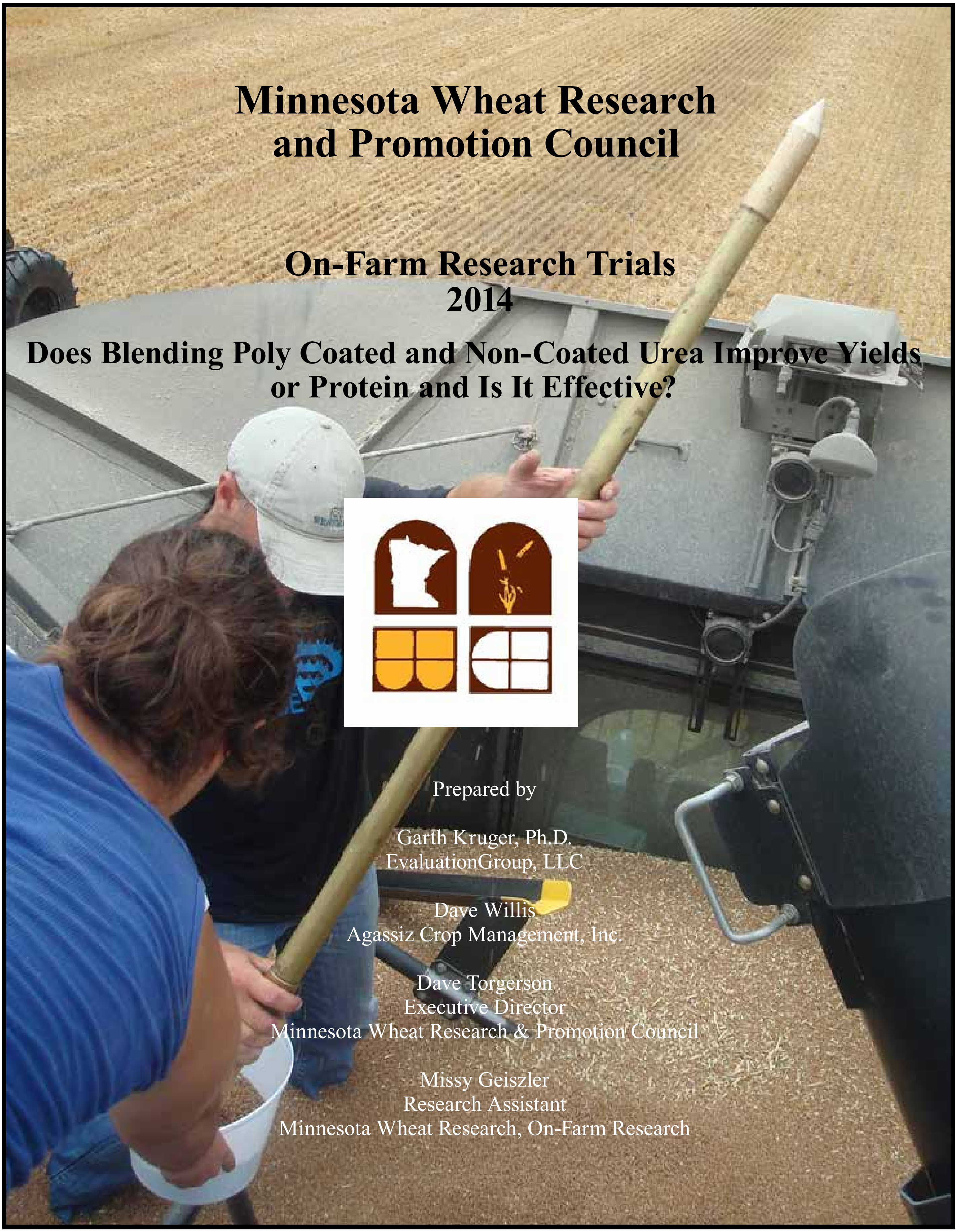

Minnesota Wheat Research and Promotion Council

On-Farm Research Trials 2014

Does Blending Poly Coated and Non-Coated Urea Improve Yields or Protein and Is It Effective?

