Agriculture Demonstration of Practices and Technologies (ADOPT)

Project Final Report

The final project report should be made available electronically (MS Word). Additional data tables and or graphs may be submitted in spreadsheet format. Due to formatting, printing and distribution requirements, final reports will not be accepted as PDF documents. Completed reports must be returned by email to Evaluation.Coordinator@gov.sk.ca.

Project Title: 4R Management: Right rate and placement for fertilizer in oats

Project Number: 20220416

Producer Group Sponsoring the Project: Saskatchewan Oat Development Commission

Project Location(s): *Provide the name or number of the rural municipality, nearest town or legal land location if possible. Provide the name of any cooperating landowner(s).* Northeast Agriculture Research Foundation, Melfort, SK RM no. 428; Western Applied Research Corporation, Scott, SK RM no. 380

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Abstract *(maximum 200 words)*

Detail key elements from the project objectives, methodology, results and conclusions to provide a short concise summary of the project. List extension activities such as field days or workshops and include the number of people who visited the project.

Oats are known to be responsive to nitrogen (N) and phosphorus (P) fertilization; however, very little is known of the response of oats to the placement of N and P fertilizers. To demonstrate the response of oats to N placement, N rates, and P placement, a small-plot demonstration was conducted at Scott and Melfort, SK in 2023. The treatments were arranged in an unbalanced split-plot, with the control treatments and midrow-banded N within one half of the split-plot and side-banded N within the second half of the split-plot. The sub-plot factors were N rates of 75, 100, and 125kg/ha and P placement in the seed-row or the side-band of 45kg P_2O_5/ha. Every treatment was replicated four times. Data collection consisted of plant density, days to maturity, grain yield, test weights (TW) and thousand kernel weights (TKW). The only significant treatment effects for N placement were that test weight decreased at Scott when nitrogen was side-band by 2.5g/0.5L as compared to midrow. Increasing N rate significantly increased yield at both sites, where yield was maximized at Melfort at 125kg N/ha and at 100kg N/ha at Scott. Lastly, there was no significant response of oats to P at either site in 2023.

Sustainable Canadian Agricultural Partnership

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Project Objectives

The objective of this demonstration was to highlight the impact of fertilizer placement and rate on oat establishment, seed yields, and quality.

Project Rationale

Oat response to different macronutrients has been investigated in previous research and has demonstrated that oats are quite responsive to additions of nitrogen and sometimes phosphorus fertilization (Mohr et al. 2007). Increased nitrogen rates are known to increase seed yields, however high nitrogen rates have the potential to increase crop lodging and decrease test weights (Mohr et. al. 2007). A 100 bu/ac oat crop requires anywhere from 97-117lbs/ac of soil and applied nitrogen (Top Crop Manager 1999). Typical oat yields in the northeast growing region of Saskatchewan often exceed 100 bu/ac, and therefore high supplies of nitrogen are required. In contrast, while phosphorus supplementation is recommended in oats, yield responses have been less consistent and effects to quality have not been detected (Mohr et al. 2007). When evaluating phosphorus placement Miller et al. found that phosphorus fertilizer absorption in oats was increased as the distance of phosphorus placement increased from the seed by 1-inch. The only instance where more phosphorus was taken up by the plant with seed placement was during the very early growth stages (Miller et al. 1960). Phosphorus absorption is also increased in oats with increasing supply of nitrogen (Miller et al. 1960). Although, yield responses were not always found to be consistent with phosphorus supplementation, 80% of Saskatchewan soils are deficient in phosphorus, and thus some amount of supplementation is likely to effect oat emergence and seed yields where P is limiting.

