PCDF

Parkland Crop Diversification Foundation

2021 ANNUAL REPORT

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Introduction

The Parkland Crop Diversification Foundation (PCDF) is located in Roblin, in the Parkland region of Manitoba. PCDF works closely with the board of directors, Manitoba Agriculture, producers, industry and cooperating research institutions, including the Manitoba Diversification Centres: Canada-Manitoba Crop Diversificaiton Centre (CMCDC) in Carberry, Prairies East Sustainability Agricultural Initiative (PESAI) in Arborg, and Westman Agricultural Diversification Organization (WADO) in Melita.

The 2021 season came with an ambitious project list and dry weather conditions. Thanks to all the PCDF staff: Jessica Frey, Brooklyn Bartel, Mackenzie Kozak, Sara Marzoff, and Ella Marzoff. Special thanks goes to Cynthia Nerbas, who retired after 18 years of working with PCDF's finances.

Funding is essential for PCDF's everyday activities to occur. This year PCDF received core funding and support from the Canadian Agricultural Partnership (CAP) and Agriculture Sustainability Initiative (ASI) programs, as well as from trial cooperators, producers, and members of the local community. PCDF is always open to project ideas and learning about the production concerns of local producers, so please feel free to contact us with any project proposals. For project submissions or additional information, please refer to the Contact info supplied on this website.

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PCDF Board of Directors

Executive

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Han Keller	Benito

**Laurie Radford, Cynthia Nerbas, and John Sandborn stepped down from the board after the 2021 growing season. Thanks to them for their many years of valuable service!*

Partners

Agricultural and Agri-Food Canada
Canadian Hemp Trade Alliance
Canola Performance Trials
Crop Development Centre
Ducks Unlimited Canada
Linseed Coop
Manitoba Agriculture
Manitoba Crop Variety Evaluation Team
Manitoba Diversification Centres
Murphy et al.
Parkland Coop
Parkland Industrial Hemp Growers
Participatory Plant Breeding Project
Pepsi-co/Quaker Oats
Phillex Ltd.
Saskatchewan Pulse Growers
Saskatchewan Variety Performance Group
University of Alberta
University of Manitoba
University of Saskatchewan

Meteorological Data

Table 1: Roblin 2021 Season Report by Month (based on 30-year average)

Month	Precipitation		Corn Heat Units		Growing Degree Days	
	Actual	Normal	Actual	Normal	Actual	Normal
April	12	24	100	33	22	7
May	50	45	281	321	148	172
Jun	62	73	596	530	380	314
Jul	37	71	723	645	467	392
Aug	82	56	568	587	360	354
Sep	16	53	448	292	266	163
Oct	20	26	172	42	92	11

Information gathered from Manitoba Agriculture Growing Season Report website at https://web43.gov.mb.ca/climate/SeasonalReport.aspx

Table 2: Roblin 2021 Season Summary April 1 – October 31

	Actual	Normal	% of Normal
Number of Days	214	-	-
Growing Degree Days	1739	1415	123
Corn Heat Units	2891	2452	118
Total Precipitation	282	350	81

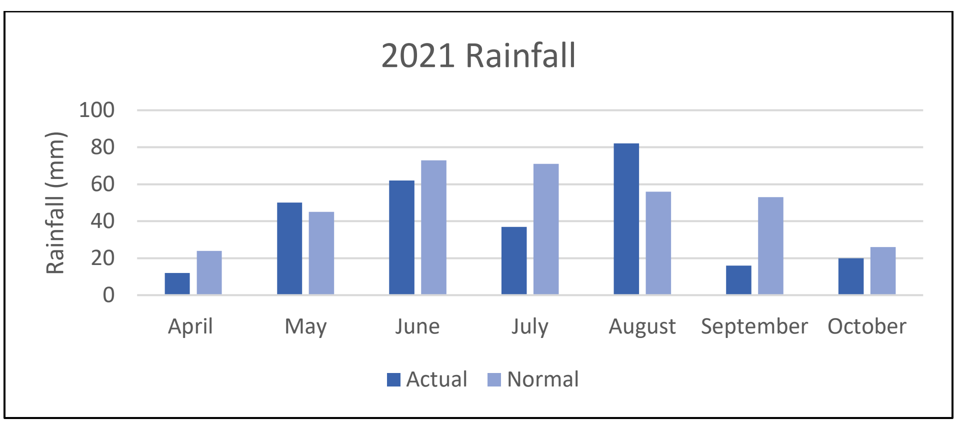

Figure 1: Roblin 2021 Precipitation by Month April – October

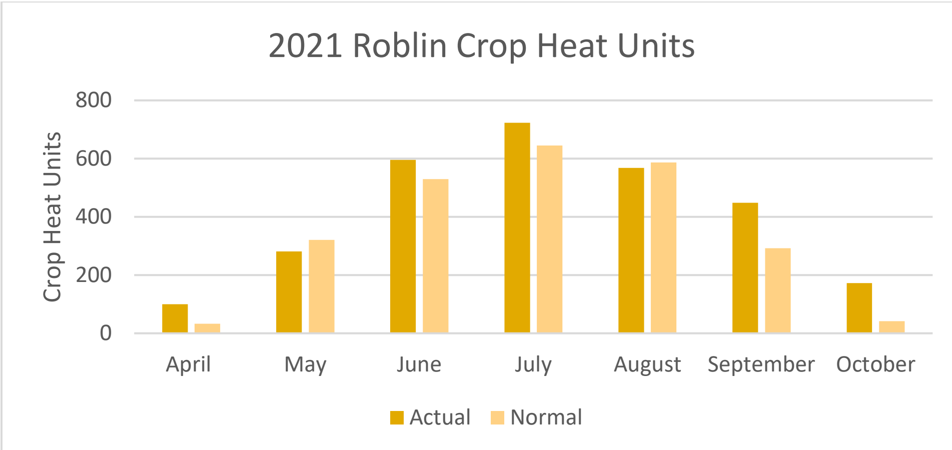

Figure 2: Roblin 2021 Crop Heat Units by Month April-October

Extension Activities

Due to the COVID-19 pandemic, key extension events were cancelled: Ag Days and CropConnect.

Table 1: PCDF 2021 Extension Activities

Name	Medium	Date	Location
Field Day	Tour	Aug 9	Roblin

PCDF Field Trials

Plot information

At seeding: 9m x 1.2m
Trimmed: 7m x 1.2m
Plot Area: $10.8m^2$
Alleyways: 2m

Equipment

5-Row Fabro Disc Seeder
Plot Sprayer
Wintersteiger Plot Combine

Manitoba Crop Variety Evaluation (MCVET) Trials

Manitoba Crop Variety Evaluation Trials (MCVET) facilitates variety evaluations of many different crop types in this province. The purpose of MCVET trials is to grow both familiar (checks or reference) and new varieties side by side in a replicated manner in order to compare and contrast various variety characteristics such as yield, maturity, protein content, disease tolerance, and many others.

During 2021, PCDF did variety evaluations for winter wheat, fall rye, oat, barley, fababean, pea, forage, and flax. Yearly data is collected, combined, and summarized in the *Seed Manitoba Guide*. Hard copies are available at most Manitoba Agriculture and agriculture industry offices.

Table 2: 2021 MCVET Trials*

Crop type	Stubble	Seeding Date	Fertility Applied N-P-K in lb/ac	Weed/Insect Control (rate/acre)	Harvest Date	# of plots
Barley	Oat	May 6	31-15-0	Curtail @ 810 ml/ac and Puma @ 271 ml/ac on June14	Sep 8	33
Oats	Oat	May 4	162-41-0	Curtail @ 810 ml/ac and Dicamba @ 117 ml/ac on June 14	Sep 7	15

Flax	Oat	May 19	27-10-0	Bentazon @ 910 ml/ac, Centurion @ 150 ml/ac and Amigo at 1 L/ac on June 22	Sep 13	21
Fababean	Oat	May 4	0-10-0	Bentazon @ 910 ml/ac and Bromoxynil @ 400 ml/ac plus Merge @ 700 ml/ac	Sep 22	45
Fall Rye	Oat	Sep 18	105-20-0	Curtail @ 810 ml/ac and Puma @ 271 ml/ac	Aug 12	18
Forage	Oat	May 20	10-10-0	None	Aug 12 and Sep 18	36
Winter Wheat	Oat	Sep 18	105-20-0	Curtail @ 810 ml/ac and Puma @ 271 ml/ac	Aug 12	18
Total plots						**150**

* See *Seed Manitoba Guide* or visit websites *www.seedinteractive.ca* or *www.seedmb.ca*.

Table 3: Summary of 2021 PCDF Trials

Crop Type	Collaborators	Purpose	# Plots
Barley, 2-row	Saskatchewan Variety Performance Group	Variety trial	84
Canola and wheat	University of Manitoba	Year 1 establishment (2021-2023)	48
Corn	Agricultural and Agri-Food Canada	Variety trial	90
	Agricultural and Agri-Food Canada	Corn nursery	500
Flax	Linseed Coop	Variety trial	24
Fruit demonstration	PCDF	Sour cherry and Haskap	10
Green manure	PCDF	Year 4 of a 6-year rotation	28
Hemp	Canadian Hemp Trade Alliance	National Industrial Hemp Variety Evaluation Trials	44
Hops	PCDF	Year 4 of hopyard	24
Intercropping	PCDF	Barley-clover intercrop	15
	PCDF	Canola-clover intercrop	15
	PCDF	Oat-clover intercrop	15
	PCDF	Wheat-clover intercrop	15
	PCDF	Chicory-cereal intercrop	36
	PCDF	Wheat-phacelia intercrop	15
	PCDF	Hemp-cereal intercrop mixes for silage production	48
	PCDF	Pea-cereal intercrop mixes for silage production	44
	Manitoba Diversification Centres	Peas intercropped with flax, oat, canola mustard and spring wheat	21
Oats (organic)	Agricultural and Agri-Food Canada	Evaluation of new oat lines being developed for organic production	75

	University of Manitoba	Evaluation of new oat lines being developed for organic production	72
Oats	Agricultural and Agri-Food Canada	Variety Trial	147
	University of Saskatchewan	Variety Trial	132
Peas	Sask Pulse Growers	Variety Trial	90
	University of Manitoba	Establishment year for stubble, tillage and phosphorus trial in 2022	
	University of Manitoba	Year 2 of stubble, tillage, and phosphorus placement	48
Soybean	Agriculture and Agri-Food Canada	Assessment of soy protein by variety	80
	Sask Pulse Growers	Assessment of long season and short season varieties	168
Spring wheat	Parkland Coop	Variety trial	81
	Saskatchewan Variety Performance Group	Variety trial	144
Spring wheat (organic)	University of Manitoba	Participatory Plant Breeding program	93
Winter wheat	Ducks Unlimited	Evaluate management practices for high yielding winter wheat	42

Table 4: 2021 PCDF Exclusive Trials

Crop Type	Collaborators	Number of Plots
Canola	Canola Performance Trials	92
Cereals	University of Manitoba	108
Fusarium Head Blight Risk Model	University of Manitoba	40
Oat	Pepsi-Co/Quaker Oats	80
Oat	Murphy et al, Inc	237

Table 5: 2021 PCDF Discontinued Trials

Crop Type	Collaborators	Purpose	Number of Plots
Intercropping – Wheat-Lupin	PCDF	Evaluation of seeding rates	18
Quinoa	Phillex	Variety trial	21

Canola Performance Trials

In 2021, PCDF participated in the Canola Performance Trials, as part of the straight-cut trials. Despite a very dry season, the conditions in Roblin allowed for strong results.

[From the Canola Performance Trials 2021 report:] The small plot system approach ensures that:

- All varieties are treated with appropriate commercially associated herbicides: LibertyLink, Roundup Ready, TruFlex and Clearfield (in Manitoba only).
- All varieties are treated with appropriate commercially associated seed treatments.
- An independent third-party representative inspects all trials.

The trials are funded by the Manitoba Canola Growers Association, Saskatchewan Canola Development Commission (SaskCanola), and Alberta Canola Producers Commission (Alberta Canola). Manitoba Canola Growers administered the program, with additional support from Alberta Canola, SaskCanola, and the Canola Council of Canada.