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Does Blending Poly Coated and Non Coated Urea Improve Yields or Protein and Is It Cost Effective?

Background [1]

Relevant Current/Past Nitrogen Research

The Poly Coated Urea (PCU), commercially known as Environmentally Smart Nitrogen (ESN, 44-0-0), (produced by Agrium, Inc.) has been available to farmers since 2007 and been widely used in the grass/turf seed industry for many years. Other newer coated slow release urea polymers are Polyon (Agrium) and Nutricote (Chisso-Ashahi Fertilizer Co., Ltd., Tokyo, Japan). ESN is the most studied PCU to date.

Poly coated urea consists of a urea granule covered with a synthetic resin (aka polymer) to prevent the release of urea from the coated seal until temperatures exceed 50 degrees and adequate moisture levels are reached. Laboratory incubation experiments have shown that release of ammonium and nitrate nitrogen is slowed when PCU products are used compared to urea.[1]

Studies have suggested that temperature, moisture (current and anticipated), timing of application, placement, handling and soil types should all be taken into consideration when using PCUs.[8]

Test strip harvesting: 2014

Temperature and Moisture

Higher daily peak temperatures cause greater release rates of N for PCU fertilizers, especially when applied to a bare soil surface. Variations in rainfall timing and amount also have an impact. In "wet" years (>13 in. rainfall during the 15-week period after ESN is applied), the product has been found to effectively reduce losses of nitrogen. But there is a decreased performance of ESN when surface applied during "dry" years (<10 in. rainfall) where full release of nitrogen from the product does not occur due to lack of moisture.[2]

Timing of Application

In cooler summer weather, ESN used as a spring fertilizer may release too slowly when used exclusively. In general, most of the nitrogen from ESN is released between approximately 4-8 weeks after application under warm moist temperatures.[3]

Placement and Handling

Some research suggests that putting ESN in the soil with seed at planting time produces the best outcomes across the widest environmental conditions. Soil placement puts the ESN in contact with moisture and provides it with more stable temperatures. Approximately 50-80lbs of ESN (and possibly more) can be safely planted with the seed without hurting yields. However, if surface temperatures and moisture are not extreme, broadcasting ESN can be effective if it is carefully handled so as to not fracture the poly coating. [4] Two studies exploring ESN damage during fertilizer mixing and loading using air-flow spreaders found average damage rates of 13-24%.[5,6]

In years with normal or below normal precipitation, a single preplant application of ESN has been found to be as effective as or more effective than side dressing or split applications of ammonium sulfate or urea. Although, during high rainfall years split applications of ammonium sulfate has outperformed preplant ESN. [9]

Soil Type

A review of ESN studies indicates that soil type, soil pH, porosity, microbial activity, history of previous crop(s) and tillage practices may all influence performance, however little work has been done examining these factors. One recent study from the University of Minnesota found that in lighter soils, the current best management practice of splitting nitrogen applications performed at least as well as ESN.[7]

ESN Yield/Protein Outcomes: Past findings

Some studies have found yield and/or protein advantages to using ESN, while others have been less conclusive.

» Very few studies focus on hard red spring wheat. Kaiser (2010) studied urea versus ESN during the 2008 and 2009 growing seasons and found Urea out-yielded ESN but ESN produced higher grain protein content.[10]

  o Yields were high (over 100 bu/ac whereas they fertilized for a 65 bushel yield goal including soil and past crop residual credits, suggesting that mineralization had occurred.

» They found no response differences between two different cultivars (Alsen and Knudson) on yield, protein and biomass accumulation relative to ESN or Urea.

» Both years in their study were cool and wet.

Urea and ESN were compared from 2007-2010 on HRSW at Thunder Bay and at New Liskeard, Ontario, Canada. Neither grain yields nor proteins varied with the two fertilizers in any of the years or locations. [11]

Only three studies using ESN on hard red spring wheat are provided at the Agrium Inc. website: http://www.smartnitrogen.com/. Bar charts show increased yields with ESN use but contain no significant contextual or research information.

