Minnesota Wheat Council – On-Farm Research Network

A Final Report for the 2016 Growing Season

By

Lauren Proulx
MN Wheat, Agronomist, CCA and On-Farm Research Coordinator

and

Dr. Grant Mehring
MN Wheat Research Director
NDSU Dept. Plant Sciences & ND Corn Council

ON-FARM RESEARCH NETWORK MINNESOTA WHEAT

Minnesota Department of Agriculture

MInnesota Wheat Research & Promotion Council

ACKNOWLEDGEMENTS

The Minnesota Wheat Research and Promotion Council – On-Farm Research Network, is supported by the Minnesota wheat checkoff for a large portion of the operating budget. The Minnesota Department of Agricultural Growth, Research, and Innovation (MDA-AGRI) grant program has generously provided additional funds for this research.

The On-Farm Research Network (OFRN) has been impacted by the direction of the leadership within the program, and today's progress is in part owed to past leaders including Dave Willis, Dr. Garth Kruger, and Dr. Dave Grafstrom. The advisory committee to the OFRN, with members including Dave Willis, Dave Grafstrom, Tony Brateng, Tim Osowski, Steve Lacey, and Ryan Casavan, continues to be invaluable in providing steering to the direction of the OFRN.

We were fortunate to have some of the products needed for our research donated. This helped to control variability, reduce the time and costs associated with doing the trials for the participants, and increases our chances of a successful research season. The producers that we collaborate with want to do the research to get the answers they need. However, they often have work of a greater importance to their business going on at the same time as the trial work and as a result, the research may get eliminated. We put great focus on making the trials as efficient and streamlined as possible for the participants, so that we can to keep our success rate high and participants continuously willing to do research with us for years to come.

BASF donated 25 gallons of Limus, a urease inhibitor for the topdressing nitrogen trial. All but one of the topdress trial participants received the free product.

TeeJet Technologies donated their SJ3 fertilizer nozzles for the six topdressing trial participants who did not own them already and for two of Dave Grafstrom's small plot research sprayers.

Syngenta donated 25 gallons of Palisade EC for our plant growth regulator trial. Palisade is the newest plant growth regulator on the market and most widely used for wheat in the USA.

Lastly, the initiative and willingness of the growers who have been in the OFRN through hosting trials or providing support has been essential to our current successes. Without willing producers, looking to improve production on their operations, this network would not be what it is today. Their excitement and encouraging words keep us going.

http://www.lh-agro.de/english/home/products/spray-products/fertilizer-spray-nozzles/stream-jet--sj3-fertilizer-nozzles.aspx

TABLE OF CONTENTS

TOPDRESSING NITROGEN AS UAN NEAR THE BOOT GROWTH STAGE

INTRODUCTION

Wheat producers in Minnesota (MN) are applying nitrogen in quantities to reach maximum yield, with economically viable sources and equipment. A large proportion of producers put the entire wheat crops nitrogen requirement on at the pre-plant stage, in either the fall or spring. With knowledge of the wheat plants nitrogen use timeline, research has shown that sidedressing or topdressing nitrogen applications might result in maximum yields, though not always enough to pay for the extra application costs associated with two nitrogen applications. Past small plot research at North Dakota State University (NDSU) has found that a UAN topdress at the boot stage, which is later than previously recommended, might be a practice to benefit both protein and yield.

The objective of this research is to compare the application of 100% nitrogen at the pre-plant timing with 100% nitrogen at the pre-plant timing plus 30 lbs acre^{-1} of nitrogen as UAN with a urease inhibitor near the boot growth stage.

MATERIALS AND METHODS

This experiment was set up in 11 locations throughout NW MN in 2016. The site descriptions are in Table 1. There were two treatments in this trial, including 100% nitrogen rate at the pre-plant timing, and 100% nitrogen rate at the pre-plant timing plus an application of 30 lbs acre^{-1} of nitrogen in the form of urea ammonium nitrate (UAN) with the urease inhibitor Limus (BASF). All applications were made with 10 gallon per acre streaming nozzles to mitigate plant tissue phytotoxicity, also known as burning, from the nitrogen fertilizer. The pre-plant nitrogen application for each individual producer's optimum nitrogen rate was up to them, with his or her preferred nitrogen form and application methods. Additionally, nitrogen applications differed in that one producer used variable rates across the trial field while all others used a blanket N rate.

At all sites, the experiment was set up in a randomized complete block design, with between two and five replicates. The replicates were not always randomized, with treatments often alternating between the control and the treatment. The topdress nitrogen application was done by the participant as close to the boot stage as the field conditions and farm workload allowed. Knowing that the timing would be critical and difficult to have at the same exact timing at all fields, the general guideline for application was after the main stem had two nodes but before awns had protruded from the sheath. Additionally, the application was intended to be sprayed before a forecasted rain event. Rain gauges were installed and monitored by the producer, to understand rainfall amounts on the field, and specifically rainfall after the topdress application. Data from Climate Fieldview's website was also included and analyzed.