While macronutrient supplementation has been investigated in prior research, demonstration of different placement methods is lacking in oats. Karamonas et al. 2014 evaluated phosphorus rates and placement options in canola, wheat and barley and found wheat and barley were not significantly impacted by fertilizer placement; however, it is acknowledged in the report that wheat plant stands were only evaluated at one site, and thus different soil types and conditions were not compared. There was one instance throughout the duration of this study where spring wheat yields responded positively to side-banded P as compared to seed-placed (Karamonas et. al. 2014). The reasoning for this was uncertain, however possible causes for this may be reduced plant stands from seed-placed P as plant stands were not evaluated under this occurrence, or that side-band placement allowed for better positioning for root uptake (Karamonas et. al. 2014). Mooleki et. al. 2010 compared midrow banding and side banding of nitrogen sources in wheat and found a tendency for wheat plant stands to decrease with side-banding as compared to midrow banding, however targeted plant densities were met with both placements. Lower plant densities were also found under dry conditions when N was placed closer to the seed (Mooleki et al. 2010). When comparing phosphorus fertilizer placement, in all years Scott demonstrated lower average plant stands with seed placed P and lower average seed yields as compared to side-banded P (Mooleki et al. 2010). At sites with finer texture soils such as Melfort, differences in plant stands and seed yields were relatively inconsistent and small. When averaged across sites no significant difference in plant stands and seed yields occurred due to phosphorus placement in wheat. The greatest limitation with P placement in this study, was that very low rates of 7 and 10 kg/ha of P were tested, which diminished the likelihood of a P placement response.

Depending on drill capabilities, farmers may choose different fertilizer placements when seeding oats. In other cereal crops, placing high rates of fertilizer close to the seed has proven to decrease plant stands; however, effects to plant establishment begin to diminish as seed-bed utilization (SBU) increases. Seed bed utilization is greater when nitrogen is midrow banded as compared to side banded, as fertilizer is placed further from the seed. Furthermore, seed bed utilization is also increased when phosphorus is placed in the sideband as compared to with the seed. Greater seed bed utilization diminishes the risk of fertilizer burn and reduced plant emergence. Keeping plant stands high is important for weed competition, insect pressure, and ensuring high seed yields. This demonstration was intended to demonstrate to oat grower's different fertilizer placements at seeding, and whether or not these different placements will affect plant stands, yield and/or quality of the crop. Rates that would be used by Saskatchewan producers were used to simplify the design, and demonstrate whether there was any effect of placement when using typical fertilizer rates for the region in oats.

Literature Cited

Barker, B. 1999. Fertilizing oats for yield and quality. Top Crop Manager. Available at: Fertilizing oats for yield and quality - Top Crop ManagerTop Crop Manager

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Mohr, R.M., Grant, C.A., and W.E. May. 2007. The influence of nitrogen, phosphorus and potash fertilizer application on oat yield and quality. Can. J. Soil. Sci. 87 (4): 459-468.

Mooleki, S.P., Mahli, S.S., Lemke, R.L., Schoenau, J.J., Lafond, G., Brandt, S., Hultgreen, G.E., Wang, H., and W.E. May. 2010. Effect of form, placement and rate of N fertilizer, and placement of P fertilizer on wheat in Saskatchewan. Can. J. Plant. Sci. 90 (3): 319-337.

Methodology

The demonstration was arranged as an unbalanced split-plot with four replications. The unbalanced design was selected due to seeder capabilities at the participating locations. Three factors were used which included nitrogen placement, nitrogen rate, and phosphorus placement to create a total of 12 treatments (Table 1). There were three factors within the main plot that consisted of no nitrogen, nitrogen in the midrow-band, or nitrogen in the side-band. To provide better randomization in the field, the midrow-band and no nitrogen main plots were completely randomized within the first half of the split-plot (Treatments 1-6), and the side-band treatments for nitrogen placement (treatments 7-12) were completely randomized within the second half of the split-plot. The sub-plot factors were also not consistent between the main plot groupings. For the no nitrogen main plot, the subplot was no phosphorus, phosphorus in the seed-row or phosphorus in the side-band, and for the midrow-band nitrogen main plot the sub plot was a nitrogen rate of 75, 100, or 125 kg/ha of applied nitrogen. Phosphorus placement remained consistent in all the midrow-band nitrogen treatments. For the side-band nitrogen placement, there were two sub-plot factors of a nitrogen rate of 75, 100, or 125 kg/ha of applied nitrogen, with phosphorus placement in the seed-row or sideband.

Table 1. Treatments used in 4R management: Right rate and placement for fertilizer in oats and Melfort and Scott, SK in 2023.

