2019 Report for the

Agricultural Demonstration of Practices and Technologies (ADOPT) Program

and Fertilizer Canada

Demonstrating 4R Nitrogen Management Principles in Spring Wheat

Principal Investigator: Robin Lokken, MSc, AAg

Conservation Learning Centre (CLC)

Project Identification

1. **Project Title:** Demonstrating 4R Nitrogen Management Principles in Spring Wheat
2. **Project Number:** 20180392
3. **Producer Group Sponsoring the Project:** Conservation Learning Centre
4. **Project Location(s):** SE 19-46-26 W2 RM #461 (Prince Albert)
5. **Project Start and End Dates (Month & Year):** September 2018 to February 2020
6. **Project Contact Person & Contact Details:**

A. Robin Lokken AAg
Manager
PO Box 1903
Prince Albert, SK
S6V 6J9
info@conservationlearningcentre.com
306-960-1834

B. Joanne Kowalski
BOD Chair
jkowalski@sasktel.net
306-980-8688

Objectives and Rationale

7. **Project Objectives:**

The objective of this project was to demonstrate the viability of using various nitrogen management strategies and determining the overall N rate response of spring wheat. The demonstration focuses on the 4R principles and examines different nitrogen rates, timing, placement, and formulation.

8. **Project Rationale:**

Single pass systems with side or mid-row banding of fertilizer is the commonly recommended best management practice for nitrogen management on farms. Side or mid-row banding reduces the potential for environmental losses and places the nitrogen at a safe distance from the seed. However, with larger farm sizes, limited time and labour during spring seeding, and the need for higher fertilizer rates, many producers have been reverting back to a two-pass seeding/fertilization system. Two-pass systems with fall applications of fertilizers are popular, because fertilizer prices are often lower in the fall, and they allow producers to spread out their workload. Fall fertilizer applications commonly involve surface broadcasting of granular products, because it is less expensive and faster than in-soil applications. Surface broadcasting granular products like urea, makes nitrogen more vulnerable to volatilization and leaching losses.

Volatilization and leaching of N result in economic losses and can potentially cause major environmental harm by releasing harmful nitrous oxide and contaminating surface and groundwater through nitrogen leaching. In response, this project examines the use of enhanced efficiency N products such as ESN, Agrotain, and SuperU to reduce the potential risks associated with fall broadcast applications. Enhanced Efficiency products are more expensive than traditional N products, but the improvements in efficacy and reductions in N losses may make up for the higher cost. As farms continue to get larger, more flexibility will be needed when managing N, and demonstrating these different N management strategies will help producers make better informed and sustainable decisions. Spring wheat was chosen as the test crop, because it is an economically and rotationally important crop in Saskatchewan, and spring wheat grain yield and protein are sensitive to N.

Methodology and Results

9. Methodology:

The demonstration was split into two separate components to help with analysis of the results, but was managed as a single trial to increase efficiency at seeding and harvest. For the first component, N was side banded and seven different rates of fertilizer were used; 0x, 0.5x, 0.75x, 1x, 1.25x, 1.5x, and 1.75 x the soil test adjusted rate of 125 kg/ha total N. The second component examined different factorial combinations of N management strategies including; two timing options (spring and fall), two placement options (broadcast and side-band), and four N sources (untreated urea, ESN, Agrotain, treated urea, and SuperU). As seen in Table 1., these treatments were arranged as an RCBD trial. The 1x side-banded untreated urea was a shared treatment between the two components.

Table 1. Treatments applied in the Demonstrating 4R Nitrogen Management Principles in Spring Wheat project.

Trial #1: Right Rate*	Trial #2: Right Time, Right Place, Right Form
1) 0x (no added N fertilizer) **	1) Fall Broadcast – untreated urea
2) 0.5x (68 kg total N/ha)	2) Fall Broadcast – ESN®
3) 0.75x (94 kg total N/ha)	3) Fall Broadcast – Agrotain® treated urea
4) 1.0x (125 kg total N/ha)	4) Fall Broadcast – SuperU®
5) 1.25x (156 kg total N/ha)	5) Side-band – untreated urea
6) 1.50x (188 kg total N/ha)	6) Side-band – ESN®
7) 1.75x (219 kg total N/ha)	7) Side-band – Agrotain® treated urea
	8) Side-band – SuperU®
*side-banded urea in all trts, rates adjusted for residual N and N from 11-52-0	9) Spring Broadcast – untreated urea
	10) Spring Broadcast – ESN®
	11) Spring Broadcast – Agrotain® treated urea
**all treatments will receive 6-8 kg N/ha from 11-52-0	12) Spring Broadcast – SuperU®

	***1.0x rate (soil + fert = 125 kg N/ha) in all trts

Table 1. Fall 2018 soil test results from a composite soil sample.