We took stand counts from multiple spots within each plot at almost all locations as a gauge of the producer's plant stand and overall field quality. We used producer machinery to harvest the trials and plot weights taken with a weigh wagon that we provided, with yields adjusted to 13.5% grain moisture. As the grain augured out of the weigh wagon into the truck, we collected sub-samples of the grain from each plot with an attachment to the weigh wagon's auger that takes a small stream of continuous grain from the grain off-loading through the auger. Sub-samples were immediately analyzed for harvest moisture and grain test weight with a Dickey John mini-GAC plus. Sub-samples were analyzed for grain protein at the Northern Crops Institute with a Perten NIR and adjusted to 12% moisture, providing accurate protein levels for each plot.

RESULTS AND DISCUSSION

Results from the 11 locations that could be taken to harvest are presented in Table 2. There is success in simply getting 11 producers to all apply topdress nitrogen applications during the difficult spray season that 2016 was. Topdressing nitrogen did not have an effect on the test weight of the grain, with average test weight across all environments registering quite high at 61.9 lb bu^{-1}. The application of topdress nitrogen did not improve yield above the control where no nitrogen was applied at the boot stage. There were two environments that when taken alone, had yield that was significantly impacted by the nitrogen application, however the results were opposite in the two environments.

Our initial hypothesis was that a late application of nitrogen at the boot stage could perhaps increase yield at the same time as protein, however this result was only seen at one environment. The environment where additional nitrogen decreased yield can be in part explained by within field variability, as this application of UAN is not known to have phytotoxic effects on the wheat plant. An increase in protein was the other expected result of this trial, and that result shined through. When combined over all 11 environments there was a 0.2%, or one-fifth, increase in protein when the topdress nitrogen was applied. Among all of those environments there were five that had between 0.4-0.6% increases with the topdress nitrogen, and five that had no increase, or even a non-significant numerical decrease in protein with the topdress N. When taken as a whole, the combined 11 locations did not produce enough extra protein with the topdress to warrant considering the extra nitrogen application in today's wheat market. However, the five locations that showed greater increases in protein levels with the topdress approached the increase needed to pay for the application if there is a sizeable protein premium/discount in place.

The results from the topdress N trials this year contrast with what was found in prior small plot research in North Dakota (ND) and MN. The environments the trial was done in during the 2016 growing season had a warm April. Farmers were able to get into the fields early and the nice weather likely increased the amount of nitrogen generated through mineralization so these plots were likely not short on nitrogen. With the results we saw in 2016, an alteration to the protocol for 2017 could be a true sidedress application where the preplant nitrogen is reduced in strips and then balanced out with an early season UAN application.

Table 1. Agronomic details for all 11 locations of the topdress nitrogen trial in 2016.

	Location										
	1	2	3	4	5	6	7	8	9	10	11
	Winger	Wylie	Crookston	Felton	Felton	Hendrum	Hendrum	Goodridge	Halstad	Red Lake Falls	Crookston
Planting Date	4/13	4/13	5/1	N/A	4/14	4/13	4/11	5/6	N/A	N/A	4/15
Harvest Date	8/9	8/8	8/14	8/6	8/7	8/2	8/2	8/22	8/8	8/3	8/7
Rainfall Total (in)	13.52	12.07	17.48	10.85	11.84	9.88	9.99	15.05	10.37	11.57	14.54
Rainfall 12 DPA[1] (in)	1.83	1.28	1.12	0.45	0.55	0.49	0.53	1.73	0.37	1.39	1.61
Previous Crop	Beets	Soybean	HRSW	HRSW	Soybean	Beets	Soybean	Soybean	Soybean	Soybean	Soybean
Soil Type	Hedman Fram	Reis Clear-water	Colvin Perella	Colvin Bearden	Wheatville Augsburg	Fargo Bearden	Fargo Colvin	Smiley	Reis Viking	Foldahl Wheatville	Bearden Colvin
Variety	Albany	Mayville	Linkert	Linkert	Linkert	Prosper	Linkert	Linkert	SY Valda	Linkert	Linkert
N Topdress Date	6/11	6/7	6/11	6/2	6/2	6/2	6/2	6/14	6/2	6/9	6/11
/Growth Stage	Feekes 9	Feekes 10	Feekes 6	Feekes 7	Feekes 7	Feekes 7	Feekes 7	Feekes 7	Feekes 7	Feekes 10	Feekes 10

[1] Days post-application of topdress UAN.

Table 2. Effect of topdressing nitrogen at the boot stage compared with no topdress of nitrogen on test weight, grain protein, and yield, at 11 diverse environments throughout NW MN and combined over all 11 environments.

Treatment	Location											
	1	2	3	4	5	6	7	8	9	10	11	Combined
	---lb bu-1---											
No Topdress N	63.5	64.1	60.3	60.2	62.9	61.1	62.3	60.1	62.5	62.0	63.7	62.0
With Topdress N	63.4	63.8	59.9	59.9	62.7	59.4	63.0	61.0	62.3	61.7	63.1	61.8
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	---%---											
No Topdress N	12.8	13.5	15.1	13.4	14.5	14.3	13.1	14.0	13.5	13.3	14.3	13.8
With Topdress N	12.7	13.5	15.2	14.0	14.9	14.8	13.2	14.5	13.9	13.6	14.2	14.0
LSD (0.05)	NS	NS	NS	0.51	NS	0.52	NS	0.43	0.24	0.17	NS	0.17
	---bu ac-1---											
No Topdress N	97.5	98.2	54.9	54.3	80.4	50.9	82.2	54.9	87.4	89.5	77.0	74.7
With Topdress N	99.1	99.0	55.8	58.3	76.0	51.3	81.9	55.9	88.3	89.1	73.4	75.4
LSD (0.05)	NS	NS	NS	1.59	2.12	NS	NS	NS	NS	NS	NS	NS

NS – non-significant difference at the 95% confidence level.
LSD – least significant difference, if the means differ by more than the LSD number the numbers are statistically different.

rate applied per gallon	weight per gallon	lbs product per ac @10 gal/ac	28-0-0 product cost per ac
10	10.67	106.7	19.72

Table 3. Economic analysis of the topdress nitrogen application of all locations individually and the combined analysis, NW MN, 2016.