Treatment #	Nitrogen Placement	Nitrogen Rate (kg/ha)	Phosphorus Placement[z]
1	N/A	0	No P
2	N/A	0	Seed Row
3	N/A	0	Side-Band
4	Mid-Row	75	Seed Row
5		100	
6		125	
7	Side-Band	75	Seed Row
8		100	
9		125	
10	Side-Band	75	Side-Band
11		100	
12		125	

[z]phosphorus to be applied at 45kg/ha of P_2O_5

The demonstration was conducted at two locations including Melfort and Scott, SK in 2023. The site at Scott is in the brown soil zone while the site at Melfort is in the black soil zone. These two locations represent different soil conditions, most notably in texture and organic matter content, while also experiencing different environmental conditions to demonstrate oat response across different environments.

Seed equipment and crop management varied by location (Table 2). The oat variety used was CDC Arborg, which was seeded at 143kg/ha to target 350 plants/m^2. Oats were seeded into canola stubble on May 17th at Scott and May 18th at Melfort. Weeds, insects, and disease were controlled using registered products at each participating site at the discretion of each site manager for best management practices. All fertility was applied as per treatment aside from potassium and sulphur, which were applied based on soil sample results at each site to be non-yield limiting (Table 3). All plots were harvested with a plot combine on August 18th at Scott and August 21st at Melfort.

Table 2. Agronomic information and dates of operation for 4R Management: Right Rate and Placement for Fertilizer in Oats at Melfort and Scott, SK in 2023.

Factor/Operation	Melfort	Scott
Previous Crop	Canola	Canola
Pre-Emergent Weed Control	Glyphosate 540 at 1L/ac May 19	Glyphosate 540 at 1L/ac and AIM at 35mL/ac May 14
Variety	CDC Arborg	CDC Arborg
Seeding rate	145kg/ha	145.5kg/ha
Seeding Date	May 18	May 17
Row Spacing (cm)	30.5cm	25.4cm
Plot size	14m2	12.2m^2
Kg/ha K_2O-SO_4	15-10	0-0
Post-emergent herbicide	Prestige XL at 947mL/ac June 7	Buctril M 400mL/ac June 5
Emergence Counts	June 5	June 13
Foliar fungicide	None	Caramba at 400mL/ac July 13
Insecticide	Decis 5EC at 60mL/ac on June 23 for grasshoppers	Decis 5EC at 60mL/ac on July 7 for grasshoppers
Maturity	August 9	August 12-16
Harvest Date	August 21	August 18

Table 3. Soil sample results for 4R Management: Right rate and Placement for fertilizer in Oats at Melfort and Scott, SK in 2023

Depth	NO3-N (kg/ha)	Olsen-P (ppm)	K (ppm)	S (kg/ha)	pH	Organic Matter (%)	Salts (mmho/cm)
Melfort							
0-15cm	19	9	414	23	6.0	8.8	0.33
15-60cm	24			54	7.5		0.58
Scott							
0-15cm	7	19	314	34	6.4	4.0	0.23

15-60cm	38			29	7.6		0.27

Data collection consisted of plant density, maturity, grain yield, test weights, and thousand kernel weights. Plant density was measured by counting the seedlings along two 1-meter sections of crop row per plot. The average between the two counted rows was then divided by the row spacing at each respective site to determine the plants/m^2 (PPMS). Days to maturity (DTM) was noted by recording the day the majority of plants in a plot reached the hard dough stage (Zadoks 87). This was then converted to the days that it took each plot to reach maturity from the day of seeding. Grain yield was determined at each site by weighing each harvested plot sample and converting the grams per plot to a kg/ha equivalent, while correcting for consistent moisture. Test weights (TW) were determined by weighing the grams of seed in a 0.5-litre to the nearest hundredth of a gram. Thousand kernel weight (TKW) was determined by counting and weighing a minimum of 500 seeds per plot and converting the weight into grams per 1000 seeds. Lastly, statistical analysis was completed for each site separately using randomized complete block for treatments 1-3, factorial analysis for treatments 8-12, and split-plot analysis for treatments 4-9. All statistical analysis was completed using Statistix 10.