Soil Depth (cm)	Nutrient			
	N (lb/ac)	P (ppm)	K (ppm)	S (lb/ac)
0-15	8	5	232	28
15-30	5			18

Each plot was approximately 2m by 7m and was seeded by a Fabro plot seeder with 10-inch row spacing, using a certified wheat variety Brandon. Seeding occurred on May 31st into canola stubble at a seeding depth between 1 3/4 to 2 inches. Based on the soil test results (Table 2) and the recommended adjusted 125 kg/ha of N, seven different rates of urea were used in component one. Table 3 summarizes the N rates used for component one and two of the study. No pre-emergent herbicide was used since there were very few weeds because of dry conditions (Table 4). The post emergent herbicides; Axel Extreme, MCPA, and Kinetic Copron and the fungicide Pivot 418EC were applied on June 19, 2019. Plots were staged and scouted often for diseases, pests, and lodging. No lodging or pests were found, but every plot was infected with fusarium head blight. Pre-harvest glyphosate was applied to the trial on September 5, 2019, and on September 23, four rows per plot were harvested using a Wintersteiger plot combine.

Table 3. N sources and fertilizer used for components one and two of the study.

N Sources	Fertilizer used	Recommended (kg/ha)	Actual used (kg/ha)
Control	0-0-0-0	0	0
0.5x urea	46-0-0-0	68	125
0.75x urea	46-0-0-0	94	182
1x urea	46-0-0-0	125	249
1.25x urea	46-0-0-0	156	317
1.5x urea	46-0-0-0	188	386
1.75x urea	46-0-0-0	219	454
1x ESN	46-0-0-0	125	262
1x Agrotain	46-0-0-0	125	249
1x SuperU	46-0-0-0	125	249
Phosphorus as MAP	11-52-0	35	67

Data collection included soil testing, plant density, lodging, yield, and protein. Several soil samples were collected across the trial area with a soil auger, were mixed and placed into a sample bag and sent off to be tested at Agvise Laboratories. Plant density was determined 3 weeks after seeding by counting two 1m sections of row. Lodging was calculated using the Belgian Lodging Scale (area x intensity x 0.2, where area is rated on a scale of 1-10 and intensity on a scale of 1-5). Yield was measured after cleaning and weighing the plot samples and was corrected to 14.5% seed moisture content. The four replicates were bulked together for each treatment, and a subsample was delivered to ICDC for analysis of grain protein. Plant density and yield data were analyzed separately for component one and two by a one-way ANOVA, and a factorial ANOVA respectively using the R program.

10. Results:

The late and relatively cool spring delayed seeding until May 31st. The below average spring precipitation (Table 4), and the previously dry year made for very dry spring conditions and resulted in poor crop emergence. These dry conditions extended into the summer (Table 4) and negatively affected spring wheat yields, since the spring wheat yield averaged around 50 bu/ac. There was no evidence of lodging in spring wheat plots, which was likely due to the low precipitation throughout the growing season.

Table 4. Mean temperatures and precipitation recorded by Saskatchewan Research Council's Climate Station located on site at the Conservation Learning Centre.

	May	June	July	August	September	October	Average/Total
				--- Temperature (°C) ---			
2019	9.5	15.8	17.4	15.1	11.6	1.0	11.7
2018	13.3	16.3	17.4	15.7	6.5	1.4	11.8
2012-2017	11.5	16.0	18.7	17.6	12.5	3.8	13.4
				--- Precipitation (mm) ---			
2019	30.0	54.4	57.4	16.8	59.6	11.6	229.8
2018	12.5	49.8	112.4	38.4	29.3	8.6	251.0
2012-2017	69.4	85.4	93.3	49.6	25.2	26.0	348.7

For component one of the study, Table 5 shows that there is a statistical difference between plant density for different N rates. However, when a Tukey test was completed there were no statistical differences between the rates. The p-values for 0x compared to 1.25x, 1.5x, and 1.75x the recommended N-rate were included from the Tukey test to show that they were very close to being significant (<0.05). Likely they were not significant because many of the plots with the higher N-rate treatments had fewer reps/count than the lower N-rate treatments. The reason for the lower reps/count was because some of the plots were not included in the statistics, because there were higher grain moisture contents and lower plant densities in one area of the trial that was not representative of the rest of the trial. Table 5 shows that the plant density means are lower for higher rates of N, this could be due to the dry conditions and possibly fertilizer burn. Despite the low plant populations for higher rates of fertilizer, the plants recovered and had observably higher yields than the 0x recommended rate of N. There were no statistical differences in yield and protein, but protein appeared to increase with higher fertilizer rates.