	Location											
	1	2	3	4	5	6	7	8	9	10	11	Combined 11
	---%---											
No Topdress N Protein	12.8	13.5	15.1	13.4	14.5	14.3	13.1	14.0	13.5	13.3	14.3	13.8
With Topdress N Protein	12.7	13.5	15.2	14.0	14.9	14.8	13.2	14.5	13.9	13.6	14.2	14.0
Protein gain/loss	-0.1	0	0.1	0.6	0.4	0.5	0.1	0.5	0.4	0.3	-0.1	0.2
$ Protein gain/bu[1]	-0.04	0	0	0.24	0.08	0.1	0.04	0.1	0.16	0.12	-0.02	0.08
Topdress Yield	99.1	99.0	55.8	58.3	76.0	51.3	81.9	55.9	88.3	89.1	73.4	75.4
Total $ Gain topdress for protein/acre ($)	-3.96	0.00	0.00	14.00	6.08	5.13	3.28	5.59	$4.12	$0.69	-1.47	6.03
Application Costs 2bu/ac ($)[2]	36.12	36.12	36.12	36.12	36.12	36.12	36.12	36.12	36.12	36.12	36.12	36.12
Financial outcome ($)	-40.08	-36.12	-36.12	-22.12	-30.04	-30.99	-32.84	-30.53	-22.00	-25.43	-37.59	-30.09

[1] Protein premium of $0.04 per fifth above 14% up to 15%, and a protein discount of $0.08 per fifth below 14%.

[2] September wheat price of $4.20. Considering 2 bu/ac lost due to tire tracks from application.

Conclusions

The additional 30 lbs per acre of nitrogen as UAN in combination with a urease inhibitor, did not improve yield beyond the control, however did increase protein by 0.2% combined over all locations. Even if 0.5% protein increase was gained, as was found in at least two individual environments, without the additional yield this timing and application does not seem to make more sense than an equal application of nitrogen at the later post-anthesis growth stage, where between 0.5-1.0% protein increases are routinely gained, without significant change to yield. An additional year of research as robust as 2016 will help to solidify whether the boot stage topdress nitrogen application is an economically viable agronomic practice

PLANT GROWTH REGULATOR APPLICATION IN HRSW

INTRODUCTION

Significant attention has been paid in recent years to the negative aspects of growing tall or weak-strawed wheat varieties. Generally speaking, producers have options from between two classes of wheat varieties; semi-dwarf containing one of the two common semi-dwarf alleles, and wild-type or tall cultivars. Practically, producers would look to the heights reported in variety testing results to make decisions about plant height. In hard red spring wheat (HRSW), increased plant height is often associated with higher grain yield, though there are exceptions. Higher yielding HRSW varieties are often prone to lodging, where due to low straw strength, stem lodging takes a plant from being completely erect, to leaning over. Increased lodging will decrease plant yield. In addition to decreasing grain yield, lodging results in a more challenging harvesting scenario. Often combine speeds will need to be reduced to combine as low as needed to collect the lodged wheat spikes, which also increases risk of colliding with exposed rocks in the field.

Producers have several agronomic practices that can decrease stem lodging, with the most widely used method in recent years being selecting a variety with strong straw strength. Recently, attention in Minnesota has turned to using a plant growth regulator chemical application in season as a practice to reduce lodging. Plant growth regulators have been commonplace in parts of Europe and South American for small grains, and are now being considered in the wheat regions of the USA. Plant growth regulators decrease the internode distance in wheat and can thicken the stems of the plant, successfully shortening the plant. In the U.S. few chemicals are offered as plant growth regulators, though a few choices do exist.

The objective of this research is to understand the effects of the plant growth regulator Palisade EC (Syngenta) on yield, height, lodging, and general combinability in HRSW. Specifically, the hypothesis is that a plant growth regulator application will protect plant yield and increase combinability when an environment for severe lodging is encountered.

MATERIALS AND METHODS

We implemented this trial at six locations in Minnesota, with one trial only having one replication, so we included it in the combined analysis but not as its own location due to no replication. We had a seventh location on durum wheat but it received severe hail and did not go to yield for research. The trial consisted of an application of Palisade EC growth regulator (Syngenta) compared with no chemical application. The participants applied Palisade at a rate of 12 fluid ounces per acre, which is in the middle of the application range of 10.5-14.4 lb ai per acre. The Palisade was sprayed as close to the Feekes 7 growth stage as spray conditions allowed. Feekes 7 is the growth stage where two stem nodes are visible above the ground.