Roblin 2021 straight-cut results

Seeding date (all varieties)		**May 20**				
Harvest date (all varieties)		**September 14**				
Herbicide application (all varieties)		**June 22**				
Distributor	**Variety**	**Yield (bu/ac)**	**Yield (% 45CM39)**	**Gross Revenue/ac**	**Days to maturity**	**Lodging (1-9; 1=low)**
LibertyLink						
BASF - InVigor	InVigor L233P	61	117	$ 1,237	93	1
BASF - InVigor	InVigor L340PC	62	119	$ 1,265	93	1
BASF - InVigor	InVigor L345PC	63	120	$ 1,272	94	1
BASF - InVigor	InVigor L357P	62	118	$ 1,254	93	1
BASF - InVigor	InVigor L255PC	60	116	$ 1,224	95	1
Corteva-Brevant	B3010M	51	98	$ 1,034	97	1
Corteva-Pioneer	P506ML	59	112	$ 1,191	95	1
Canterra Seeds	CS4000 LL	58	110	$ 1,167	97	1
Bayer-DEKALB	DKLL 82 SC	54	104	$ 1,101	95	1
Bayer-DEKALB	DKTFLL 21 SC	51	98	$ 1,037	94	1
	LSD	5	9			
Roundup						
Corteva-Brevant	45CM39	52	100	$ 1,060	107	1
Corteva-Pioneer	D3158CM	54	103	$ 1,094	100	1
	LSD	1	2			
TruFlex						
Bayer-DEKALB	DKTF 99 SC	58	110	$ 1,169	99	1
Bayer-DEKALB	DKTF 96 SC	48	91	$ 969	102	1
Bayer-DEKALB	DKTF 97 CRSC	50	95	$ 1,011	98	1
Nutrien-Proven Seeds	PV 761 TM	48	93	$ 983	104	1
WinField United-CROPLAN	CP21T3P	51	97	$ 1,025	105	1
BrettYoung Seeds	BY 6211TF	53	102	$ 1,078	101	1
Canterra Seed	CS2600 CR-T	55	105	$ 1,109	101	1
	LSD	6	12			

Agronomic Trials

Determining Optimum Target Plant Stands for Spring Cereal Crops in Manitoba

Project duration: May 2019 – August 2021

Objectives: 1) Determine if target plant stand recommendations should be adjusted for spring wheat, oat, and barley
2) Determine if optimum plant stands differ for individual varieties
3) Assist producers with determining target plant stand and seeding rate for newer spring cereal varieties

Collaborators: Anne Kirk, Manitoba Agriculture; Manitoba Agriculture Diversification Centres

Background

Yield of spring cereals is impacted by many agronomic practices, but starts with variety selection, seeding date, target plant stand, and the seeding rate needed to achieve those plant stands. Optimum plant population is determined by factors including crop management practices and growing conditions. Manitoba Agriculture currently recommends target plant stands of 23-28 plants/ft2 for spring wheat, 18-23 plants/ft2 for oat, and 22-25 plants/ft2 for barley. With the introduction of semi-dwarf and higher yielding cultivars, target plant stands may need to be adjusted to maximize profitability. Pervious research has shown that optimum plant populations can differ by both crop type and variety. In a North Dakota study, Mehring et al. (2016) found that optimum seeding rates for spring wheat ranged from 14 to 46 plants/ft2 depending on the characteristics of the variety.

Results

Plant Stand

Stand establishment increased as seeding rate increased at most site years. There was no significant difference in plant stand between seeding rate treatments for wheat at Roblin, results will not be shown for this site as a range of plant populations were not established. At many locations plant stands were lower than the target. The exception was Arborg where plant stands ranged from 18-57, 12-47, and 25-35 plants/ft^2 in the barley, oat, and wheat plots, respectively (Table 4).

Table 4. Plant stand (plants/ft^2) for barley, oat, and wheat at the Arborg (Arb), Carberry (Car), Melita (Mel), and Roblin (Rob) locations. Barley varieties are CDC Austenson (A) and AAC Connect (B), oat varieties are CS Camden (A) and Summit (B), and wheat varieties are AAC Brandon (A) and Faller (B). Least significant difference (LSD) values are shown for sites where there is a significant difference (Pr<0.05) between treatments. At sites with significant differences between treatments, means within the same site year followed by the same letter within a column are not significantly different.

	Barley				Oat			Wheat			
	Arb	Car	Mel	Rob	Arb	Mel	Rob	Arb	Car	Mel	Rob
	plants/ft^2										
Variety											
A	40	15	16.3b	18	33	17a	12	29	19	14	11
B	43	14	17.8a	18	29	13b	10	31	21	14	13
LSD	-	-	*1.3*	-	-	*2*	-	-	-	-	-
Target Plant Population (pl/ft^2)											
9	18e	6d	7f	8c	12e	6f	6f	25d	9e	6d	11
15	36d	10cd	12e	14b	23d	10e	9ef	27cd	15d	10c	12

21	40cd	13bc	15d	17b	29cd	14d	10de	30bc	20c	13b	11
27	47bc	14b	19c	21a	34bc	16c	12cd	33ab	23bc	16b	17
33	53ab	19ab	23b	23a	40b	21b	14bc	33ab	26b	19a	11
39	57a	24a	28a	23a	47a	24a	16a	35a	30a	19a	9
LSD	*9*	*5*	*2*	*3*	*7*	*3*	*3*	*5*	*3*	*3*	-

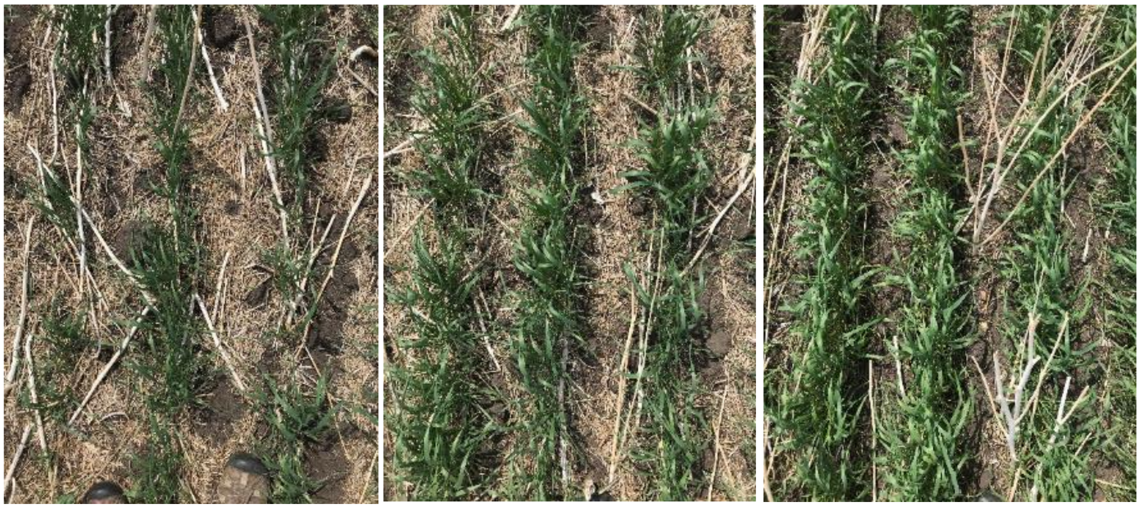

Figure 1. AAC Brandon wheat planted at target plant stands of 9, 21, and 33 plants/ft^2 at Melita in 2021.

<u>Heading</u>

Cereals can compensate for lower plant populations by increasing tillering. Research in which spring wheat plants were given ample room found that stems per plant ranged from 19 to 44 depending on the variety (Wiersma 2014). While cereal cultivars have differing abilities to tiller, at the majority of sites there was no difference in heads per plant between cultivars (Table 5). The actual number of spikes or panicles present at maturity depends on the number of tillers produced and the number that survive to maturity. The effect of drought stress on yield components depends on the timing of drought stress, and early season drought stress reduces yield potential through tiller death (Duggan et al. 2000). This is evident in the results from the Arborg location, where heads per plant were low across all crop types and treatments.

Heads per plant decreased as seeding rate increased, which demonstrates the ability of cereal crops to compensate for reduced plant populations by increasing tillering (Table 5). There was no significant difference in heads per plant at target plant populations ranging from 21-39 plants/ft^2 at five out of the eight sites where there were significant differences in heads per plant.

Table 5. Heads per plant for barley, oat, and wheat at the Arborg, Carberry, Melita, and Roblin locations. Barley varieties are CDC Austenson (A) and AAC Connect (B), oat varieties are CS Camden (A) and Summit (B), and wheat varieties are AAC Brandon (A) and Faller (B). Least significant difference (LSD) values are shown for sites where there is a significant difference (Pr<0.05) between treatments. At sites with significant differences between treatments, means within the same site year followed by the same letter within a column are not significantly different. Roblin wheat data is not shown due to high coefficients of variation.

	Barley			**Oat**			**Wheat**		
	Arborg	Carberry	Roblin	Arborg	Melita	Roblin	Arborg	Carberry	Melita
	--- Heads/plant ---								
Variety									
A	0.8	6.0	6.8	0.77	1.7b	6.03	1.1	5.8	2.7
B	0.8	5.7	6.7	0.89	2.2a	6.74	1.2	5.9	2.8
LSD	-	-	-	-	*0.2*	-	-	-	-
Target Plant Population (pl/ft^2)									
9	1.5a	6.5ab	10.2a	1.2a	3.2a	7.8	1.8a	6.7a	4.3a
15	0.9b	6.8a	7.9b	0.7b	2.2b	6.7	1.3b	5.9b	3.1b
21	0.7c	5.1c	7.2b	0.8b	1.8bc	6.9	1.2b	5.8b	2.6bc
27	0.6c	5.5c	5.7c	0.9b	1.7cd	6.0	0.9c	5.6b	2.3c
33	0.6c	5.7bc	4.5c	0.8b	1.4d	5.8	0.9c	5.5b	2.0c
39	0.5c	5.3c	4.9c	0.7b	1.4d	5.1	0.8c	5.8b	2.2c
LSD	*0.2*	*0.9*	*1.4*	*0.3*	*0.4*	-	*0.3*	*0.8*	*0.7*

<u>Yield</u>

Wheat

There were significant yield differences between the wheat varieties at the three locations where yields are reported, with AAC Brandon yielding significantly higher than Faller at two sites (Table 6). Yields were generally low at Arborg and Carberry due to drought conditions, with Carberry yields being further reduced as a result of hail.

When averaged across cultivars, there were no differences in wheat yield across plant densities at Melita. At the Carberry location yields increased as plant stand increased, with the highest yields being reported at target plant densities of 27 to 39 plants/ft^2 (Table 6, Figure 2). At Arborg, the 9 plants/ft^2 treatment had the lowest yield overall, with 33 plants/ft^2 yielding the highest (Table 6, Figure 2). Actual plant populations ranged from 9 to 30 plants/ft2 at Carberry, 6 to 19 plants/ft2 at Melita, and 25-35 plants/ft2 at Arborg. Figure 3 shows yield plotted against plant stand, giving context to the results. There was no interaction between seeding rate and cultivar, both cultivars responded similarly to higher seeding rates (data not shown).

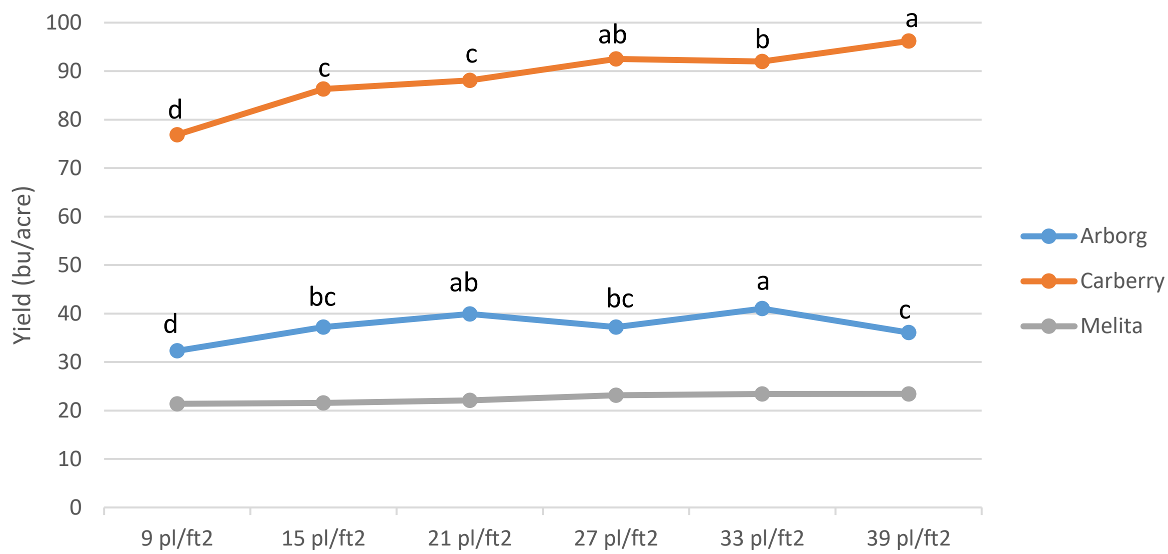

Figure 2. Wheat yield (bu/acre) at six target plant densities at Arborg, Carberry and Melita. Statistically significant differences are shown by letters above the line. Treatments within the same site with the same letter are not significantly different (P<0.05).