One of the earliest studies comparing urea to ESN (2002) examined the timing of fertilizer treatments on winter wheat in Kentucky. Yields in this study were equivalent for ESN and urea applied in the fall. Very late winter applications of ESN appeared most effective. Applications of ESN later in the spring were not recommended because the slow release appeared to have reduced yield.[12]

Numerous studies of ESN on corn have been conducted. Some of the findings include:

- ESN was 21 bushels per acre higher over 4 years compared to Urea in a study of no-till corn production whereas ESN that was broadcast and incorporated was 3 bushels per acre higher in yield.[2]
- Another study found that ESN on corn yielded between 2 to 10 bu/ ac more compared to urea and UAN but found no difference compared to anhydrous.[13]

Gathering protein samples: 2014

Methods

- » This study examined yield and protein outcomes on hard red spring wheat comparing a 50% Urea 50% ESN blend to 100% Urea.
- » Each replication strip was +/- one acre.
- » There were 24 total sites over three years.
  - o 22 sites in 2012, 1 site in 2013, and 1 site in 2014.
- » All applications were in the spring with the exception of one site that applied in the fall of 2013 for the 2014 season.
- » Randomized complete block design was used. A minimum of three replications were completed at each location (most had four).
- » There were a total of 100 replications using the 50/50 blend and 100 using 100% Urea.
- » Sample yields were standardized to 13.5% moisture and 60lb test weight.
- » Participants were paid $1,500 to help meet costs associated with their involvement in the study in 2014. In 2012 and 2013, no participation incentives were given.
- » Participants were responsible for purchasing the ESN, applying it and conducting all fieldwork according to research protocols.

Weather Conditions

* In 2012 weather conditions were warm and dry with little or no major nitrogen loss observed at any of the research locations.

* 2013 was an exceptionally wet and late spring. Later in the season it grew extremely dry at the participating site. Adding to the challenge was that a number of local suppliers were unable to deliver ESN, even to those who had pre-paid. This forced all but one participant to drop out.

* 2014 was another wet spring that made it difficult to get crops planted. Many suppliers stopped handling ESN, thus a number of individuals withdrew from the study. One study participant from the Red Lake Falls area was able to conduct both a fall and a spring applied study in 2014. Precipitation and temperature data by month at this site are shown in Table 1 on page 39.

Results

Table 2 shows the average yields and proteins for each of the three years of the study to date.

Table 2

	Average Yield		
	2012	**2013**	**2014+**
ESN/Urea	70.86	49.71	92.78*
Urea	70.80	49.66	88.57
	Average Protein		
	2012	**2013**	**2014**
ESN/Urea	13.83	13.67	14.13
Urea	13.76	13.44	14.05

+ spring applied plot only included in data presented for consistency with previous years.
* $p<.05$, sig difference between means 2012=22 sites, 2013=1 site, 2014=1 site

A paired samples t-test comparing 2012 average yield between 100% urea and 50/50 ESN/Urea found no significant differences on yields (M=70.80 for Urea, M=70.86 for ESN) ((t (88) = -.090, p>.05). In 2012 the average protein for Urea was M=13.76 and for Urea/ESN blend it was M=13.83. This difference was also not significant ((t88) = 1.13,p=.26). Similarly, in 2013 there was no significant difference on either yield or protein.

Table 1.