Table 5. Summary of statistical analysis and means of main effects for component one of Adopt Demonstrating 4R Nitrogen Management Principles in Spring Wheat at the Conservation Learning Center in 2019.

Treatment	Count	Plant Density	Yield	Protein
		plants/m^2	bu/ac	%
		P-value		
N Rates	23	0.00868**	0.834	0.3508
0x-1.25x	N/A	0.099	NS	NS
0x-1.50x	N/A	0.0533	NS	NS
0x-1.75x	N/A	0.094	NS	NS
		Means		
0x	4	219[a]	43.7[a]	12.7[a]
0.5x	4	209[a]	53.8[a]	11.8[a]
0.75x	3	209[a]	51.8[a]	13.6[a]
1x	4	152[a]	46.1[a]	14[a]
1.25x	2	125[a]	56.5[a]	14.6[a]
1.5x	3	127[a]	51.3[a]	14[a]
1.75x	3	135[a]	44.8[a]	14.3[a]

†values with the same letter are not statistically different (P>0.05)

Component two of the study showed no significant treatment effects for the twelve overall treatments lists in Table 1. When each treatment was individually evaluated in Table 6, there was a significant difference between the placements of fertilizer for plant density. The plant density for broadcasting was significantly higher than the plant density for side-banded fertilizer. This difference could be because of the dry conditions, and potential fertilizer burn with side-banding. Despite the low plant densities for side-banding, the plants recovered and there was no significant difference between yield for fertilizer placement. Fertilizer application date, fertilizer type and their interactions had no significant effect on plant density, yield, or protein.

Table 6. Summary of statistical analysis and means of main effects for component two of Adopt Demonstrating 4R Nitrogen Management Principles in Spring Wheat at the Conservation Learning Center in 2019.

Treatment	Plant Density plants/m²	Yield bu/ac	Protein %
	P-value		
Overall Treatment (TRT)	0.0909	0.896	0.961
Placement (P)	0.00676**	0.8	0.981
Application date (AD)	0.89826	0.338	0.592
Fertilizer type (FT)	0.55824	0.501	0.808
P*FT	0.07333	0.755	0.81
AD*FT	0.60451	0.853	0.62
	Means		
Placement			
Broadcast	231[a]	51.1[a]	14[a]
Side-band	198[b]	52.1[a]	14[a]
Application date			
Fall	232[a]	53.4[a]	13.8[a]
Spring	214[a]	50.5[a]	14[a]
Fertilizer type			
Urea	210[a]	47[a]	14.1[a]
Agrotain	220[a]	51.7[a]	13.6[a]
ESN	232[a]	55[a]	14[a]
SuperU	218[a]	52.4[a]	14.2[a]

†values with the same letter are not statistically different (P>0.05)

11. Conclusion and Recommendations:

The extremely dry conditions and resulting poor crop emergence, the excluded plots, and potential fertilizer burn from side-banding likely created inconsistencies in the data. The data showed the opposite of what was expected; that the lower fertilizer rates and broadcasting had significantly higher plant densities than higher fertilizer rates and side-banding. In spite of the lower plant densities, there was no significant differences for yield and protein. In general, the effects of N rates, placement, timing, and fertilizer type were inconclusive. This study could likely be successfully carried out in a wetter year where there would be less risk of poor emergence and fertilizer burn.

12. Acknowledgements:

The Conservation Learning Centre graciously acknowledged the Ministry's support through signage directly in field with the project, verbally during the Field Day and on the Field Day agenda handed out to all visitors.

13. Abstract:

Many agricultural producers are switching back to a two-pass system where they broadcast fertilizer in the fall instead of side-banding in the spring. The two-pass system allows producers to spread out their workload, and fertilizer is often cheaper in the fall. However, broadcasting granular fertilizer in the fall can potentially cause economic losses and environmental degradation. This study examines different nitrogen rates, fertilizer placement (broadcast or side-band), timing (fall or spring), and types of fertilizer. Enhanced efficiency N products are more expensive, but they can reduce N losses, and may be a good option for producers who need more flexibility with their N management. The purpose of this study was to provide producers with N management information to help them make informed decisions that best fit with their farm. Unfortunately, the results for this study were somewhat inconclusive because of the extremely dry conditions, potential issues with fertilizer burn, and inconsistent data within the trial. Plant densities were low for higher rates of nitrogen, and broadcasting fertilizer had significantly higher plant densities than side-banding. A wetter year may show more conclusive results.