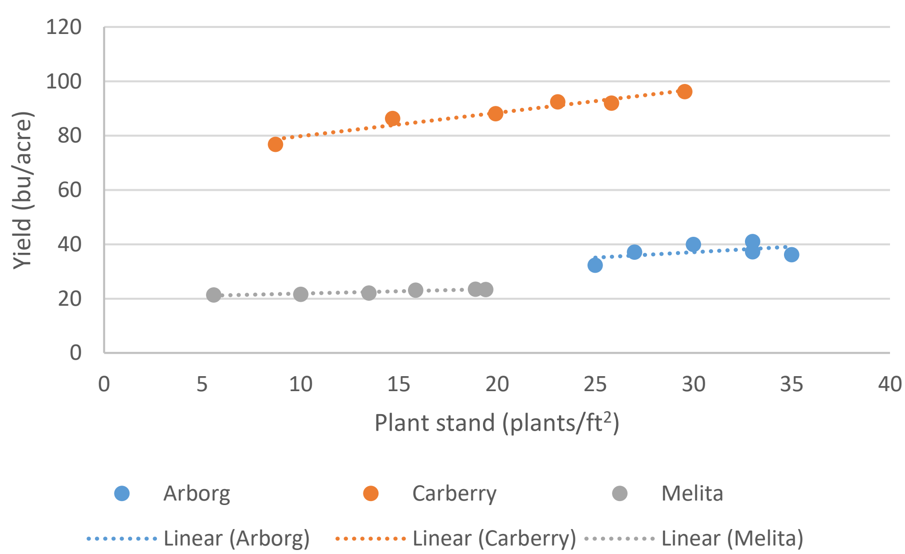

Figure 3. Wheat yield (bu/acre) plotted against actual plant density (plants/ft^2) at Arborg, Carberry and Melita. Statistically significant differences for plant stand and yield can be found in Tables 4 and 6, respectively.

Barley

There were no significant yield differences between barley varieties at three of four locations. At Arborg, CDC Austenson yielded significantly higher than AAC Connect (Table 6). When averaged across cultivars, there were no significant yield differences between target plant stands at three of the four locations. There were only significant yield differences between target plant densities at Arborg, with the 9 plants/ft^2 treatment yielding significantly lower than the higher target plant densities (Figure 4 and Table 6). Actual plant populations ranged from 6 to 28 plants/ft^2 at Carberry, Melita, and Roblin, and 18 to 57 plants/ft^2 at Arborg (Table 4). Figure 5 shows yield plotted against plant stand, giving context to the results and highlighting the higher plant populations at Arborg. There was no interaction between plant density and cultivar, both cultivars responded similarly to higher seeding rates (data not shown).

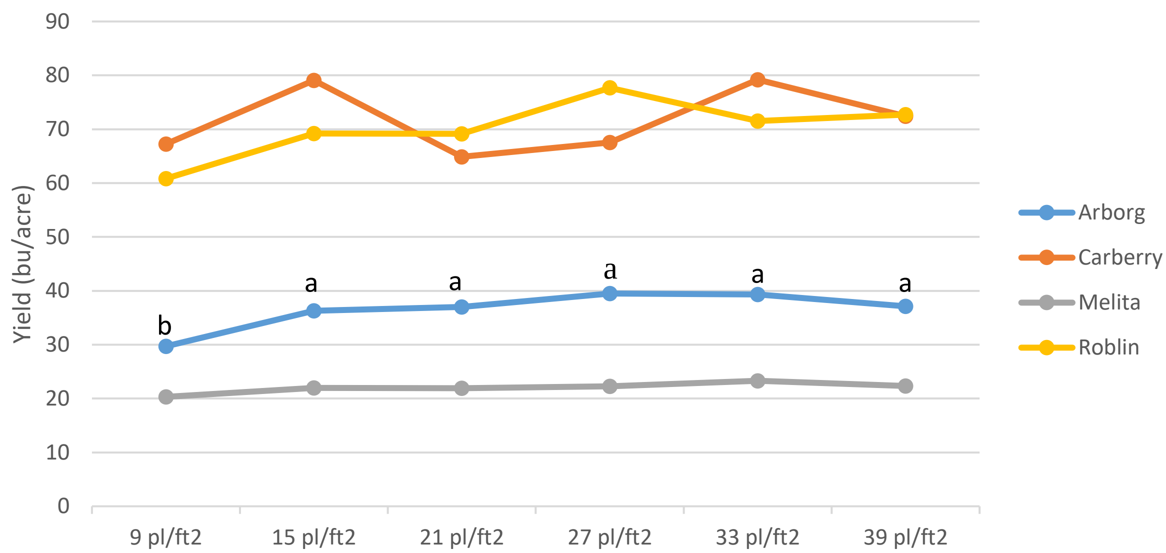

Figure 4. Barley yield (bu/acre) at six target plant densities at Arborg, Carberry, Melita, and Roblin. Statistically significant differences are shown by letters above the line. Treatments within the same site with the same letter are not significantly different (P<0.05).

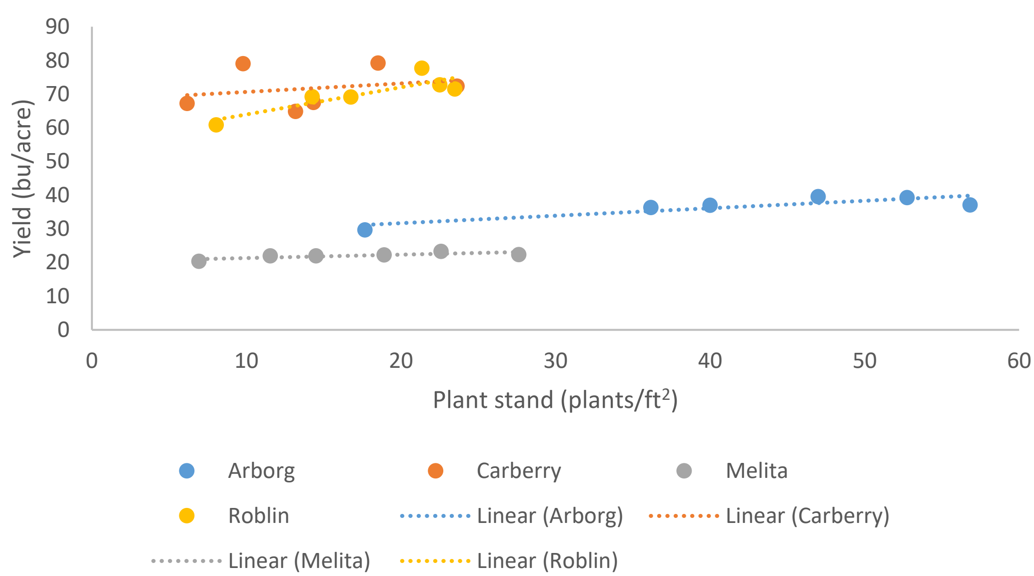

Figure 5. Barley yield (bu/acre) plotted against actual plant density (plants/ft^2) at Arborg, Carberry Melita, and Roblin. Statistically significant differences for plant stand and yield can be found in Tables 4 and 6, respectively.

Oat
There was a significant yield difference between the two oat varieties at two of the three locations, with CS Camden yielding higher than Summit in both cases (Table 6). Averaged across cultivars, there was no difference in oat yield across the range of target plant densities at two of the three locations. There were significant yield differences across target plant densities at the Arborg location, but no consistent trend (Figure 6). Oat yield plotted against plant stand is shown in Figure 7. There was no interaction between plant density and cultivar, both cultivars responded similarly to higher seeding rates (data not shown).

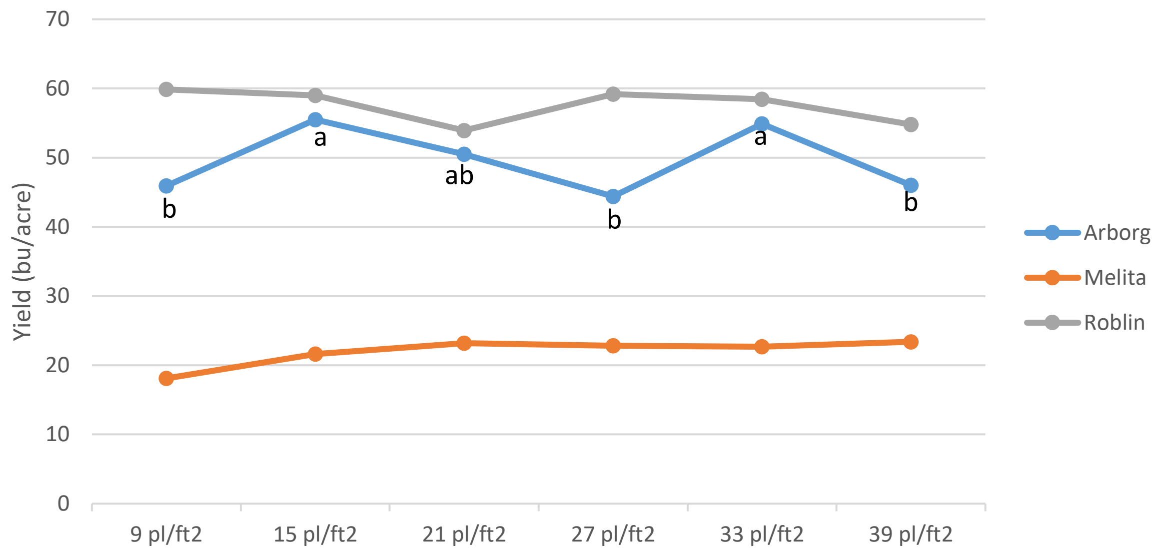

Figure 6. Oat yield (bu/acre) at six target plant densities at Arborg, Melita, and Roblin. Statistically significant differences are shown by letters below the line. Treatments within the same site with the same letter are not significantly different (P<0.05).

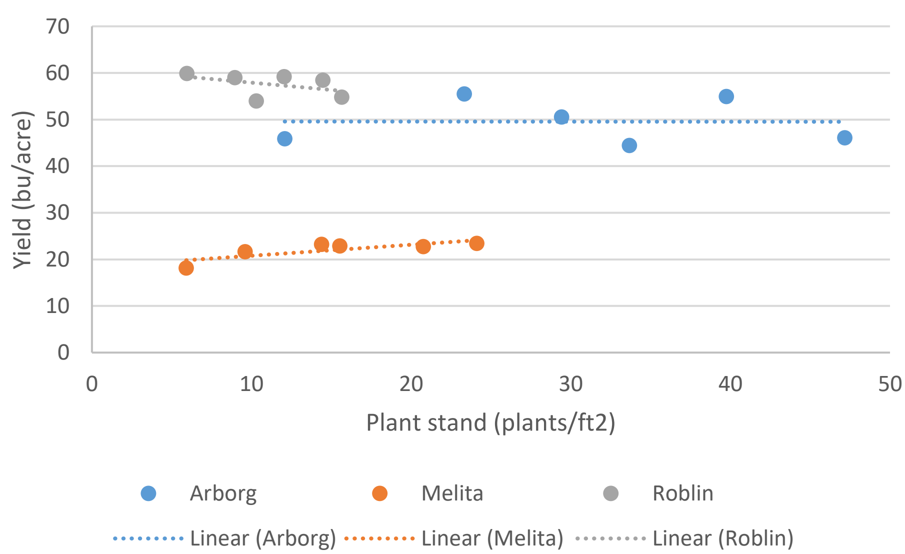

Figure 7. Oat yield (bu/acre) plotted against actual plant density (plants/ft^2) at Arborg, Melita, and Roblin. Statistically significant differences for plant stand and yield can be found in Tables 4 and 6, respectively.

Table 6. Yield (bushels/acre) for barley, oat, and wheat at the Arborg, Carberry, Melita, and Roblin locations. Barley varieties are CDC Austenson (A) and AAC Connect (B), oat varieties are CS Camden (A) and Summit (B), and wheat varieties are AAC Brandon (A) and Faller (B). Least significant difference (LSD) values are shown for sites where there is a significant difference (Pr<0.05) between treatments. At sites with significant differences between treatments, means within the same site year followed by the same letter within a column are not significantly different.

	Barley				Oat			Wheat		
	Arborg	Carberry	Melita	Roblin	Arborg	Melita	Roblin	Arborg	Carberry	Melita
	------------ Yield (bu/acre) ------------									
Variety										
A	38.5a	73.9	22.0	70.9	53.8a	21.1	86.9a	38.3a	84.9b	23.6a
B	34.4b	69.5	22.1	69.5	45.3b	22.8	28.1b	36.3b	92.4a	21.4b
LSD	*2.3*	-	-	-	*4.1*	-	*4*	*2.0*	*2.7*	*0.9*
Target Plant Population (pl/ft^2)										
9	29.7b	67.2	20.3	60.8	45.9b	18.1	59.9	32.3d	76.9d	21.4
15	36.3a	79.1	22.0	69.2	55.5a	21.6	59.0	37.2bc	86.3c	21.6
21	37.0a	64.9	21.9	69.1	50.5ab	23.2	53.9	39.9ab	88.1bc	22.1
27	39.5a	67.5	22.3	77.7	44.4b	22.8	59.2	37.2bc	92.5ab	23.2
33	39.3a	79.2	23.3	71.5	54.9a	22.7	58.4	41.0a	92.0b	23.4
39	37.1a	72.4	22.4	72.7	46.0b	23.4	54.8	36.1c	96.2a	23.4
LSD	*4*	-	-	-	*7*	-	-	*3.5*	*4.7*	-

This study is a continuation of a research project that took place at Arborg, Carberry, Melita, and Roblin in 2017 and 2018. The oat and barley sites in 2017 and 2018 showed similar yields across a range of plant stands, indicating that the current recommended target plant populations for barley and oat are sufficient. At the wheat sites in 2017 and 2018 there was a general trend of higher yields with increased plant stands, but no significant difference in yields between target plant stands of 21 to 39 plants/ft^2 at four of the five sites.