2014 Precipitation (in inches) by Month-RLF					
Precipitation	**April**	**May**	**June**	**July**	**August**
RLF Site	4.20	4.50	11.50	4.35	3.60
Historical Average	*1.26*	*2.99*	*4.49*	*3.35*	*3.82*
Diff From Ave	***+2.94***	***+1.51***	***+7.01***	***+1.00***	***-0.22***

Temperature by Month-RLF					
Temp	**April**	**May**	**June**	**July**	**August**
RLF Site	36.8	52.6	64.9	66.1	67.75
Historical Average	*42*	*55*	*64*	*68*	*67*
Diff From Ave	***-5.2***	***-2.4***	***0.9***	***-1.9***	***0.75***

In 2014, the plot in Red Lake Falls found an increase of 4.2 bushels/acre using the ESN/Urea blend in the spring as shown in Table 2. This difference was significant at the p<.05 level. However, in the same field, the identical fertilizer regimen was applied in the fall and produced a 2.24 bu/ac increase for urea see Table 3 (site 24). This finding was only significant at p<.20, which is a fairly liberal threshold.

Data for each of the 24 sites throughout the three-year study are shown in Table 3. Variety, protein and yields are presented along with significance tests conducted between those receiving the 50/50 ESN/Urea blend versus 100% urea.

Table 3.

2012-14 On Farm Research Hard Red Spring Wheat Trials Comparing a 50%ESN/50% Urea blend to 100% Urea.								
Site	**Year**	**Cooperator**	**Variety**	**Treatment**	**Yield (Bu/A)**	**Sig**	**Protein %**	**Sig**
1	2012		RB07	ESN/Urea	66.48	0.42	14.70	0.59
				Urea	68.57		14.62	
2	2012		RB07	ESN/Urea	69.33	0.68	14.52	0.52
				Urea	70.52		14.45	
3	2012		Vantage	ESN/Urea	68.11	0.62	15.04	0.28
				Urea	69.88		14.95	
4	2012	Argyle	Barlow	ESN/Urea	66.31	0.45	14.30	0.79
				Urea	63.42		14.32	
5	2012	Argyle	Barlow	ESN/Urea	74.27	0.95	13.25	0.31
				Urea	74.14		13.55	
6	2012	Argyle	Faller	ESN/Urea	67.97	0.95	13.75	0.09*
				Urea	69.56		14.05	
7	2012	Stephen	Faller	ESN/Urea	83.64	0.12 +	14.07	0.01+
				Urea	80.89		13.87	

8	2012	Stephen	Faller	ESN/Urea	78.37	0.1*	14.22	0.14^{+}
				Urea	82.39		14.02	
9	2012	Stephen	Faller	ESN/Urea	81.40	0.06*	14.05	0.31
				Urea	82.84		13.92	
10	2012	Stephen	Faller	ESN/Urea	82.83	0.57	14.00	1.00
				Urea	84.34		14.00	
11	2012	Warren	Faller	ESN/Urea	55.54	0.84	13.15	0.84
				Urea	54.95		13.25	
12	2012	TRF	Faller	ESN/Urea	81.90	0.85	13.52	0.72
				Urea	81.70		13.47	
13	2012	TRF	Faller	ESN/Urea	81.63	0.09^{+}	13.87	0.32
				Urea	79.50		13.87	
14	2012		RB07	ESN/Urea	70.13	0.02^{+}	15.22	0.18*
				Urea	68.38		15.27	
15	2012		Barlowe	ESN/Urea	68.82	0.83	12.52	0.61
				Urea	67.82		12.77	
16	2012		Barlowe	ESN/Urea	84.47	0.31	13.02	0.33
				Urea	82.60		13.22	
17	2012		Faller	ESN/Urea	67.85	0.70	13.12	0.65
				Urea	67.22		12.90	
18	2012		RB07	ESN/Urea	50.25	0.22*	12.45	0.01*
				Urea	52.00		13.45	
19	2012		Faller	ESN/Urea	66.77	0.95	13.82	0.30
				Urea	66.70		13.67	
20	2012		Faller	ESN/Urea	76.05	0.50	12.75	1.00
				Urea	74.57		12.75	
21	2012		RB07	ESN/Urea	53.80	0.68	12.62	0.14*
				Urea	53.05		13.72	
22	2012		RB07	ESN/Urea	63.00	0.58	14.87	0.86
				Urea	62.50		14.95	
23	2013	Warren	Norden	ESN/Urea	49.71	0.95	13.67	0.42
				Urea	49.66		13.44	
24	2013 Fall	R. Lake Falls	Mayville	ESN/Urea	76.20	0.2*	14.38	0.62
				Urea	78.44		14.35	
24	2014	R. Lake Falls	Mayville	ESN/Urea	92.78	0.03^{+}	14.13	0.76
				Urea	88.57		14.05	