Results *(you must provide the following information)*

Present and discuss any project results, including any data or measurements taken to evaluate the demonstration. Include things that didn't appear to work. These results are just as important to share. List extension activities such as field days or workshops. List the activity, the date it occurred, and the number of people who attended.

Environmental Conditions:

The 2023 growing season at both locations in the demonstration was much warmer and drier as compared to the long-term average (Table 4). At both Scott and Melfort, the average growing season temperature was increased by 1.9°C as compared to the long-term. At Scott, all growing season months had greater average temperatures than the long-term, except for July, where the average temperature was 0.2°C colder than the long-term average. At Melfort, the same trend occurred where July was the only month to demonstrate a reduced average temperature from the long-term by an average of 0.9°C. As for precipitation, Scott had 70% of the long-term cumulative precipitation and Melfort had 54% of the long-term precipitation. At Scott, all growing season months demonstrated reduced rainfall, except for July where there was an excess of 11.4mm as compared to the long-term average. At Melfort, all growing season months also demonstrated reduced average rainfall except for August, where there was an excess of 4.1mm as compared to the long-term average. Furthermore, when comparing the conditions between the two locations, Melfort had a drier season with 34.8mm less cumulative precipitation as compared to Scott. This deficit was most notable in June where Melfort had approximately 30% of the rainfall of Scott. Melfort was also slightly warmer in average growing season temperature as compared to Scott by an average of 0.2°C.

Table 4. Mean temperatures and precipitation collected from the Environment Canada Weather Station for 4R Management: Right Rate and Placement for Fertilizer in Oats at Melfort and Scott, SK from May to August 2023.

	May	June	July	August	Average/Total
--Temperature(°C)--					
Scott 2023	14.9	17.2	17.1	17.4	16.7
Long-term[x]	10.8	14.8	17.3	16.3	14.8
Melfort 2023	14.1	19.2	16.9	17.3	16.9
Long-term[x]	10.1	15.2	17.8	16.7	15.0
--Precipitation(mm)--					
Scott 2023	16.6	81.1	29.7	31.7	159.1 (70%)
Long-term[x]	38.9	69.7	69.4	48.7	226.7
Melfort 2023	31.5	26.4	16.4	50.0	124.3 (54%)
Long-term[x]	33.4	79.5	69.6	45.9	228.4

[x]Long-term for Scott is from 1985-2014; Long-term for Melfort is 1997-2021

Plant Density (PPMS)

Plant density (PPMS) was not significant at either location for any of the data collected. For the phosphorus effect at both sites, there was a tendency for average plant stands to increase when phosphorus was applied; however, the difference was not significant between treatments (Table 5). At Melfort, plant density was increased by 3 PPMS when side banding phosphorus and 24 PPMS when phosphorus was seed placed. At Scott, plant density was increased by 8 PPMS when seed placing phosphorus and 19 PPMS when side banding phosphorus. As for the effect of nitrogen on plant density, there was no significant effect of nitrogen rate, nitrogen placement, or a 2-way interaction between the two at either site (Table 6; Table 7). At Melfort, there was a tendency for plant densities to increase as nitrogen rate increased in the side-band from 75 to 100kg/ha; however, as nitrogen rate increased to 125kg/ha plant densities tended to decline as compared to 100kg/ha, but not as compared to 75kg/ha (Table 6). Also, at Melfort, plant density was greater on average when midrow banding nitrogen (269 PPMS) as compared to side banding nitrogen (230 PPMS). At Scott, there was an average increase in plant density as nitrogen rate increased from 75kg/ha (161 PPMS) to 100kg/ha (176 PPMS), but plant density was not increased beyond this when nitrogen rate was increased to 125kg/ha (175 PPMS) (Table 7). At Scott, the difference in plant density between nitrogen placement was only 1 PPMS when comparing midrow banding and side banding, which has very little agronomic significance. Lastly, when comparing sites, plant densities were higher on average at Melfort as compared to Scott. At Scott, the average plant density was 171 PPMS and at Melfort the average plant density was 293 PPMS.