The 2021 results are similar, in that there were no significant yield differences across the range of plant densities at most sites. There was a general trend of higher yields with higher plant stands at the wheat, barley, and one of the oat sites, although the data indicates that these trends should be taken with caution. There were no significant difference in yields between target plant stands of 21 to 39 plants/ft^2 at nine out of the 10 sites. At all sites, both varieties tested responded similarly to each target plant stand, indicating that similar seeding rate recommendations could be made for both varieties of each crop type studied.

Materials and methods

- Locations: Arborg, Carberry, Melita, and Roblin
- Year: 2021
- Experimental Design: Randomized complete block design with factorial treatments and replicated three times

- Treatments: Two cultivars of spring wheat, oat, and barley planted at six seeding rates. Target plant populations were 9, 15, 21, 27, 33, and 39 plants/ft^2. See Table 1 for a complete treatment list.
    - Experiments were separated by crop type
    - Seeding rates were calculated based on thousand kernel weight and assumed 15% seedling mortality
- Data Collection: Plant stand, mortality, heads per plant, and yield.
    - Carberry oat plots had poor emergence and were terminated.
    - Melita had hail on July 17. It is estimated that the hail resulted in 20% yield loss in the wheat, and 30% yield loss in the barley and oats.

Table 1. Crop types, varieties, and target plant stands studied.

Crop Type	Variety	Target Plant Stand (pl/ft^2)
Spring Wheat	AAC Brandon	9, 15, 21, 27, 33, 39
	Faller	9, 15, 21, 27, 33, 39
Oat	CS Camden	9, 15, 21, 27, 33, 39
	Summit	9, 15, 21, 27, 33, 39
Barley	AAC Connect	9, 15, 21, 27, 33, 39
	CDC Austenson	9, 15, 21, 27, 33, 39

Table 2. Agronomic information

	Arborg	Carberry	Melita	Roblin
Soil Series	Peguis Clay	Wellwood Loam	Waskada Loam	Erickson Loamy Clay
Wheat				
Seeding Date	07-May	3-May	4-May	6-May
Fertility (lb/ac)				
Residual	93 N, 44 P	12 N, 4 P, 158 ppm K, 12 S	10 N, 14 P, 364 K, 90 S	93 N, 46 ppm P, 709 ppm K
Applied	60 N, 20 P	78 N, 34 P, 15 K	105 N, 28 P, 20 K, 12 S	96 N, 15 P
Harvest Date	17-Aug	13-Aug	4-Aug	31-Aug
Oat				
Seeding Date	10-May	-	6-May	4-May
Fertility (lb/ac)				
Residual	93 N, 44 P	-	10 N, 14 P, 364 K, 90 S	162 N, 41 ppm P, 703 ppm K
Applied	60 N, 20 P	-	112 N, 28 P, 20 K, 12 S	10 N, 15 P
Harvest Date	18-Aug	-	6-Aug	15-Sep
Barley				
Seeding Date	10-May	30-Apr	4-May	6-May
Fertility (lb/ac)				
Residual	93 N, 44 P	12 N, 4 P, 158 ppm K, 12 S	10 N, 14 P, 364 K, 90 S	93 N, 46 ppm P, 709 ppm K
Applied	60 N, 20 P	78 N, 34 P, 15 K	105 N, 28 P, 20 K, 12 S	31 N, 15 P
Harvest Date	18-Aug	13-Aug	4-Aug	8-Sep

Table 3. Monthly and growing season (May 1 - September 30) summaries. (Data from Manitoba Agriculture Growing Season Report web43.gov.mb.ca/climate/SeasonalReport.aspx)

	May	June	July	August	September	Growing Season
Arborg						
Precipitation (mm)	19	39	11	116	34	221
% of Normal precipitation[1]	36	51	20	147	71	69
Growing degree days (GDD)	163	412	502	397	291	1767
% of Normal GDD[1]	80	122	116	103	153	114
Carberry						
Precipitation (mm)	36	74	12	111	8	243
Normal precipitation[1]	75	106	17	158	16	79
Growing degree days (GDD)	156	419	496	389	308	1770
Normal GDD[1]	85	125	117	100	161	116
Melita						
Precipitation (mm)	28	87	35	125	13	289
Normal precipitation[1]	52	86	51	160	38	86
Growing degree days (GDD)	108	426	522	426	323	1878
Normal GDD[1]	88	121	115	103	153	115
Roblin						
Precipitation (mm)	50	62	37	82	16	249
Normal precipitation[1]	111	84	52	148	31	83
Growing degree days (GDD)	148	380	467	360	266	1623
Normal GDD[1]	86	121	119	102	163	116

[1]Based on 30-year averages

All sites has lower than normal precipitation over the entire growing season. Arborg had very low precipitation throughout May, June, and July, which resulted in short plants, few tillers, and low yields overall. Low precipitation was especially evident at all sites in July, where Arborg and Carberry had 20 and 17% or normal precipitation, respectively, and Melita and Roblin has 51 and 52% of normal precipitation, respectively. July was warmer than normal at all locations, and the warm and dry conditions affected plant growth and development.

References

Crop Production. 2020. Manitoba Agriculture. Available online.

Duggan, B.L., Domitruk, D.R., and Fowler, D.B. 2000. Yield component variation in winter wheat grown under drought stress. Can. J. Plant Sci. 80: 739-745.

Mehring, G., Wiersma, J., and Ransom, J. 2016. What do the results from the recent seeding rate studies suggest for new spring wheat varieties? NSDU Crop and Pest Report. Available online.

Wiersma, J. 2014. Optimum seeding rates for diverse HRSW varieties. 2014 Research Report. Northwest Research and Outreach Centre, NDSU, Crookston. Available online.

FHB Risk Model University of Manitoba – Barley, Durum, Spring Wheat, Winter Wheat

Project duration: September 2019 – August 2021
Objectives: To increase understanding of resulting Fusarium Head Blight (FHB) infection for spring and winter wheat, barley and durum based on the current model.
Collaborators: Manasah Mkhabela PhD., Research Associate University of Manitoba Soil Science

Background
Farmers need improved decision-making tools in order to assess the local risk of Fusarium Head Blight (FHB). Better tools would improve judgement on whether or not to use fungicide and how to time application. The project recognizes that the current model for predicting the presence of FHB is insufficient and is gathering data across the province for different treatment plans using both known fusarium resistant and fusarium susceptible varieties.

This project design centred on learning more about how spore density in the air at specific times of plant maturation affected FHB infection. The specific window of interest is during flowering and up to five days before flowering.

Results
Grain samples sent away to analyze for grading, fusarium species assessment, and mycotoxin analysis. PCDF will post a link when this report is available.

Materials and methods
Entries: 3 varieties for each winter wheat, spring wheat and barley; 1 variety for durum
Seeding: Winter wheat seeded 09.18.20; barley, spring wheat and durum seeded 05.13.21
Harvest: 08.25.21

Table 1: Varieties in 2021 FHB Trial

Winter Wheat	Spring Wheat	Barley	Durum
Moats	AAC Elie	CDC Copeland	Strongfield
AAC Gateway	AAC Brandon	AAC Connect	
Emerson	Muchmore	AAC Synergy	

Data collected	Date collected
Plant Counts:	Three leaf stage (and spring emergence for winter wheat)
Plant Staging:	Weekly staging beginning at late booting through late flowering
Spore Traps:	Beginning just before winter wheat flowering spanning five weeks and covering all cereals flowering
FHB sampling:	18-21 days after flowering – Enumeration of FHB afflicted kernels per head in a given sample size of fifty heads per plot
Heights:	Aug 5
Yield:	Aug 31
Moisture:	Aug 31

Agronomic info
Previous year's crop: Oat Silage
Soil Type: Erickson Clay Loam

Landscape: Rolling with trees to the east
Seedbed preparation: Tilled once and then harrowed

Table 2: Fertility Information for Barley, Wheat, and Durum

	Available	Added for Barley	Added for Wheat	Added for Durum
N	93 lb/ac	83 lb/ac	96 lb/ac	96 lb/ac
P	46 ppm	10 lb/ac	10 lb/ac	10 lb/ac
K	709 lb/ac	-	-	-

Table 3: Fertility Information for Winter Wheat

	Available	Added
N	52.7	105
P	70.5	20
K	410.0	-

N side banded; P banded with seed

Table 4: Herbicide Application

Crop stage	Date	Product	Rate	
Pre-emerge	Sep 12	Glyphosate	640	ml/ac
		Heat	28	g/ac
In-crop	Jun 14	Curtail M	810	ml/ac
		Puma	271	ml/ac

Yellow Pea Response to Preceding Crop, Residue Management, and P Fertilizer Placement

Project duration: 2020 – 2022
Objectives: Determine the effect of preceding crop, residue management and P fertility strategy, and their interactions, on pea establishment, weed community, disease incidence, yield, and seed quality
Collaborators: Kristen MacMillan – Soybean and Pulse Agronomy and Cropping Systems Research Lab, University of Manitoba

Background (provided by Kristen MacMillan)
In Manitoba, 38% of pea acres are grown on wheat stubble and 20% on canola stubble [Manitoba Agricultural Services Corporation (MASC) 2010-2015]. The yield impact of preceding crop on pea yield is not currently known despite some obvious agronomic concerns. Crop rotation data from MASC (2010-2015) points to some of these risks by showing that the relative yield of pea grown on wheat stubble is 103% compared to 96% for peas grown on canola stubble. Canola is a non-mycorrhizal crop and a host to Sclerotinia white mould. Peas are also susceptible to white mould and are a mycorrhizal crop, therefore, may be negatively affected by reduced AMF populations and increased sclerotinia risk following canola stubble. Starter P is commonly recommended in fields with low soil test levels. We aim to investigate if there is an interaction between field pea response to P fertilizer and preceding stubble type arising from the mycorrhizal and non-mycorrhizal crops. Little research has been conducted on P fertilizer strategy in field pea and strategies vary widely among farmers. In an informal Twitter poll in August 2019, the majority of farmers apply P fertilizer as starter in the seed row (44%) followed by side band or mid placement (26%), seed row plus side band or mid row (14%) and none (16%). According to the 2015 fertilizer use survey, only 45% of western Canadian farmers are applying P, primarily in the seed row (44%) and at an average rate of 19 lbs P205/ac. Yield response to 25 kg ha-1 of starter P has been documented, but no work is currently available on P fertilizer placement. Overall, there are fewer agronomic risks associated with seeding peas into wheat stubble. Peas are also tolerant to early seeding into cool soil and present an opportunity for reduced or rotational no-till systems in regions of Manitoba where tillage is common practice.

Results
In 2020, spring wheat and canola crops were established on Site 1 (Year 1) to provide the residue treatments for the Site 1 (Year 2) pea test. In 2021, pea plots were established on Site 1 (Year 2), with differing methods of phosphorous application. Spring wheat and canola crops were also established on Site 2 (Year 1) to provide the residue treatments for the Site 2 (Year 2) pea test. Target spring wheat and canola seeding rates for both years are shown in Table 1. Treatments for Years 1 and 2 are shown in Table 2. Spring wheat, canola and pea yields for Site 1 (Year 1) and Site 2 (Year 1) are shown in Table 3.

Table 1: Targets

	Seeding Rate seeds/ft2	Live Plant Stand plants/ft2	Seed Survival %
Wheat	32	27	85
Canola	10	6	60

Table 2: Treatment Structure

Treatment No	Year 1 crop	Residue Management	Year 2 (Pea) Phosphorus Application
1	Wheat	Tilled	None
2	Wheat	Tilled	Seed row
3	Wheat	Tilled	Side band
4	Wheat	Direct Seed	None
5	Wheat	Direct Seed	Seed row
6	Wheat	Direct Seed	Side band
7	Canola	Tilled	None
8	Canola	Tilled	Seed row
9	Canola	Tilled	Side band
10	Canola	Direct Seed	None
11	Canola	Direct Seed	Seed row
12	Canola	Direct Seed	Side band

Table 3: Average yield comparison (bu/ac) for wheat and canola (Site 1, Year 1; Site 2; Year 1)

Treatment	Site 1		Site 2
	(Year 1)	(Year 2)	(Year 1)
Canola	67.2	-	60.5
Wheat	88.3	-	49.0
Pea			
Canola, tilled – No added P	-	23.4	-
Canola, direct seed – No added P	-	23.9	-
Canola, tilled – Side band P	-	23.7	-
Canola, direct seed – Side band P	-	26.7	-
Canola, tilled – Seed row P	-	23.2	-
Canola, direct seed – Seed row P	-	22.9	-
Wheat, tilled – No added P	-	23.9	-
Wheat, direct seed – No added P	-	20.8	-
Wheat, tilled – Side band P	-	21.9	-
Wheat, direct seed – Side band P	-	25.0	-
Wheat, tilled – Seed row P	-	21.9	-
Wheat, direct seed – Seed row P	-	23.0	-

Materials and methods

Experimental Design: Rectangular Lattice

Varieties: Wheat – AAC Brandon; Canola – L233P; Pea – AC Carver

	Seeding date	Harvest date
Site 1 (Year 1)	May 19, 2020	Sept 22, 2020
Site 1 (Year 2)	May 10, 2021	Aug 31, 2021
Site 2 (Year 1)	May 19, 2021	Sept 20, 2021