$^{+}$ 50% ESN/50% Urea blend significantly higher (at p-value indicated) than 100% urea

* 100% Urea significantly higher (at p-value indicated) than 50% ESN/ 50% Urea blend

Cost/Benefit Analysis

Participants in this study used a 50% blend of Urea and ESN to help control some of the costs and potentially capture some of the benefits purported to be expressed by ESN. The costs of Urea and ESN are as follows:

Product Costs

- Urea $550/ton ($60 per 100 lbs/N, 46%N)
- ESN $675/ton ($73 per 100 lbs/N, 44%N)
  - ESN pricing is usually approximately $0.20/lbs of N premium over urea.

Per Acre Costs

- $99.75 using the 50/50 ESN/Urea blend for 150 lb/N
- $90 for 150 lbs/N using Urea
  - $9.75 per acre difference in cost.
- At 5$ a bushel, 50/50 blend has to do 2 bu/ac better to pay for itself.
- At 7$ a bushel, the blend has to do 1.4 bu/ac better.

- Of the three years under study, only the 2014 site/year appears to have provided any economic return. The ESN/Urea blend in 2014 produced an extra 4.2 bushels/acre for a net profit of $11.25/Ac ($5/bu wheat * 4.2 = $21 benefit, minus $9.75 added cost for ESN).

- Ransom (2014b), studied ESN and other nitrogen inhibiting products in 2012. His trials in Northern Minnesota/North Dakota found that the extra cost incurred for any nitrogen inhibiting additives was not returned. [14,15]

- A return on investment calculator for ESN is located on the Agrium website. While it provides broad guidance about utility of the product under certain environmental conditions, it lacks a degree of specificity that would give it greater utility in making on farm management decisions.

Discussion

Does ESN Improve Yields or Protein?

It may improve both given the right conditions.

Given the significantly wetter conditions throughout the growing season at the Red Lake Falls site it was not unexpected to have a significantly higher yield in the ESN condition in this study in 2014. Weather data for the month of June suggests that significant denitrification likely occurred at Red Lake Falls. Across all months, average precipitation was higher than the historical average, but in June it was 7 inches greater. The growing season also exhibited slightly cooler to average monthly temperatures. Weather conditions in 2012 and 2013 did not favor N responses through the use of ESN because little denitrification appeared to have occurred.

No significant improvements in protein were demonstrated in any of the years.

Is ESN Cost Effective?

It can be, given the right environmental conditions. Judging when those conditions may occur, and timely application is the challenge.

- In two out of three years (2012 and 2013) of this study, producers lost approximately $9.75 per acre using a 50/50 ESN blend.
  - Our findings generally support Dr. Joel Ransom, NDSU Extension who finds that in the environments they tested, the extra cost of additives is not justified.[14,15]

In 2014, there was an economic benefit of $11.25/acre in this study.

Our findings suggest that there are a number of environmental (weather) and soil conditions that must be considered before using ESN to achieve positive economic outcomes.

- Increased yields and fertilizer nitrogen recovery may occur in wetter years on sandier soils.
- Lower probability of payback in years with excessive early season rainfall or significantly dry or cool years.

Future Directions

- √ Very few ESN studies focus on spring wheat, and even fewer have rigorously collected weather data accompanying their findings.
- √ Few if any differences between the nitrogen needs of a wide range of cultivars have been explored.
- √ PCU performance by soil type(s) and product placement has generally not been conducted to assess the varying rates of denitrification.

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[1] The mission of the NWMN On-Farm Research collaborative is to address priority production concerns through field scale research. Activities are funded through support from the Minnesota wheat check-off and the Minnesota Department of Agriculture.