Days to Maturity (DTM)

Days to Maturity (DTM) was not significantly different at either location for any of the data collected. At Melfort, days to maturity was always 83 days, and there were no differences between any of the treatments (Table 5; Table 6; Table 7). At Scott, there were slight variations in days to maturity between treatments, but differences were very small, with days to maturity only ranging between 88 to 90 days across treatments. Due to the dry and hot season, oats reached maturity very early in the season at both locations, which diminished the likelihood of a treatment response in days to maturity.

Grain yield (yield)

Grain yield (yield) was only significant at Scott for nitrogen rate ($p=0.0478$) and at Melfort for nitrogen rate($p=0.0071$). At Scott, yield was significantly increased from 75kg/ha (4661.9kg/ha) to 100kg/ha (5139.9kg/ha) of applied nitrogen (Table 7). At 125 kg/ha (4976.6kg/ha) grain yield was not significantly different from 75 or 100kg/ha. Although not statistically significant, at Scott yield did tend to increase in response to phosphorus (Table 5) and nitrogen placement (Table 7). Average yields increased with additions of seed-placed (4033.8kg/ha) and side-band (3983.2kg/ha) phosphorus as compared to the unfertilized control (3647.6kg/ha). Average yields also increased at Scott with side-band nitrogen (5105.6kg/ha) as compared to midrow band nitrogen (4746.7kg/ha). At Melfort, the significant effect of nitrogen rate was that yield was significantly increased at 125kg/ha (5375.9kg/ha) as compared to 75kg/ha (5084.7kg/ha) of applied nitrogen. There was also an increase in average yields at 100kg/ha (5247.6kg/ha) as compared to 75kg/ha of nitrogen; however, the difference was not statistically significant. Furthermore, similar to Scott, Melfort did not demonstrate a significant yield response to phosphorus or nitrogen placement in 2023; however, average yields did increase at Melfort with additions of seed-placed phosphorus (3862.2kg/ha) as compared to the control (3766.4kg/ha) and with side-band nitrogen (5279.2kg/ha) as compared to midrow band nitrogen (5193.0kg/ha). Lastly, when comparing sites, yield was quite comparable with average yield ranging across treatments from 3647.6-5229.7kg/ha at Scott and 3698.0-5428.4kg/ha at Melfort.

Grain Quality

Grain quality consisted of Test weight (TW) and Thousand Kernel Weights (TKW).

TW was only significant at Scott for nitrogen rate (p=0.0316) and nitrogen placement (p=0.0017). The significant effect of nitrogen rate at Scott only occurred when all nitrogen was side-band (Table 6). The effect of nitrogen rate was that test weight was significantly reduced from 75kg/ha (237.8g/0.5L) to 125kg/ha (233.3g/0.5L) of applied nitrogen. Test weight was also reduced for 75kg/ha to 100kg/ha (234.6g/0.5L) of nitrogen; however, the difference was not statistically significant. Secondly, the effect of nitrogen placement at Scott was that test weight was reduced when nitrogen was side band (234.6g/0.5L) as compared to midrow band (236.9g/0.5L). There were no discernable differences in test weight at either site for phosphorus application; however, at both sites treatments 1-3 did have higher average test weight as compared to treatments with nitrogen application (Treatments 4-12). As compared to the unfertilized control at Scott, test weight was reduced from the control (243.2g/0.5L) by 4.2-10.1g/0.5L when nitrogen was applied. At Melfort, test weight was reduced as compared to the control (249.3g/0.5L) by 8.8-12.1g/0.5L when nitrogen was applied. Furthermore, at Melfort there was no average difference in test weights when comparing nitrogen rates; however, there was a similar trend as to Scott with nitrogen placement, where test weight was reduced with side band nitrogen (237.5g/0.5L) as compared to midrow band nitrogen (239.6g/0.5L); however, the difference was not significant at Melfort. Lastly, test weight was quite comparable between sites in the demonstration with test weight ranging from 233.1-243.2g/0.5L at Scott and 237.2-252.0g/0.5L at Melfort.

TKW was not significantly affected by any of the treatments at either site. TKW remained quite consistent across all treatments, with no discernable trends as a result of phosphorus, nitrogen rate or nitrogen placement. TKW was also quite consistent across sites with averages across treatments ranging from 36.3-37.6g at Scott and 35.8-37.7g at Melfort.