We took stand counts from multiple spots within each plot at almost all locations as a gauge of the producers plant stand. Plant height measurements close to maturity were collected within each plot. We used producer machinery to harvest the trials and measured plot weights with a weigh wagon, with yields adjusted to 13.5% grain moisture. As the grain augured out of the weigh wagon into a truck, we collected sub-samples of the grain from each plot with an attachment to the weigh wagon auger that takes a small stream of continuous grain from the grain off-loading through the auger. Two of the locations were weighed with the participant's grain cart and the sample was taken by manually holding a tube into the stream of grain coming out of the auger. With a Dickey John mini-GAC plus testing device, we immediately analyzed each sample for harvest moisture and grain test weight. We analyzed the samples for protein at the Northern Crops Institute with a Perten NIR and adjusted to 12% moisture.

Table 4. Agronomic details for all six locations of the palisade growth regulator trial in 2016

	Location					
	1	2	3	4	5	6
	Hendrum	**Fertile**	**Fertile**	**Dorothy**	**Red Lake Falls**	**St. Hilaire**
Planting Date	N/A	4/13	4/13	4/18	4/22	4/28
Harvest Date	8/1	8/6	8/6	8/9	8/22	8/13
Previous Crop	Beets	Soybean	Soybean	Soybean	Soybean	Soybean
Soil Type	Bearden Fargo	Chapett Knute	Chapett Knute	Glyndon	Hecla Borup	Clearwater
Variety	Prosper	Forefront	Forefront	Digger	Prosper/ Faller	Prosper
Palisade Date/Stage	6/2 Feekes 7	5/26	Feekes 6.5-7	6/7 Feekes 7.5-8	6/8 Feekes 7-8	6/7 Feekes 7

RESULTS AND DISCUSSION

The growth regulator Palisade impacted plant height, grain test weight, and yield combined over six diverse environments in NW MN in 2016. The impact of Palisade on plant height was clear in our research. Palisade reduced plant height by 4.6, 3.5, 2.7, and 3.1 inches at locations 1, 2, 3, and 5, respectively, and 3.6 inches combined over all locations where we measured height. Lodging was observed at all locations, but the exact effect of Palisade on lodging was difficult to quantify over the large plot size. At location 3, the researchers saw no lodging (score of 1) in the palisade treated plots, and an average lodging of a 45 degree angle on the plant stem (4-5 lodging score) in the untreated plots, as an example of the lodging seen. Palisade increased the test weight of the grain by 0.7 lb bu^{-1} combined over all locations, which was numerically evident at all locations. This result of an increase in test weight with Palisade has been replicated in other Palisade trials, however not in all years or locations. Protein was not impacted by Palisade, as expected.

We found a significant increase in grain yield with Palisade compared to the untreated check at all locations besides 1 and 4. When combined over all six locations, a 3.0 bu ac-1 yield increase was found with Palisade above the untreated check. At location 4 there was no yield increase from Palisade, so analyzing the combined analysis without that location increased the yield advantage with Palisade to 3.7 bu ac^{-1} (data not reported). When looking at an input that has a cost attached to it, a cost-benefit analysis is useful for determining if the input makes economic sense. When looking at a 3 bu ac^{-1} increase with Palisade compared to the untreated check, the yield increase does not pay for the application cost (Table 6).

Table 5. Effect of the plant growth regulator Palisade EC (Syngenta) applied at the two nodes above ground growth stage in HRSW on test weight, grain protein, and yield, at 5 diverse environments throughout NW Minnesota and combined over all 6† environments, 2016.

Treatment	Location					
	1	2	3	4	5	Combined
	------Height (inches)------					
No Palisade	32.5	39.7	NA	33.2	33.8	35.6
Palisade	27.9	36.2	NA	30.5	30.7	32.0
LSD (0.05)	1.63	2.1	NA	NS	3.0	2.2
	------Test Weight (lb bu^{-1})------					
No Palisade	61.8	62.1	62.4	62.3	60.7	61.7
Palisade	62.3	62.7	62.6	63.0	62.3	62.4
LSD (0.05)	NS	NS	NS	NS	0.7	0.2
	------Protein (%)------					
No Palisade	13.7	12.8	12.7	13.9	12.4	13.2
Palisade	13.5	12.6	12.6	14.1	12.4	13.2
LSD (0.05)	NS	NS	0.1	NS	NS	NS
	------Yield (bu ac^{-1})------					
No Palisade	65.2	87.4	84.7	78.9	83.5	78.3
Palisade	68.8	91.8	88.2	78.6	86.9	81.3
LDS (0.05)	NS	1.6	1.5	NS	2.0	2.1

NS – non-significant difference at the 95% confidence level.
LSD – least significant difference, if the means differ by more than the LSD number the numbers are statistically different.
† 6 environments includes one that did not have replication within the trial, so we included it in the combined analysis but did not report numeric means in for the location alone.

Table 6. Economic analysis of the palisade application of all locations individually and the combined analysis, NW MN, 2016.