Agronomic information

Previous year's crop: Barley silage (2020); Oat Silage (2021)

Soil Type: Erickson Clay Loam

Seedbed preparation: Vertical Tilled

Data collected	Date collected		
	Site 1 (Year 1)	Site 1 (Year 2)	Site 2 (Year 1)
Plant density	Jun 16	Jun 16	Jun 16
Disease risk at wheat flag leaf	Jun 24	-	Jun 6-15
Pea Root Rot Rating	-	Jun 16	-
Pea Shoot Symptoms Rating	-	Jul 6	-
Mycosphaerella Blight Rating	-	Jun 16	-
Disease risk at canola anthesis (20-50% bloom)	Jul 8-15	-	Jul 2
Days to Maturity Rating	-	Beginning of August	-
Height	Aug 15	-	early Aug
Lodging	Aug 15	Aug 18	Sep 20

Table 3: Site 1 (Year 1) fertility information

	Available	Wheat Added	Canola Added	Type
N	58 lb/ac	131 lb/ac	96 lb/ac	46-0-0
P	71 ppm	15 lb/ac	10 lb/ac	11-56-0-0
K	513 ppm	-	-	-

Table 4: Site 2 (Year 1) fertility information

	Available	Wheat Added	Canola Added	Type
N	120 lb/ac	69 lb/ac	55 lb/ac	46-0-0
P	48 ppm	20 lb/ac	20 lb/ac	11-56-0-0
K	674 ppm	-	-	-

Table 5: Site 2 (Year 1) Pesticide Application

Crop stage	Date	Product	Rate
Pre-emerge	May 26	Liberty	0.54 ml/ac
In-crop	Jul 9	Decis	0.82 ml/ac

Table 6: Site 1 (Year 2) Pesticide Application

Crop stage	Date	Product	Rate
Pre-emerge	May 19	Authority	118 ml/ac
In-crop	Jun 14	Viper (ADV)	400 ml/ac
		UAN 28%	810 ml/ac

Barley Trials

SVPG 2-Row Barley Variety Evaluation

Project duration: May – September 2021
Objectives: Evaluate 2-row barley varieties for the Saskatchewan Variety Performance Group
Collaborators: SVPG, Saskatchewan Agriculture

Background
(From the Saskatchewan Wheat Development Commission website): The Saskatchewan Variety Performance Group (SVPG) is an informal group made up of stakeholders who are interested in variety performance testing in Saskatchewan. SVPG has coordinated the post-registration regional performance testing of spring wheat, durum, barley, oats, and flax varieties since 2006. The data collected from these trials is entered into annual publications "Varieties of Grain Crops" and the Saskatchewan Seed Guide.

Results
The yield results (bu/ac) for the Roblin site are shown in Figure 1. The results are for one site-year only, and should be interpreted with caution. Consult a seed guide for multi-site-year data for available varieties.

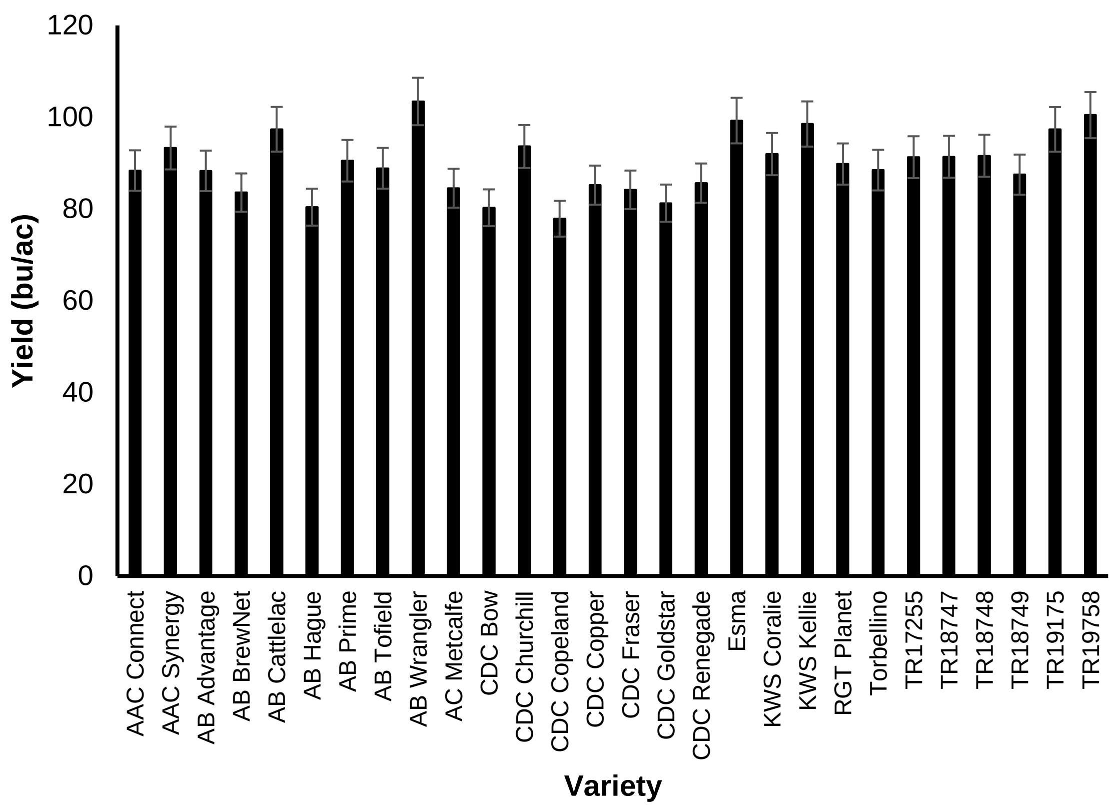

Figure 1: Statistical differences for yield by variety (bu/ac)

Table 1: Means for yield by variety and comparison of statistical difference

Variety	Significant Difference for Yield				Mean (bu/ac)
TR18748	A				105.7
AB Wrangler	A	B			103.4
Esma	A	B	C		99.3
KWS Kellie	A	B	C	D	98.5
TR19175	A	B	C	D	98.3
AB Cattlelac	A	B	C	D	97.4
TR18749	A	B	C	D	94.9
CDC Churchill	A	B	C	D	93.6
AAC Synergy	A	B	C	D	93.3
KWS Coralie	A	B	C	D	92.0
TR18747	A	B	C	D	91.4
TR17255	A	B	C	D	91.3
AB Prime	A	B	C	D	90.5
RGT Planet	A	B	C	D	89.8
TR19758	A	B	C	D	89.7
AB Tofield	A	B	C	D	88.9
Torbellino	A	B	C	D	88.5
AAC Connect	A	B	C	D	88.4
AB Advantage	A	B	C	D	88.3
CDC Renegade	A	B	C	D	85.6
CDC Copper	A	B	C	D	85.2
AC Metcalfe		B	C	D	84.5
CDC Fraser		B	C	D	84.2
AB BrewNet		B	C	D	83.6
CDC Goldstar			C	D	81.3
AB Hague			C	D	80.4
CDC Bow			C	D	80.3
CDC Copeland				D	77.9
LSD	20.7				
% CV	13.9				

Materials and methods

Experimental Design: Random Complete Block Design
Entries: 28 varieties
Seeding: May 6
Harvest: Sep 8

Data collected Date collected
Yield: Sep 8
Moisture: Sep 8

Agronomic info
Previous year's crop: Oat Silage
Soil Type: Erickson Clay Loam
Landscape: Rolling with trees to the east
Seedbed preparation: Vertical Tilled

Table 2: Fertility Information

	Available	Added	Type
N	93 lb/ac	31 lb/ac	46-0-0
P	46 ppm	15 lb/ac	11-52-0-0

Table 3: Spraying Information

Crop stage	Date	Product	Rate
Pre-emerge	Sep 12	Heat LQ	35 ml/ac
		Amigo	750 ml/ac
In-crop	Jun 14	Curtail M	810 ml/ac
		Puma	271 ml/ac

Corn Trials

Agriculture Agri-Food Canada Corn Variety Evaluation

Project duration: May 2021 – October 2021
Objectives: To develop and release early maturing cold tolerant corn inbreds with emphasis on the 1800-2000 CHU market.
Collaborators: Aida Kebede PhD – AAFC Research Scientist Ottawa Research and Development Centre; Manitoba Corn Growers Association

Background
The trial is year four of a five-year project, lead by Dr. Aida Kebede, AAFC-Ottawa (following Dr. Lana Reid's retirement in 2021. The project's objective will be achieved using conventional corn breeding methodology enhanced by double haploid inbred production and specialized screening techniques for cold tolerance and disease resistance. The trial is being conducted at sites across five provinces. The anticipated impact of developing earlier maturing, cold tolerant corn will expand the acreage of corn production in Canada. AAFC will make research findings available at the conclusion of the project.

Materials and methods
Experimental Design: Random Complete Block Design
Entries: 30 varieties
Seeding: May 18
Harvest: Oct 20

Data collected Date collected
Yield: Nov 8
Moisture: Nov 8

Agronomic info
Previous year's crop: Oat Silage
Soil Type: Erickson Clay Loam
Landscape: Rolling with trees to the east
Seedbed preparation: Vertical tilled

Table 1: Fertility Information

	Available	Added	Type
N	93 lb/ac	100 lb/ac	46-0-0
P	46 ppm	20 lb/ac	11-52-0-0
K	709 ppm	N/A	N/A

Table 2: Pesticide Application

Crop stage	Date	Product	Rate
Pre-emerge	May 26	Heat LQ	30 ml/ac
		Sortan	30 g/ac
		Merge	300 ml/ac
In crop	Jun 22	Bentazon	0.91 L/ac
		Bromoxynil	0.40 L/ac

Agriculture Agri-Food Canada Corn Nursery

Project duration: 2018 – October 2023
Objectives: To develop and release early maturing cold tolerant corn inbreds with emphasis on the 1800-2000 CHU market.
Collaborators: Aida Kebede PhD – AAFC Research Scientist Ottawa Research and Development Centre; Manitoba Corn Growers

Background and project findings
The trial is year four of a five-year project, lead by Dr. Aida Kebede, AAFC-Ottawa (following Dr. Lana Reid's retirement in 2021). The project's objective will be achieved using conventional corn breeding methodology enhanced by double haploid inbred production and specialized screening techniques for cold tolerance and disease resistance. The trial is being conducted at sites across five provinces. The anticipated impact of developing earlier maturing, cold tolerant corn will expand the acreage of corn production in Canada. AAFC will make research findings available at the conclusion of the project.

Materials and methods
Experimental Design: 500 row observation nursery
Seeding: May 18
Harvest: Oct 20

Data collected Date collected
Tasseling Date: Jul 21 – Aug 24
Silking Date: Jul 25 – Sep 21
Ear Formation: Jul 27 – Sep 26

Agronomic info
Previous year's crop: Oat Silage
Soil Type: Erickson Loam Clay
Landscape: Rolling with trees to the east
Seedbed preparation: Direct-seed

Table 1: Fertility Information

	Available		Added	Type
N	93	lb/ac	100 lb/ac	46-0-0
P	46	ppm	20 lb/ac	11-52-0-0
K	709	ppm	N/A	N/A

Table 2: Pesticide Application

Crop stage	Date	Product	Rate
Pre-emerge	May 26	Heat LQ	30 ml/ac
		Sortan	30 g/ac
		Merge	300 ml/ac
In crop	Jun 22	Bentazon	910 ml/ac
		Bromoxynil	400 ml/ac

Flax Trials

CDC Linseed Flax Coop Variety Evaluation

Project duration: May 2021 – September 2021
Objectives: To evaluate pre-registration varieties for the Linseed Coop.
Collaborators: Helen Booker – University of Saskatchewan Plant Sciences Flax Breeder
Ken Jackle – Crop Development Centre Flax Breeding Program

Background
The trial was conducted in partnership with Helen Booker and the Prairie Recommending Committee for Oilseeds (PRCO). For further information, contact Ken Jackle: ken.jackle@usask.ca.

Results
The mean yields by named and unnamed varieties are shown in Figure 1. Statistical differences and summary statistics for yield are shown in Table 1. Statistical differences and summary statistics for height are shown in Table 2.