Table 5. Statistical Analyses and treatment means for phosphorus placement (P place) in 4R Management: Right Rate and Placement for Fertilizer in Oats at Scott and Melfort, SK in 2023. Means within a column followed by the same letter do not significantly differ (Tukey-Kramer, P ≤ 0.05).

	Scott[y,z]					Melfort[y,z]				
	PPMS	DTM	Yield	TW	TKW	PPMS	DTM	Yield	TW	TKW
P place (p-value)	0.1977	0.702	0.115	0.7723	0.6568	0.3478	--	0.3746	0.2196	0.371
Grand Mean	171.0	89.7	3888.2	241.6	37.2	292.7	83.0	3775.5	250.7	37.7
CV	7.88	2.1	6.07	2.2	2.85	7.89	--	4.05	0.77	
P-place										
No fertilizer	161.7	90.0	3647.6	243.2	37.5	283.8	83.0	3766.4	249.3	37.7
Seed-placed P	170.0	90.0	4033.8	240.7	36.8	307.6	83.0	3862.2	252.0	38.2
Side-banded P	181.4	89.0	3983.2	241.0	37.2	286.7	83.0	3698.0	250.9	37.4

[y]The analyses only includes the control treatments (1-3) within the split-plot, with phosphorus placement analyzed as a randomized complete block

[z]Significance level of the p-value: *p<0.05, ** p<0.01, *** p<0.001

Table 6. Statistical Analyses and treatment means for nitrogen rate (N rate) and phosphorus placement (P place) in 4R Management: Right Rate and Placement for Fertilizer in Oats at Scott and Melfort, SK in 2023. Means within a column followed by the same letter do not significantly differ (Tukey-Kramer, P ≤ 0.05).

	Scott [y,z]					Melfort [y,z]				
	PPMS	DTM	Yield	TW	TKW	PPMS	DTM	Yield	TW	TKW
N rate (p-value)	0.9227	0.428	0.5413	0.0316*	0.0653	0.5349	--	0.1452	0.9716	0.564
P place (p-value)	0.7647	0.254	0.9657	0.3406	0.8425	0.8548	--	0.6803	0.2839	0.782
N rate X P Place (p-value)	0.131	0.801	0.841	0.7051	0.9769	0.964	--	0.8721	0.937	0.973
Grand Mean	168.9	88.6	5103.0	235.2	37.0	228.1	83.0	5256.7	238.3	36.1
CV	12.49	1.94	5.74	1.35	1.82	17.35	--	4.84	1.43	2.18
N rate										
75 kg/ha	170.8	88.3	5015.1	237.8a	37.5	221.4	83.0	5092.3	238.6	35.8
100 kg/ha	169.3	89.3	5179.7	234.6ab	36.8	241.3	83.0	5347.7	238.2	36.3
125 kg/ha	166.6	88.3	5114.0	233.3b	36.7	221.5	83.0	5330.0	238.2	36.2
P Place										
Side-band (SB)	167.6	89.0	5100.3	235.8	37.1	226.5	83.0	5234.1	239.1	36.1
Seed-place (SP)	170.2	88.2	5105.6	234.6	37.0	229.6	83.0	5279.2	237.5	36.1
N rate X P Place										
75 kg/ha SB	182.3	88.5	5050.1	239.0	37.6	221.9	83.0	5030.3	239.4	35.8
100 kg/ha SB	159.2	90.0	5129.7	235.5	36.9	240.9	83.0	5335.4	239.3	36.4
125 kg/ha SB	161.2	88.5	5121.2	233.1	36.7	216.8	83.0	5336.6	238.6	36.3
75 kg/ha SP	159.2	88.0	4980.2	236.7	37.5	220.9	83.0	5154.2	237.7	35.9
100 kg/ha SP	179.4	88.5	5229.7	233.7	36.8	241.8	83.0	5360.0	237.2	36.2
125 kg/ha SP	172.0	88.0	5106.8	233.4	36.7	226.2	83.0	5323.4	237.7	36.1

[y]The analyses only includes the side-banded nitrogen treatments within the split-plot, with nitrogen rate and phosphorus rate analyzed as a two-way factorial

[z]Significance level of the p-value: *p<0.05, ** p<0.01, *** p<0.001

Table 7. Statistical Analyses and treatment means for nitrogen placement (N place) and nitrogen rate (N rate) in 4R Management: Right Rate and Placement for Fertilizer in Oats at Scott and Melfort, SK in 2023. Means within a column followed by the same letter do not significantly differ (Tukey-Kramer, P ≤ 0.05).