	Location					
	1	2	3	4	5	Combined
No Palisade	65.2	87.4	84.7	78.9	83.5	78.3
With Palisade	68.8	91.8	88.2	78.6	86.9	81.3
Yield gain/loss	3.6	4.4	3.5	-0.4	3.4	3.0
$ Yield gain/bu	14.94	18.36	14.69	-1.51	14.31	12.60
Application Costs[1]	$28.40	$28.40	$28.40	$28.40	$28.40	$28.40
Financial outcome	-$13.46	-$10.04	-$13.71	-$29.91	-$14.09	-$15.80

[1] September wheat price of $4.20. Considering 2 bu/ac lost due to tire tracks from application. Palisade cost of $1 per ounce at a $12 oz per acre rate.

CONCLUSIONS

Combined across all locations the application of the growth regulator Palisade decreased plant height by 3.6 inches, and increased yield by 3.0 bushels per acre. When looking at the economic analysis the application of Palisade was not profitable at any individual location or the combined results, but if was not so far off as to discourage the use of the chemical for other purposes. In a more lodging-prone environment, the benefit of wheat that has lodged less would add into the financial outcome quite significantly.

OPTIMUM SEEDING RATES FOR THE HRSW VARIETIES LINKERT AND BOLLES

INTRODUCTION

At the Small Grain Update meetings in January of 2016, there were many questions from producers about what rate to seed the newer HRSW varieties. It takes three years to get enough data to identify the best seeding rate for a newly released variety. Additionally, on farm results carried out by producers often differ from small plot results, specifically that higher yields are achieved by increasing their seeding rate beyond that of what the small plot research shows as optimum.

Seeding rate in the field has an effect on lodging and yield, with certain varieties being more negatively impacted by increased seeding rates than others. When deciding on a seeding rate, producers often default to what has worked in past growing seasons. However, this line of thought comes with some challenges. If the kernel weight, or number of seeds in a pound has changed in a seedlot from year to year, seeding rates in bushels per acre would not adjust for that change. If producers do not get a seed weight test done on a seedlot, then they could be seeding at much different rate than what they intend to, or that they seeded in previous years.

For this trial, we picked two recently released varieties Linkert and Bolles, that have been increasing in popularity according to yearly variety surveys in MN, to do a seeding rate study. Our objective was to test the yield response curve at three seeding rates to determine the optimum seeding rate for maximum yield, and the most economic seeding rate.

MATERIALS AND METHODS

We implemented the seeding rate trial at seven total locations in 2016, with four locations being with the variety Linkert and three locations being with the variety Bolles. The treatments for this study consisted of three seeding rates at 1.0 million, 1.5 million and 2.0 million seeds per acre. There were between three and four replicates at every environment. One location planted some additional seeding rates of 0.75 million and 1.75 million seeds per acre, and a treatment of as high as their equipment would allow, which was 2.262 million seeds per acre (data not shown).

At all sites, the trials were set up in a randomized complete block design although not all of the treatments were randomized in each replication. We took stand counts twice at each location. The second stand count taken was to account for delayed seed germination due to poor early seed germination and stand establishment across NW MN due to dry planting conditions and infrequent rainfall. A stand loss estimation was made with the formula: stand loss = ((live seed planted – initial plant population)/live seed planted)*100. At all sites except for location 1 in both the Linkert and Bolles trial, no stand loss percentage was added into the seeding rate calculation, however at location 1 for both trials, 10% stand loss was added into the seeding rate.

As the HRSW crop was nearing physiological maturity, we did stem or head counts from each plot. We did this by measuring out three feet of row, from at least three locations in each strip and counting the number of wheat spikes or stems. The strips are usually a half a mile long and with time constraints, we normally took the counts within a quarter mile. At two of the locations during harvest we collected head measurements to aid in explaining the yield results.

We used our weigh wagons and the producer's equipment for harvesting the plots and the yields were adjusted for moisture to 13.5 %. Grain samples were collected to analyze for protein, test weight and moisture. The grain samples were collected in two different ways; with an attachment on the auger of the weigh wagon that collects the subsample as the grain is being unloaded into the truck, or from the bottom of the weigh wagon's auger through a hole cut in the side. With a Dickey John mini-GAC plus testing device, we immediately analyzed each sample for harvest moisture and grain test weight. We analyzed the samples for protein at the Northern Crops Institute with a Perten NIR and adjusted to 12% moisture.

Table 7. Agronomic details for three locations of Bolles seeding rate trial in 2016, NW MN, 2016.

	Location		
	1	2	3
	Roseau	Campbell	Red Lake Falls
Planting Date	5/8	3/28	4/20
Harvest Date	8/31	7/20	8/15
Previous Crop	Soybean	Soybean	Soybean
Soil Type	Borup Zippel	Foldahl Antler Mustinka	Hecla Borup

Table 8. Agronomic details for four locations of Linkert seeding rate trial in 2016, NW MN, 2016.