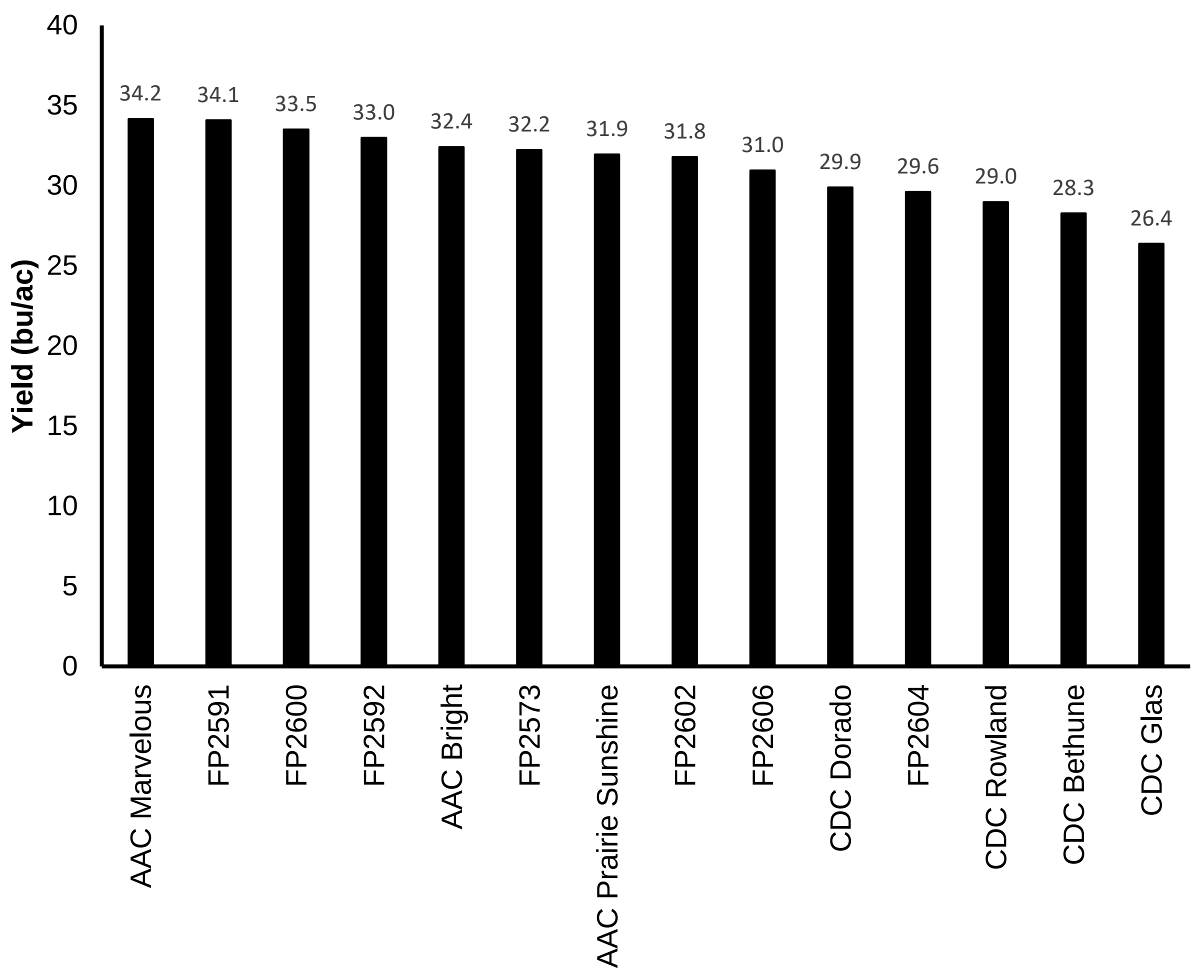

Figure 1: Average yield for linseed entries (bu/ac).

Table 1: Comparison of yield means and statistical difference for linseed entries (varieties connected by the same letter are statistically significant)

Variety	Statistical significance for yield			Yield (bu/ac)
AAC Marvelous	A			34.2
FP2591	A			34.1
FP2600	A	B		33.5
FP2592	A	B		33.0
AAC Bright	A	B		32.4
FP2573	A	B		32.2
AAC Prairie Sunshine	A	B		31.9
FP2602	A	B	C	31.8
FP2606	A	B	C	31.0
CDC Dorado	A	B	C	29.9
FP2604	A	B	C	29.6
CDC Rowland	A	B	C	29.0
CDC Bethune		B	C	28.3
CDC Glas			C	26.4
LSD	5.4			
% CV	11.2			

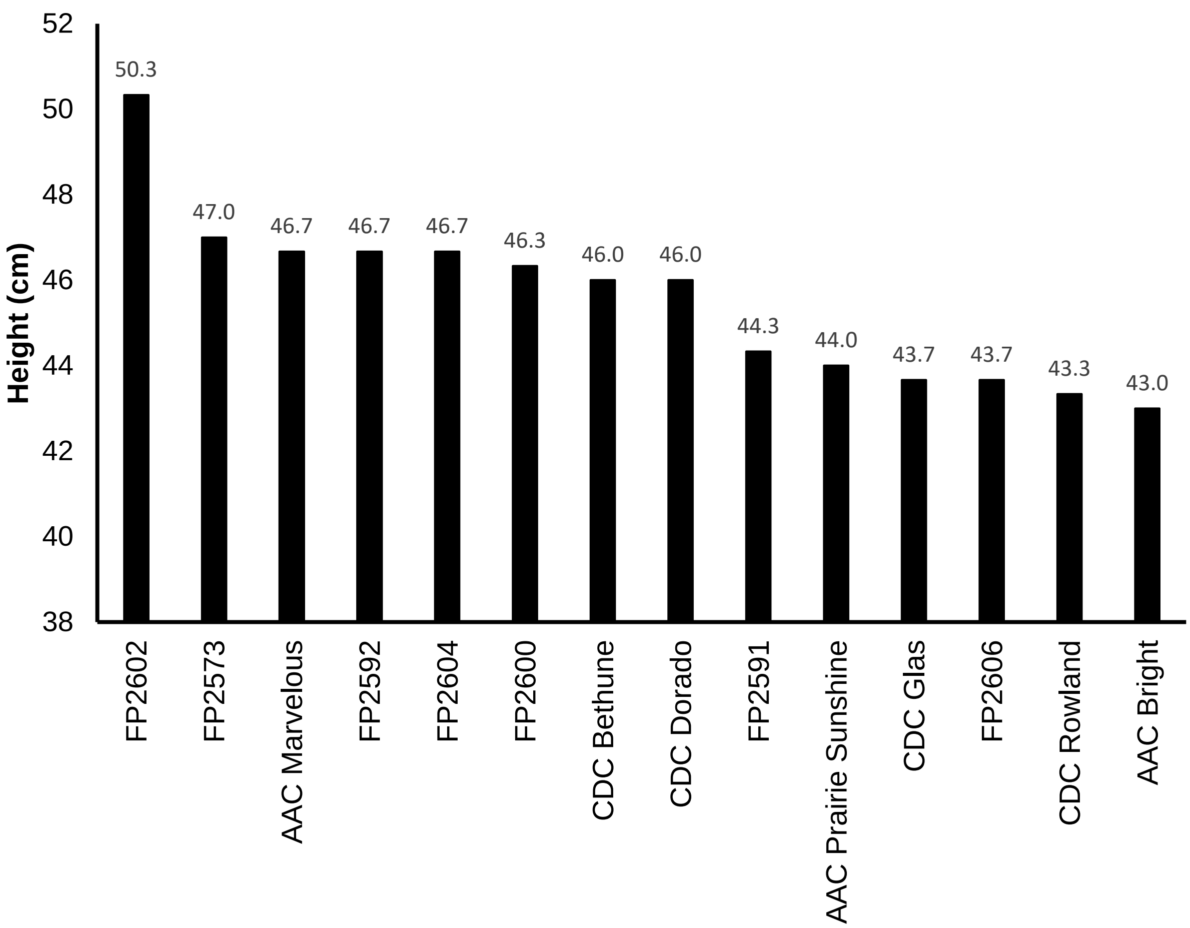

Figure 2: Average height for linseed entries (cm).

Table 2: Comparison of height means and statistical difference for linseed entries (varieties connected by the same letter are statistically significant)

Variety	**Statistical significance for yield**		**Height (cm)**
FP2602	A		50.3
FP2573	A	B	47.0
AAC Marvelous	A	B	46.7
FP2592	A	B	46.7
FP2604	A	B	46.7
FP2600	A	B	46.3
CDC Bethune	A	B	46.0
CDC Dorado	A	B	46.0
FP2591		B	44.3
AAC Prairie Sunshine		B	44.0
CDC Glas		B	43.7
FP2606		B	43.7
CDC Rowland		B	43.3
AAC Bright		B	43.0
LSD	5.3		
% CV	7.1		

Materials and methods

Experimental Design: Random Complete Block Design
Entries: 14
Seeding: May 19
Harvest: Sep 24

Data collected	Date collected
Height:	Aug 16
Determinate Habit:	End of August
Dry down Habit:	End of August
Maturity:	End of August
Lodging:	Sep 24
Yield/moisture:	Oct 15

Agronomic info
Previous year's crop: Oat Silage
Soil Type: Erickson Clay Loam
Landscape: Rolling with trees to the east
Seedbed preparation: Vertical tilled

Table 3: Fertility Information

	Available		Added	Type
N	93	lb/ac	58.7 lb/ac	46-0-0
P	46	ppm	19.0 lb/ac	11-52-0-0
K	709	ppm	-	

P banded with seed; N side-banded

Hemp Trial

National Hemp Variety Field Trial

Project duration: May 2021 – October 2021
Objectives: To evaluate industrial hemp varieties for the National Hemp Variety Field Trials coordinated by the Canadian Hemp Trade Alliance
Collaborators: Canadian Hemp Trade Alliance
Parkland Crop Diversification Foundation (PCDF)
PI, James Frey (Manitoba Agriculture and Resource Development)

Background
Established in 2003, the CHTA is a national organization that aims to develop the Canadian hemp industry. CHTA membership includes farmers, processors, equipment suppliers, consumer product suppliers, consultants, researchers, students, industry associations and government. In 2021, the National Hemp Variety Field Trials were implemented at 9 sites across Canada (NB, QC, MB, SK and AB). The 2021 CHTA report for all sites can be accessed here.

Results
The evaluations tested entries for grain yield (Table 1) and fibre yield (Table 2), cannabinoids (Table 3), and agronomic variables (Table 4). Fibre yield was not calculated for grain-only varieties. The results are adapted from a report compiled from data for all participating trial sites (9 in total).

Table 1: Grain yield by variety (lb/ac)

	Lb/ac	% Check*	Statistical difference**		
Grain entries					
CRS-1	744.3	100%	A		
Katani	423.0	57%	A		
Henola	821.0	110%	A	B	
LSD	154.9				
%CV	14.6				
Dual purpose (grain and fibre) entries					
CRS-1	468.7	100%	C		
CFX-2	455.6	97%	C		
Bialobrzeskie	542.5	116%	C	D	
Angie	562.5	120%	C	D	E
Judy	560.0	119%	C	D	E
Maureen	566.1	121%	C	D	E
Quida	638.2	136%		D	E
Vega	669.8	143%			E
LSD	115.8				
%CV	13.0				

* Check = CRS-1, repeated for both grain and dual purpose entries
** Columns with the same letters are not statistically different

Table 2: Fibre yield by variety (lb/ac)

	Lb/ac	% Check*	Statistical difference**			
CRS-1	2012.5	100%	A	B		
CFX-2	1590.0	79%		B		
Bialobrzeskie	3352.5	167%			C	
Angie	2885.0	143%			C	D
Judy	2337.5	116%	A			D
Maureen	2400.0	119%	A			D
Quida	2602.5	129%	A			D
Vega	2597.5	129%	A			D
LSD	608.2					
%CV	15.4					

* Check = CRS-1

** Columns with the same letters are not statistically different

Table 3: Cannabidiol (CBD) and Cannabigerol (CBG) content by variety (%)*

	CBD	CBG
CRS-1	0.97	0.03
Angie	1.22	0.02
Bialobrzeskie	0.86	0.02
CFX2	1.27	0.04
Henola	1.27	0.06
Judy	1.03	0.02
Katani	1.15	0.03
Maureen	1.27	0.04
Quida	0.73	0.01
Vega	0.80	0.02

* Derived from leaf and flower parts from upper 20 cm of plant

Table 4: Agronomic characteristics by variety

	Grain Entries			**Dual Purpose Entries**							
Cultivar	**CRS-1**	**Katani**	**Henola**	**CRS-1**	**CFX-2**	**Bialobrzeskie**	**Angie**	**Judy**	**Maureen**	**Quida**	**Vega**
Early vigour[1]	7.3	7.5	6.8	7.0	7.3	7.5	7.0	7.0	7.0	6.5	7.8
Plant height (cm)[2]	144	126	135	140	130	172	164	156	151	155	152
Disease incidence[3]	0.1	0.1	0.3	0.0	0.4	0.1	0.1	0.4	0.6	0.3	0.3

[1] At canopy closure, 1-10 (1=low).

[1] From ground to top of inflorescence, one week prior to harvest.

[1] Sclerotinia, 0-5 (1=20%, 2=40%, 3=60%, 4=80%, 5=100%).