	Scott [y,z]					Melfort [y,z]				
	PPMS	DTM	Yield	TW	TKW	PPMS	DTM	Yield	TW	TKW
N place (p-value)	0.8023	0.205	0.2164	0.0017**	0.175	0.0857	--	0.5767	0.085	0.202
N rate (p-value)	0.2853	0.844	0.0478*	0.4997	0.6091	0.3375	--	0.0071**	0.7512	0.792
N place X N rate (p-value)	0.7819	0.762	0.3975	0.1604	0.4751	0.5272	--	0.1122	0.9165	0.967
Grand Mean	170.9	88.8	4926.1	235.8	36.7	249.5	83.0	5236.1	238.5	36.4
CV	11.47	2.0	7.01	1.01	2.13	14	--	2.85	1.41	3.22
N place										
Midrow-band (MB)	171.5	89.4	4746.7	236.9a	36.5	269.3	83.0	5193.0	239.6	36.8
Side-band (SB)	170.2	88.2	5105.6	234.6b	37.0	229.6	83.0	5279.2	237.5	36.1
N rate										
75 kg/ha	161.4	89.0	4661.9b	236.5	37.0	250.5	83.0	5084.7b	239.1	36.3
100 kg/ha	176.1	88.9	5139.9a	235.8	36.6	262.4	83.0	5247.6ab	237.9	36.7
125 kg/ha	175.1	88.5	4976.6ab	235.0	36.7	235.5	83.0	5375.9a	238.7	36.4
N place X N rate										
MB 75 kg/ha	163.6	90.0	4343.6	235.3	36.4	280.1	83.0	5015.3b	240.5	36.7
MB 100 kg/ha	172.7	89.3	5050.1	237.9	36.3	283.0	83.0	5135.2ab	238.6	37.1
MB 125 kg/ha	178.2	89.0	4846.4	236.7	36.7	244.8	83.0	5428.4a	239.6	36.7
SB 75 kg/ha	159.2	88.0	4980.2	236.7	37.5	220.9	83.0	5154.2ab	237.7	35.9
SB 100 kg/ha	179.4	88.5	5229.7	233.7	36.8	241.8	83.0	5360.0ab	237.2	36.2
SB 125 kg/ha	172.0	88.0	5106.8	233.4	36.7	226.2	83.0	5323.4ab	237.7	36.1

[y]The analyses only includes the side-banded and midrow-banded nitrogen treatments with seed-placed phosphorus. The two-way interaction of N place and N rate was analyzed as a split-plot with placement as the main plot and nitrogen rate as the sub-plot.

Extension

The Northeast Agriculture Research Foundation presented the results of this demonstration at the Prairie Oat Grower's Annual Conference on December 6, 2023 in Winnipeg, MB. The presentation slides have been made available on the POGA website. The project was not included as a formal presentation, but was passed by with treatment and funder signage at the NARF & AAFC Joint annual field day on July 26th, 2023. The final project report will be made available on both the Northeast Agriculture Research Foundation's (neag.ca) and the Western Applied Research Corporation's (warc.ca) websites.

Conclusions and Recommendations

Describe what was learned from the demonstration. Highlight any significant conclusions and provide recommendations for the application and adoption of the project results. Be sure that you have presented the relevant data to support your conclusions. Identify any further research, development and communication needs, if applicable.