	Location			
	1	2	3	4
	Roseau	Waukon	Argyle	Dorothy
Planting Date	5/5	4/14	4/25	4/15
Harvest Date	8/31	8/6	8/22	8/3
Previous Crop	Soybean	Soybean	Soybean	Soybean
Soil Type	Borup Augsburg	Hamerly Vallers	Fargo	Fargo

RESULTS AND DISCUSSION

There was not a perfect stand of spring wheat established at any of the seven seeding rate trial sites. The established plant stand was taken to verify how far off from the desired plant stand the actual stand was (Table 9). Combined over all locations the stand loss in the Bolles trial ranged from 14.7-22.0%, and in the Linkert trial ranged from 15.6-24.9%. This estimation is live seeds that did not make it to the growth stage from when we went into the field to count plant stand, and is the percent stand away from the desired seeding rate a treatment was. Head counts were done near harvest, and showed that all seeding rates led to a similar number of wheat spikes per acre, with Bolles averaging 2.0 million heads per acre and Linkert averaging slightly higher at 2.2 million heads per acre. The stand counts and head counts combined to provide an estimate of stems per individual plant. Combined over all locations for each variety, stems per plant decreased as seeding rate increased. Bolles ranged from 1.3-1.9 stems per plant and Linkert ranged from 1.5-2.6 stems per plant, from lowest to highest seeding rates, respectively. It is important not to take this as absolute evidence that Linkert tillers more than Bolles, as the two varieties were in separate trials at geographically spread sites.

At all individual locations for both trials, and combined over all locations within a trial, seeding rate did not affect test weight or protein. The hypothesis was that yield would be affected by varying the seeding rate. In all locations and combined over all locations for a trial, except for the Linkert trial location 4, the yields were flat across the three seeding rates. Yield did not increase or decrease as seeding rates increased. These yield results are evidence that in 2016, increasing the seeding rate beyond 1.0 million seeds per acre did not lead to an increased yield. Additionally, using a rough economic analysis (Table 10 and 12), the most economic treatment was the lowest seeding rate in both the Linkert and Bolles trials. The head count data leads us to think that enough stems per acre were produced regardless of seeding rate because of the wheat varieties ability to compensate with tillering, which made yields similar.

CONCLUSIONS

Stand loss was in the same range as has been reported in many previous small plot research trials in the region, so producers should be aware that their seeding rates should reflect the potential live seeds that do not make it through early season conditions. The varieties Linkert and Bolles had the capacity to tiller at levels that did not leave any significant differences in heads per acre between seeding rate treatments. Seeding rate did not impact test weight, grain protein, or yield in the combined analysis for all trials. The treatment with the highest net income was the lowest seeding rate averaged across all locations in both trials.

Table 9. Effect of seeding rate in the HRSW variety Bolles on initial plant population, stand loss, stems per acre, stems per plant, test weight, protein, and yield at 3 diverse locations throughout NW and WC MN and combined over all three environments, 2016.

Treatment	Location			
	1	2	3	Combined
	------Population (plants acre^{-1})------			
1,000,000	1,014,464	826,672	787,307	876,148
1,500,000	1,455,872	1,198,384	1,099,648	1,251,301
2,000,000	1,775,312	1,517,824	1,393,920	1,562,352
LSD (0.05)	226,063	223,230	225,779	111,783
	------Stand loss away from seeding rate (%)------			
1,000,000	4.9	17.3	21.3	14.7
1,500,000	7.3	20.1	26.7	18.2
2,000,000	11.2	24.1	30.3	22.0
LSD (0.05)	NS	NS	NS	NS
	------Stems at harvest (Spikes acre^{-1})------			
1,000,000	1,657,216	1,670,381	2,431,616	1,919,738
1,500,000	1,717,232	1,742,400	2,431,616	1,963,749
2,000,000	1,930,192	1,918,963	2,516,800	2,121,985
LSD (0.05)	NS	NS	NS	NS
	------Tillering (Stems plant^{-1})------			
1,000,000	1.7	2.1	3.1	1.9
1,500,000	1.2	1.6	2.3	1.4
2,000,000	1.1	1.4	1.8	1.3
LSD (0.05)	0.3	0.2	0.6	0.3
	------Test Weight (lb bu^{-1})------			
1,000,000	60.9	61.0	59.8	60.5
1,500,000	61.7	60.8	59.8	60.8
2,000,000	61.2	60.9	59.5	60.5
LSD (0.05)	NS	NS	NS	0.07
	------Protein (%)------			
1,000,000	13.9	16.3	15.5	15.2
1,500,000	13.7	16.2	15.2	15.1
2,000,000	13.6	16.3	15.3	15.0
LSD (0.05)	NS	NS	NS	NS
	------Yield (bu ac^{-1})------			
1,000,000	53.9	67.2	74.4	65.0
1,500,000	53.2	65.6	74.4	64.2
2,000,000	51.3	67.2	73.4	64.1
LSD (0.05)	NS	NS	NS	NS

NS – non-significant difference at the 95% confidence level.
LSD – least significant difference, if the means differ by more than the LSD number the numbers are statistically different.

Table 10. Economic analysis of the yield results for the Bolles seeding rate trial combined over all locations.

Seeding Rate	Seeding Rate[1]	Seed cost[2]	Yield	Gross Income[3]	Net Income
Seeds/ac	**-Bushels/ac-**	**--$/acre--**	**-Bushels/ac-**	**----$/ac----**	**----$/ac----**
1,000,000	1.5	18.0	65	261.3	243.30
1,500,000	2.2	26.4	64.2	258.08	231.68
2,000,000	2.9	34.8	64.1	257.68	222.88

[1] Estimated.
[2] Certified seed cost of $12.00 per bushel of HRSW.
[3] October wheat price of $4.02.

Table 11. Economic analysis of the yield results for the Bolles seeding rate trial combined over all locations.