Figure 1: a) hemp plant, b) hemp plant at flowering, c) hemp plant nearing grain maturity, d) hemp plant with trichomes forming on flower and leaf parts, e) close-up of trichomes on a hemp leaf, f) hemp flowers

Materials and methods

Experimental Design:	Random Complete Block Design
Entries:	3 grain entries and 8 dual purpose entries, 4 replications
Seeding:	May 28
Fibre Harvest:	Aug 27
CBD Harvest:	Aug 27
Grain Harvest:	Sep 29

Data collected	**Date collected**
Emergence:	Second week of June
Mortality plant counts:	Jun 22
Stem Elongation plant counts:	Beginning of July
Height:	End of August
Fibre Wet Yield:	Aug 28
Fibre Dry Yield:	Sep 15
Grain Yield:	Oct 28
Grain Moisture:	Oct 28
CBD levels	Aug 28

Agronomic info (Roblin)	
Previous year's crop:	Oat Silage
Soil Type:	Erickson Loam Clay
Landscape:	Rolling with trees to the east
Seedbed preparation:	Vertical Tilled

Table 7: Fertility Information (Roblin)

	Available	Added	Type
N	120 lb/ac	52 lb/ac	46-0-0
P	52 ppm	20 lb/ac	11-52-0-0
K	670 ppm		

Table 8: Herbicide Application (Roblin)

Crop stage	Date	Product	Rate
Pre-emerge	May 26	Liberty	540 ml/ac
No in-crop			

PCDF In-House Trials

Barley-Cover Crop (Year 1 and 2)

Project duration: May 2020 – September 2021
Objectives: To evaluate intercropping potential for barley and cover crops
Collaborators: PCDF

Background
The Manitoba Agriculture website states that producers may plant cover crops to minimize wind and water erosion. Cover crops can play an important role after low-residue crops, such as soybean and potatoes, or in spring as a new crop is establishing. Another import function is to immobilize excess nutrients, especially nitrogen, and prevent losses. Additionally, cover crops can help to trap snow, enhancing moisture conditions in spring.

Despite these benefits, the limited growing season before or after another crop can make establishing cover crops a challenge. A common practice is to establish a cover crop in-season, with a cash crop. This trial examined the effect of establishing four cover crops with barley.

Results
The data presented here are for Years 1 and 2 of a multi-year study. Figure 1 shows a comparison of barley yield (bu/ac) by treatment for 2020 and 2021.

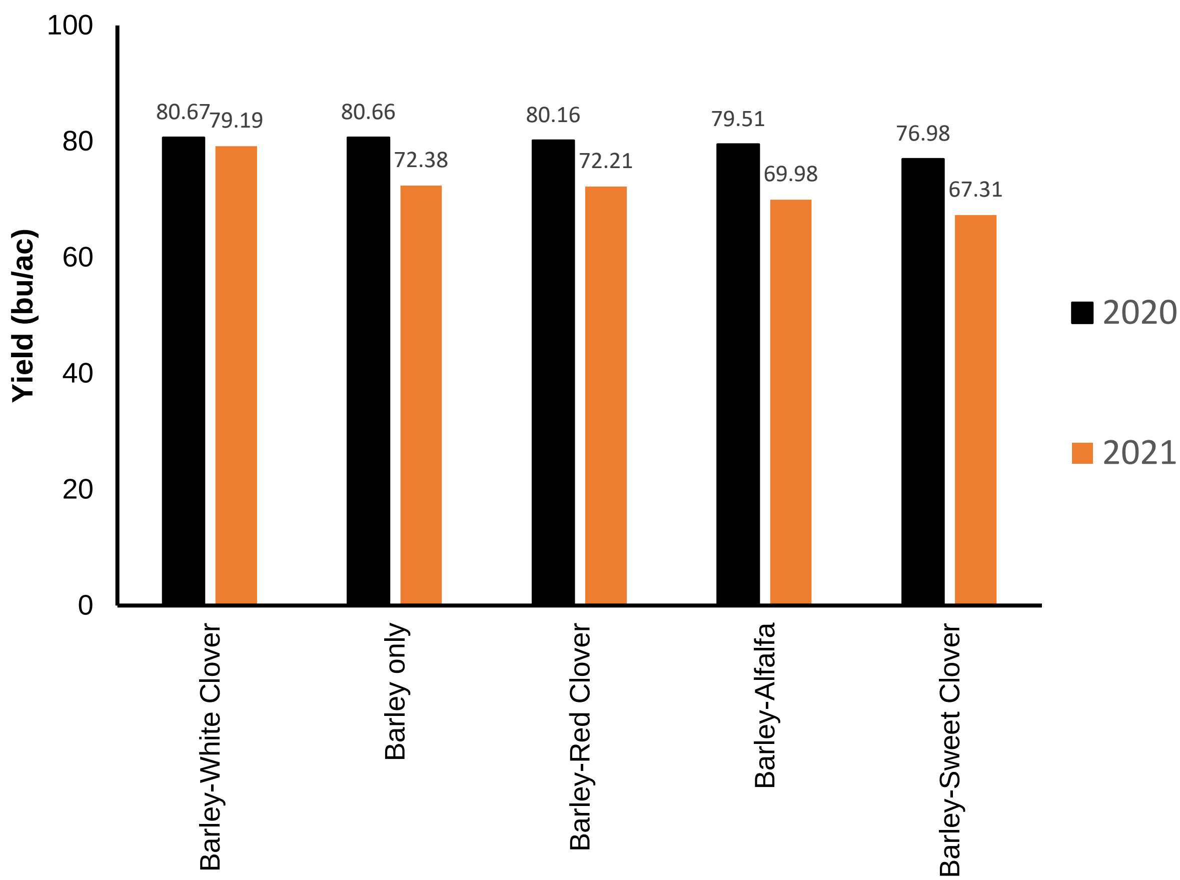

Figure 1: Average yield for barley-cover crop by treatment (2020-2021).

In 2020, there was no significant difference between treatments, indicating that seeding a cover crop with barley did not affect barley yield. However, in 2021, a difference was observed between treatments (Table 1).

Table 1: Comparison of yield means and statistical difference for barley-cover crop entries for 2020 and 2021 (varieties connected by the same letter are statistically significant)

	Statistical significance for yield			**Yield (bu/ac)**	
Variety	**2020**	**2021**		**2020**	**2021**
Barley-White Clover	A	A		80.67	79.19
Barley only	A	A	B	80.66	72.38
Barley-Red Clover	A	A	B	80.16	72.21
Barley-Sweet Clover	A	A	B	76.98	69.98
Barley-Alfalfa	A		B	79.51	67.31
LSD				**9.17**	**10.24**
% CV				**5.64**	**10.06**

Figure 2 shows forage July 2021 yields for cover crops seeded in 2020. Note that yields for white clover are for two reps only, and are included for reference only. All results are for one year only, and should be interpreted with caution.

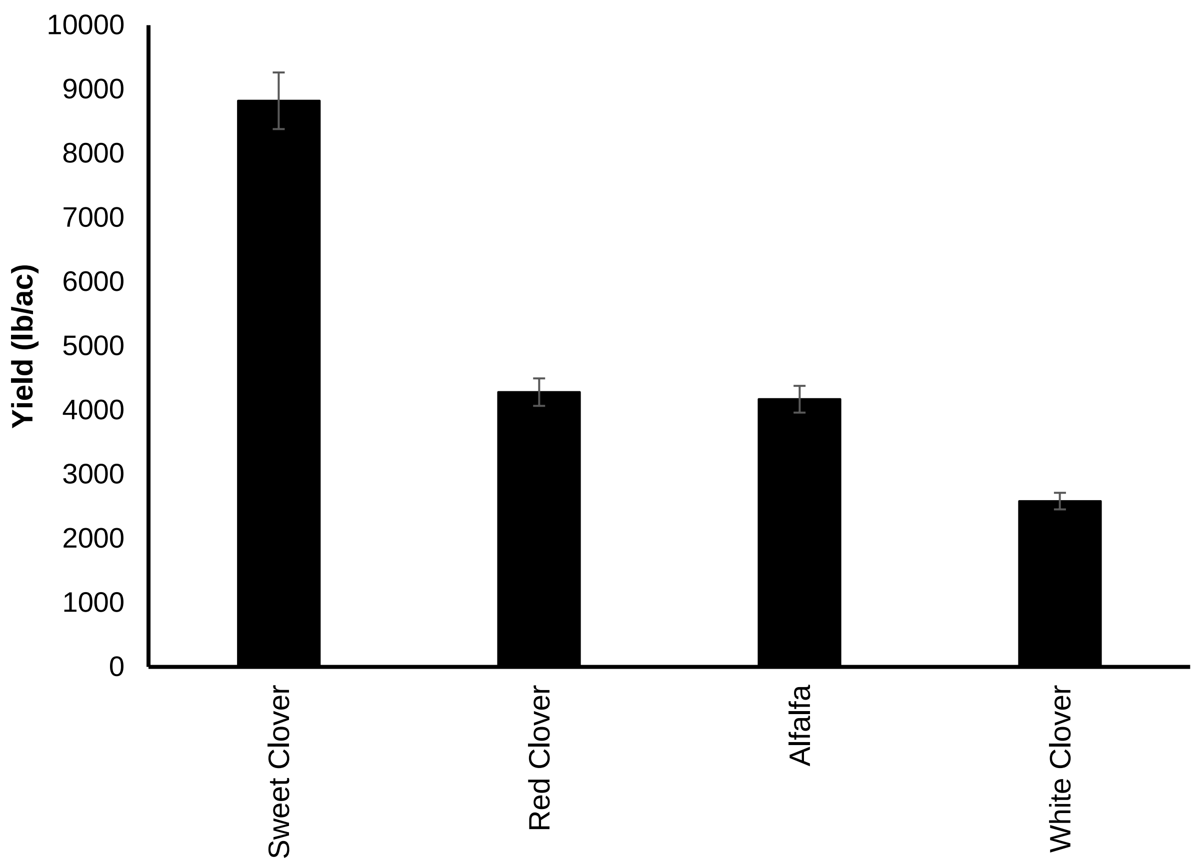

Figure 2: Average forage yield for cover crop by treatment, seeded 2020, harvested July 16, 2021 (lb/ac, 15% moisture).

Figure 3 shows the yield for cover crops in the 2021 growing season (planted with the barley crop). White clover yields were negligible and are not show. Note that yields are for one rep only, and are included for reference only. The results are for one year only, and should be interpreted with caution.

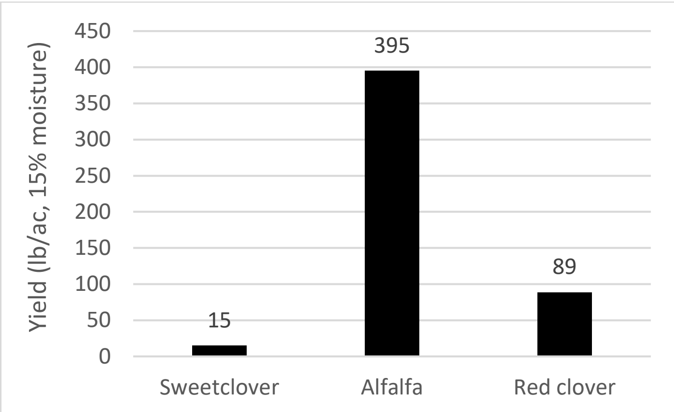

Figure 3: Figure 2: Average forage yield for cover crop by treatment, seeded 2021, harvested Sept 15, 2021 (lb/ac, 15% moisture).

Observations (2020)

The cover crops established slowly in the understory of the barley. At the time of harvest, the yellow sweet clover and alfalfa crops were well established, whereas the red clover and white clover crops appeared to be less successful. The barley crop was cut about 15" above the ground, and the loose straw was removed from the field so that the cover crop could continue to grow for the remainder of the season. The tall stubble appeared to trap more snow during the winter, providing better protection for the crop.

Observations (2021)

Despite the dry conditions in spring, all cover crop treatments produced well (including the white and red clover, which did not appear to have competed well against the barley crop in 2020). The crops broke dormancy in late April and were swathed in mid-July. Because white clover is a very short crop (less than six inches high), swathing and baling presents a challenge. A better option for use as a forage would be to graze the crop in-field. Other uses might include discing the crop into the ground as a green manure, or harvesting the crop for seed.

No herbicides were applied to the 2020 or 2021 crop. Limited herbicide options are available for barley-cover crop intercrops, and the close proximity of the plots (and danger of spray drift) made it more feasible to hand-weed the plots. On a field-scale, careful field selection and pre-emergence herbicide application would be crucial to the establishment of a successful intercrop. Consult a herbicide guide or dealer to determine the best herbicide option for each intercrop.

Materials and methods

Experimental Design:	Random Complete Block Design
Barley variety:	CDC Austenson
Treatments:	5
Replications:	3
Seeding:	May 14
Harvest:	Sep 29

Table 2: Seeding rates (lb/ac)

	Barley	Red Clover	White Clover	Sweet Clover	Alfalfa
Treatment 1	105 lb/ac	-	-	-	-
Treatment 2	105 lb/ac	10lb/ac	-	-	-
Treatment 3	105 lb/ac	-	5lb/ac		
Treatment 4	105 lb/ac	-	-	5lb/ac	-
Treatment 5	105 lb/ac	-	-	-	18lb/ac

Data collected	Date Collected
Emergence:	Barley: May 22-30, Cover crop: May 22-30
Barley Heading:	Jul 14-15
Stand rating:	Jul 1
Vigor Rating:	Jul 1
Yield:	Oct 21
Moisture:	Oct 21

Agronomic info	
Previous year's crop:	Oat Silage
Soil Type:	Erickson Loam Clay
Landscape:	Rolling with trees to the east
Seedbed preparation:	Vertical tilled

Table 3: Fertility Information (for 2021 barley)

	Available		Added	Type
N	162	lb/ac	27 lb/ac	46-0-0
P	41	ppm	10 lb/ac	11-52-0-0
K	703	ppm	-	

Cover crops inoculated; no herbicide applied (hand weeded)

Canola-Cover Crop (Year 1 and 2)

Project duration: May 2020 – September 2021
Objectives: To evaluate intercropping potential for canola and cover crops
Collaborators: PCDF

Background
The Manitoba Agriculture website states that producers may plant cover crops to minimize wind and water erosion. Cover crops can play an important role after low-residue crops, such as soybean and potatoes, or in spring as a new crop is establishing. Another import function is to immobilize excess nutrients, especially nitrogen, and prevent losses. Additionally, cover crops can help to trap snow, enhancing moisture conditions in spring.