In 2023 in this demonstration, nitrogen rate significantly affected yield and test weight, nitrogen placement only significantly affected test weight, while there were no significant treatment effects of phosphorus. Nitrogen rate was significantly different at both sites for grain yield (kg/ha) when comparing treatments 4-9. At Melfort grain yield was maximized at 125kg/ha of N and at Scott grain yield was maximized at 100kg/ha of N. At Scott, increasing N rate also reduced test weight significantly from 75kg/ha to 125kg/ha of N, but only when comparing increasing N rate in the side-band alone (treatments 7-12). Furthermore, test weight was reduced from the control at both sites when N was applied as compared to the control. Test weight was reduced by up to 10g/0.5L at Scott and 12g/0.5L at Melfort when N was applied. As for N placement, the only significant effect was at Scott for test weight. Test weight was reduced by 2.3g/0.5L when N was side band as compared to midrow banded. Although not significant, it is important to note that side-banding N also tended to increase yield as compared to midrow-banding. The conditions of the 2023 growing season were hot and dry at both locations, so it is important to note that the response of oats to nitrogen rate, placement and phosphorus may differ from that of a year with greater precipitation and temperatures more comparable to the long-term average. Other considerations, such as variety characteristics and residual soil nutrients also have the potential to impact the response of oats to N and P fertilization. In conclusion, the results of this one-year demonstration suggest that applying high rates of N (100-125kg/ha) will maximize oat yields, but applying high rates and side banding N may reduce test weights.

Multi-year Summary:

This project was conducted in 2022 (ADOPT20211039) as well using the same protocol as 2023. Because of this a 2-year combined analysis was also completed on the data collected, although the results were not included in this one-year report. The demonstration was completed at 2 sites (Scott and Melfort) over 2 seasons (2022 & 2023), so there were 4 site years for the combined analysis. For the combined analysis, seed placed phosphorus (4418.8kg/ha) significantly ($p=0.0194$) increased grain yield from the untreated control (4052.4kg/ha), but not as compared to side-banded phosphorus (4199.1kg/ha). Grain yield was also significantly ($p=0.0091$) increased when nitrogen was side-band (5338.3kg/ha) as compared to midrow-banded (5156.4kg/ha), and test weight was significantly reduced ($p=0.0330$) when nitrogen was side-band (239.6g/0.5L) as compared to midrow-banded (241.1g/0.5L). As for the response to nitrogen rate, there was a tendency for yield to increase as nitrogen rate increased, but the difference between rates was never significant. Overall, side-banding nitrogen, and seeding placing phosphorus were the best options for optimizing oat yields, whereas high nitrogen rates often decreased test weights and increased yields, but the optimal rate was dependent on the year and site conditions.

Sustainable Canadian Agricultural Partnership (Sustainable CAP) Performance Indicators

a) List of performance indicators

Sustainable CAP Indicator	Total Number
Scientific publications from this project (List the publications under section b)	
• Published	00
• Accepted for publication	00
HQPs trained during this project	
• Master's students	00

• PhD students	00
• Post docs	00
Knowledge transfer products developed based on this project (presentations, brochures, factsheets, flyers, guides, extension articles, podcasts, videos). List the knowledge transfer products under section (c)	1 to date1 to date

[1] Please only include the number of unique knowledge transfer products.

b) List of scientific journal articles published/accepted for publication from this project.

Title	Author(s)	Journal	Date Published or Accepted for Publication	Link (if available)

c) List of knowledge transfer products/activities developed from this project.

Knowledge Transfer Product or Activity	Event/Location Where Knowledge Transfer Was Conducted	Estimated Number of Producers Participated In Knowledge Transfer	Link (if available)
Prairie Oat Grower's Conference	Winnipeg, MB December 6, 2023	100100	McInnes-POGA-AGM.pdfMcInnes-POGA-AGM.pdf

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Appendices

Identify any changes expected to industry contributions, in-kind support, collaborations or other resources.

Nothing to report at this time.

Expenditure Statement

You must provide an expenditure statement showing how ADOPT funds were used. Expenditures must be reported using the budget categories shown in Appendix B of your contract. We recommend that you report your expenditures using the Excel spreadsheet we have developed for this purpose (ADOPT Expenditure Statement.xls). That spreadsheet is available from the research branch project manager or the evaluation coordinator.
Note that the ADOPT contract requires you to retain all receipts and financial records relating to the project for at least six years after the project is completed.

See attached budget spreadsheet