Seeding Rate	Seed Rate [1]	Seed cost [2]	Yield	Gross Income [3]	Net Income
Seeds/ac	**-Bushels/ac-**	**--$/acre--**	**-Bushels/ac-**	**----$/ac----**	**----$/ac----**
1,000,000	1.5	18.0	70.7	284.21	266.21
1,500,000	2.2	26.4	71.2	286.22	259.82
2,000,000	2.9	34.8	71.2	286.22	251.42

[1] Estimated.
[2] Certified seed cost of $12.00 per bushel of HRSW.
[3] October wheat price of $4.02.

Table 12. Effect of seeding rate in the HRSW variety Linkert on initial plant population, stand loss, stems per acre, stems per plant, test weight, protein, and yield at 4 diverse environments throughout NW MN and combined over all four environments, 2016.

	Location				
	1	2	3	4	Combined
	---Population (plants acre^{-1})---				
1,000,000	818,928	787,952	882,816	921,536	846,665
1,500,000	1,169,344	894,432	1,113,200	1,299,056	1,118,587
2,000,000	1,597,200	1,236,136	1,77,1440	1,746,272	1,597,471
LSD	341,420	261,180	267,009	425,944	176,132
	---Stand loss away from seeding rate (%)---				
1,000,000	18.1	21.2	11.7	7.8	15.6
1,500,000	22.0	40.4	25.8	13.4	24.9
2,000,000	20.1	38.2	11.4	12.7	20.0
LSD	NS	NS	NS	NS	NS
	---Stems at harvest (Spikes acre^{-1})---				
1,000,000	2,205,104	1,866,304	1,874,048	2,514,864	2,123,736
1,500,000	2,241,888	1,972,784	2,094,752	2,681,360	2,257,272
2,000,000	2,319,328	2,102,496	2,292,224	2,656,192	2,329,833
LSD	NS	NS	NS	NS	NS
	---Tillering (Stems plant^{-1})---				
1,000,000	2.8	2.5	2.1	2.8	2.6
1,500,000	1.9	2.2	1.9	2.1	2.0
2,000,000	1.5	1.7	1.3	1.5	1.5
LSD	1.1	NS	0.6	0.9	0.7
	---Test Weight (lb bu^{-1})---				
1,000,000	62.1	61.1	61.9	62.8	62.0
1,500,000	61.5	61.3	62.0	62.6	61.8
2,000,000	61.7	61.6	61.4	63.0	61.9
LSD	NS	NS	NS	NS	NS
	---Protein (%)---				
1,000,000	13.7	14.1	14.4	14.1	14.2
1,500,000	13.6	14.5	14.5	14.1	14.1
2,000,000	13.4	13.6	14.3	14.2	14.0
LSD	NS	NS	NS	NS	NS
	---Yield (bu ac^{-1})---				
1,000,000	58.2	74.2	56.6	93.2	70.7
1,500,000	58.6	74.0	56.4	96.0	71.2
2,000,000	55.4	75.6	59.9	93.4	71.2
LSD	NS	NS	NS	1.0	NS

NS – non-significant difference at the 95% confidence level.
LSD – least significant difference, if the means differ by more than the LSD number the numbers are statistically different.

ESN COMPARED WITH UREA AS A NITROGEN FERTILIZER SOURCE

INTRODUCTION
Agriculture in Minnesota is prone to variable and adverse weather conditions, which leads to nitrogen that can become vulnerable to losses. A one-time nitrogen fertilizer application in the late fall or early spring is quite common for producers, but may result in nitrogen that is not available when the plants need it most during the growing season. This set of circumstances has led to interest in products that protect the nitrogen, such as environmentally smart nitrogen (ESN), which is a controlled release product. Additionally, low grain protein in spring wheat has led to alternative nitrogen applications rather than the one-time nitrogen application. The theory behind ESN is that there should be more nitrogen available later in the season than compared to the standard nitrogen sources, which could lead to increased yield or protein.

The objective for this research was to evaluate the effectiveness of 100% ESN with 100% urea at the same nitrogen rate in NW MN.

MATERIALS AND METHODS
We implemented this trial at two locations in MN. Both locations applied 100% of their nitrogen in the fall as ESN or as urea, and had four replicates. At both sites the trials were set up in a randomized complete block design, although not all of the treatments were randomized in each replication.

We used our weigh wagons and the producer's equipment for harvesting the plots and the yields were adjusted for moisture to 13.5 %. Grain samples were collected to analyze for protein, test weight and moisture. The grain samples were collected in two different ways; with an attachment on the auger of the weigh wagon that collects the subsample as the grain is being unloaded into the truck, or from the bottom of the weigh wagon's auger through a hole cut in the side. With a Dickey John mini-GAC plus testing device, we immediately analyzed each sample for harvest moisture and grain test weight. We analyzed the samples for protein at the Northern Crops Institute with a Perten NIR and adjusted to 12% moisture.

RESULTS AND DISCUSSION
Both of these fields experienced extreme weather events. One looked beautiful all year and then a couple of weeks before harvest a windstorm flattened the crop. This participant shared concerns about harvesting flat wheat plants and was not sure if he could accurately harvest the trial, however he did and we are thankful to have the results. The other trial had crusting, poor emergence, and severe waterlogging through harvest. Stressed environments have higher potential for a product like ESN to be effective, however neither of these sites showed a protein or yield difference between urea or ESN. With these results there is no way that the added cost of ESN was recovered through extra protein or yield, which is a part of the larger probability of getting your investment back when using nitrogen stabilizers. The results from these two trials are part of the larger collection of data from this network that has mostly shown ESN to not be an effective nitrogen tool for increasing protein or yield.

Table 13. Agronomic details for both locations of the ESN vs. urea nitrogen trial in 2016.

	Location	
	1	**2**
	Alvarado	Red Lake Falls
Planting Date	4/14	4/12
Harvest Date	8/17	8/3
Rainfall (in)	19.72	12.39
Previous Crop	Soybean	Soybean
Soil Type	Bearden Colvin	Hattie Reis Clearwater
Variety	Mayville	SY Soren
N Timing	10/21	11/3

Table 14. Effect of using 100% ESN or 100% urea as the nitrogen source at pre-plant timing, on test weight, grain protein, and yield, at two diverse environments throughout NW Minnesota and combined over both environments, 2016.

	Location		
	1	**2**	**Combined**
	------Test Weight (lb bu-1)------		
ESN	59.8	63.2	61.5
Urea	60.0	63.2	61.6
LSD (0.05)	NS	NS	NS
	------Protein (%)------		
ESN	14.3	12.6	13.4
Urea	14.1	12.7	13.4
LSD (0.05)	NS	NS	NS
	------Yield (bu ac^{-1})------		
ESN	55.1	95.6	75.4
Urea	57.0	94.1	75.5
LSD (0.05)	NS	NS	NS

NS – non-significant difference at the 95% confidence level.
LSD – least significant difference, if the means differ by more than the LSD number the numbers are statistically different.

CONCLUSIONS

Neither treatment of ESN or urea provided a protein or yield improvement. ESN is a product that depends largely on the right environmental stresses for nitrogen loss to be an effective management tool. Additionally, even though this trial looked at 100% of the nitrogen as ESN, the more preferred practice currently is to mix only a portion of the overall nitrogen as ESN.

USING A NITRIFICATION INHIBITOR FOR ANHYDROUS AMMONIA APPLICATION

INTRODUCTION

The environment that wheat is subject to in Minnesota production systems is one where nitrogen losses due to the environment are common. Anhydrous ammonia (AA) comes with concerns for losses just as other nitrogen sources such as urea and UAN do. One tested and proven product on the market to use with AA for farmers is N-Serve, a nitrification inhibitor. It is supposed to have an approximately 90-day effective period when the soils are 40 degrees Fahrenheit or warmer. Producers in NW MN like to spread out their workload so they try to apply some of their fertility requirements in the fall, where the product N-Serve has utility.

The objective for this research trial is to determine if a nitrification inhibitor improves yield in spring wheat above the same rate of N without the nitrification inhibitor, and compared to a higher rate of nitrogen.

MATERIALS AND METHODS

We had this trial at one location near Roseau, Minnesota, on a Borup-Glyndon loam. The location applied 100% of their nitrogen in the fall as anhydrous ammonia, at either 100 or 135 lbs N per acre and with and without N-Serve at the 100 lb rate of nitrogen, with four replications. The trial was set up in a randomized complete block design.

We used our weigh wagons and the producer's equipment for harvesting the trial, and the yields were adjusted for moisture to 13.5%. Grain samples were collected to analyze protein, test weight and moisture. The grain samples were collected with an attachment on the auger of the weigh wagon that collects the subsample as the grain is being unloaded into the truck, or from the bottom of the weigh wagon's auger through a hole cut in the side. With a Dickey John mini-GAC plus testing device, we immediately analyzed each sample for harvest moisture and grain test weight. We analyzed the samples for protein at the Northern Crops Institute with a Perten NIR and adjusted to 12% moisture.

RESULTS AND DISCUSSION

At this single location, no treatment gave an advantage in test weight, protein, or grain yield. It is not impossible to find statistical significance with just one location of a trial. However, this location had too much variability to let any treatment shine through, even with 6.9 bushels per acre difference in yields between two different treatments. This trial would have benefitted from a few more locations to help make the results more robust.

Table 15. Effect of using fall applied anhydrous ammonia with N-Serve at 100 lbs N acre^{-1} compared to 100 lbs N acre^{-1} or 130 lbs N acre^{-1} alone on test weight, protein, and yield at one location in NW MN, 2016.

Treatment	Location 1
	-Test Weight (lb bu^{-1})-
100 lbs N	61.3
100 lbs N + NSERVE	61.0
135 lbs N	61.6
LSD (0.05)	NS
	-------Protein (%)------
100 lbs N	12.9
100 lbs N + NSERVE	12.7
135 lbs N	13.0
LSD (0.05)	NS
	----Yield (bu ac^{-1})-----
100 lbs N	75.0
100 lbs N + NSERVE	68.1
135 lbs N	70.8
LSD (0.05)	NS

NS – non-significant difference at the 95% confidence level.
LSD – least significant difference, if the means differ by more than the LSD number the numbers are statistically different.

CONCLUSIONS

Adding N-Serve did not improve grain yield or protein at the 100 lb N rate. Additionally, the results suggest that the 100 lbs per acre N rate was the optimum N rate as well, as an additional 135 lbs of N per acre did not lead to increased yield or protein.