Despite these benefits, the limited growing season before or after another crop can make establishing cover crops a challenge. A common practice is to establish a cover crop in-season, with a cash crop. However, producers do not commonly establish cover crops with canola. This trial examined the effect of establishing four cover crops with canola (Table 1).

Results
The data presented here are for Years 1 and 2 of a multi-year study. Figure 1 shows a comparison of canola yield (bu/ac) by treatment for 2020 and 2021.

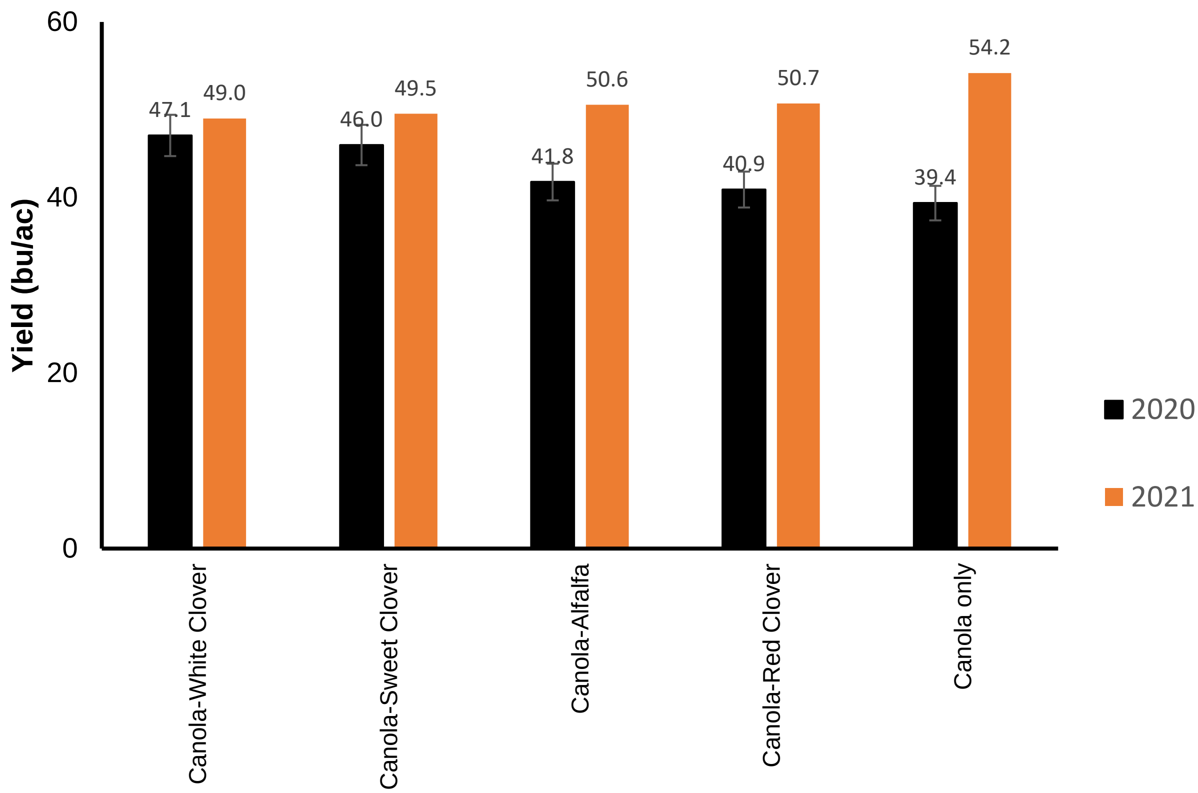

Figure 1: Canola yield (bu/ac) by treatment.

Table 1: Comparison of yield means and statistical difference for canola-cover crop entries for 2020 and 2021 (varieties connected by the same letter are statistically significant)

	Statistical significance		**Yield (bu/ac)**	
Treatment	**2020**	**2021**	**2020**	**2021**
Canola only	A	A	47.1	49.0
Canola-Alfalfa	A	A	46.0	49.5
Canola-Red Clover	A	A	41.8	50.6
Canola-Sweet Clover	A	A	40.9	50.7
Canola-White Clover	A	A	39.4	54.2
CV (%)			**12.8**	**10.4**

* Treatments not marked with the same letter are statistically different from other treatments.

Figure 2 shows forage July 2021 yields for cover crops seeded in 2020. All results are for one year only, and should be interpreted with caution.

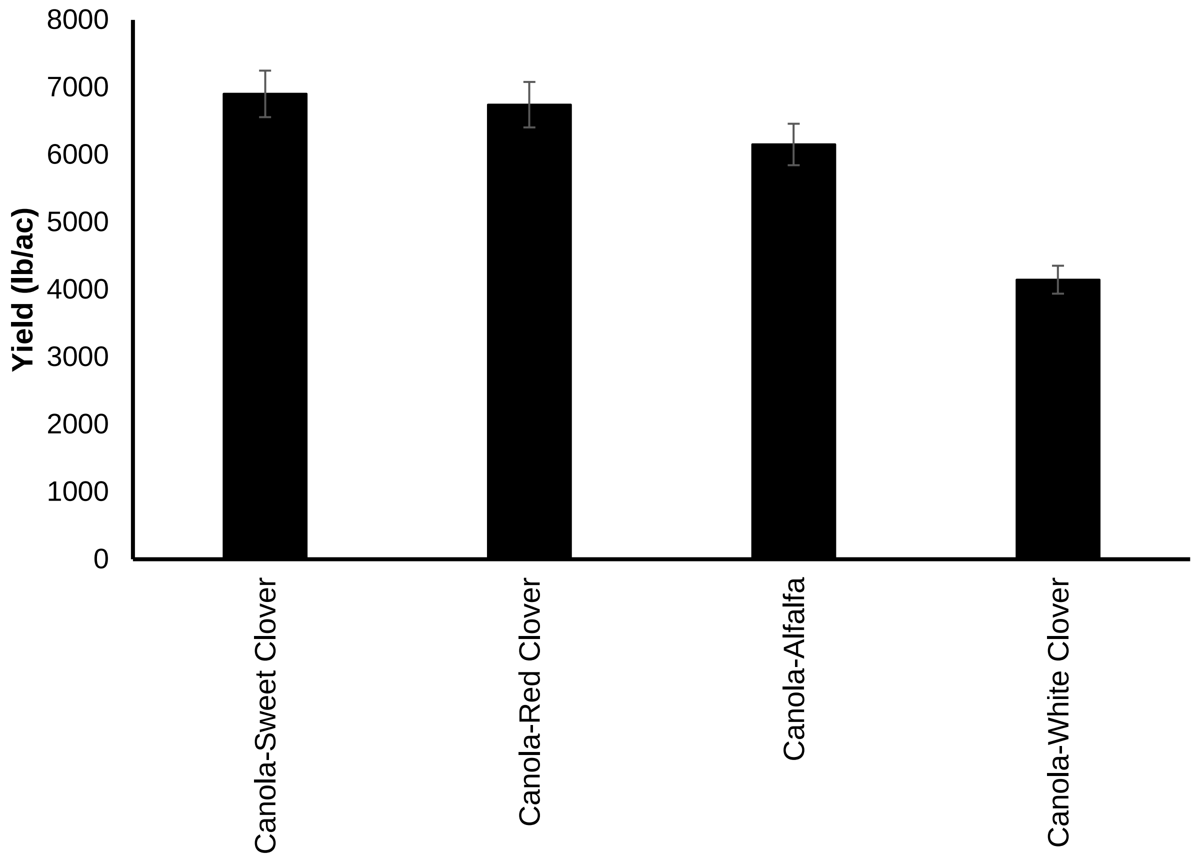

Figure 2: Average forage yield for cover crop by treatment, seeded 2020, harvested July 16, 2021 (lb/ac, 15% moisture).

Figure 3 shows the yield for cover crops in the 2021 growing season (planted with the canola crop). White clover yields were negligible and are not show. Note that yields are for one rep only, and are included for reference only. The results are for one year only, and should be interpreted with caution.

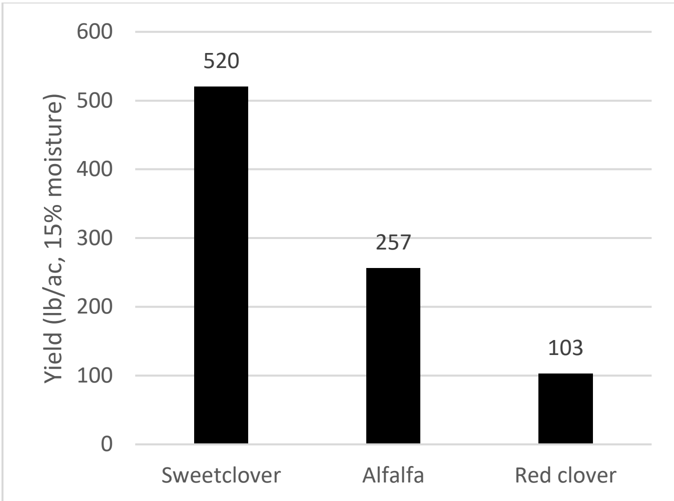

Figure 3: Figure 2: Average forage yield for cover crop by treatment, seeded 2021, harvested Sept 15, 2021 (lb/ac, 15% moisture).

Observations (2020)

The cover crops established slowly in the understory of the canola. At the time of harvest, the yellow sweet clover and alfalfa crops were well established, whereas the red clover and white clover crops appeared to be less successful. The canola crop was cut about 15" above the ground, and the loose straw was removed from the field so that the cover crop could continue to grow for the remainder of the season. The tall stubble appeared to trap more snow during the winter, providing better protection for the crop.

Observations (2021)

Despite the dry conditions in spring, all cover crop treatments produced well (including the white and red clover, which did not appear to have competed well against the canola crop in 2020). The crops broke dormancy in late April and were swathed in mid-July. Because white clover is a very short crop (less than six inches high), swathing and baling presents a challenge. A better option for use as a forage would be to graze the crop in-field. Other uses might include discing the crop into the ground as a green manure, or harvesting the crop for seed.

No herbicides were applied to the 2020 or 2021 crop. Limited herbicide options are available for canola-cover crop intercrops, and the close proximity of the plots (and danger of spray drift) made it more feasible to hand-weed the plots. On a field-scale, careful field selection and pre-emergence herbicide application would be crucial to the establishment of a successful intercrop. Consult a herbicide guide or dealer to determine the best herbicide option for each intercrop.

Materials and methods

Experimental Design:	Random Complete Block Design
Canola Variety:	Clearfield
Treatments:	5
Replications:	3
Seeding:	May 20
Harvest:	Sep 14

Table 2: Seeding rate (lb/ac)

	Canola	Red Clover	White Clover	Sweet Clover	Alfalfa
Treatment 1	5 lb/ac	-	-	-	-
Treatment 2	5 lb/ac	10lb/ac	-	-	-
Treatment 3	5 lb/ac	-	5lb/ac		
Treatment 4	5 lb/ac	-	-	5lb/ac	-
Treatment 5	5 lb/ac	-	-	-	18lb/ac

Data collected	Date Collected
Emergence:	Canola: May 31-Jun 2, Clover: May 31- Jun 3
Canola Flowering:	Jul 5-10
Stand rating:	Jul 1
Vigor Rating:	Jul 1
Yield:	Sep 14
Moisture:	Sep 14

Agronomic info

Previous year's crop:	Oat Silage
Soil Type:	Erickson Loam Clay
Landscape:	Rolling with trees to the east
Seedbed preparation:	Vertical tilled

Table 3: Fertility Information

	Available		Added	Type
N	169	lb/ac	24 lb/ac	46-0-0
P	44	ppm	10 lb/ac	11-52-0-0
K	613	ppm	-	

Cover crops inoculated; no herbicide applied (hand weeded)

Oat-Cover Crop (Year 1 and 2)

Project duration: May 2020 – September 2021
Objectives: To evaluate intercropping potential for oat and cover crops
Collaborators: PCDF

Background

The Manitoba Agriculture website states that producers may plant cover crops to minimize wind and water erosion. Cover crops can play an important role after low-residue crops, such as soybean and potatoes, or in spring as a new crop is establishing. Another import function is to immobilize excess nutrients, especially nitrogen, and prevent losses. Additionally, cover crops can help to trap snow, enhancing moisture conditions in spring.

Despite these benefits, the limited growing season before or after another crop can make establishing cover crops a challenge. A common practice is to establish a cover crop in-season, with a cash crop. This trial examined the effect of establishing four cover crops with oats (Table 1).

Results

The data presented here are for Years 1 and 2 of a multi-year study. Figure 1 shows a comparison of oat yield (bu/ac) by treatment for 2020 and 2021. Very dry conditions in 2021 resulted in poor oat yield.

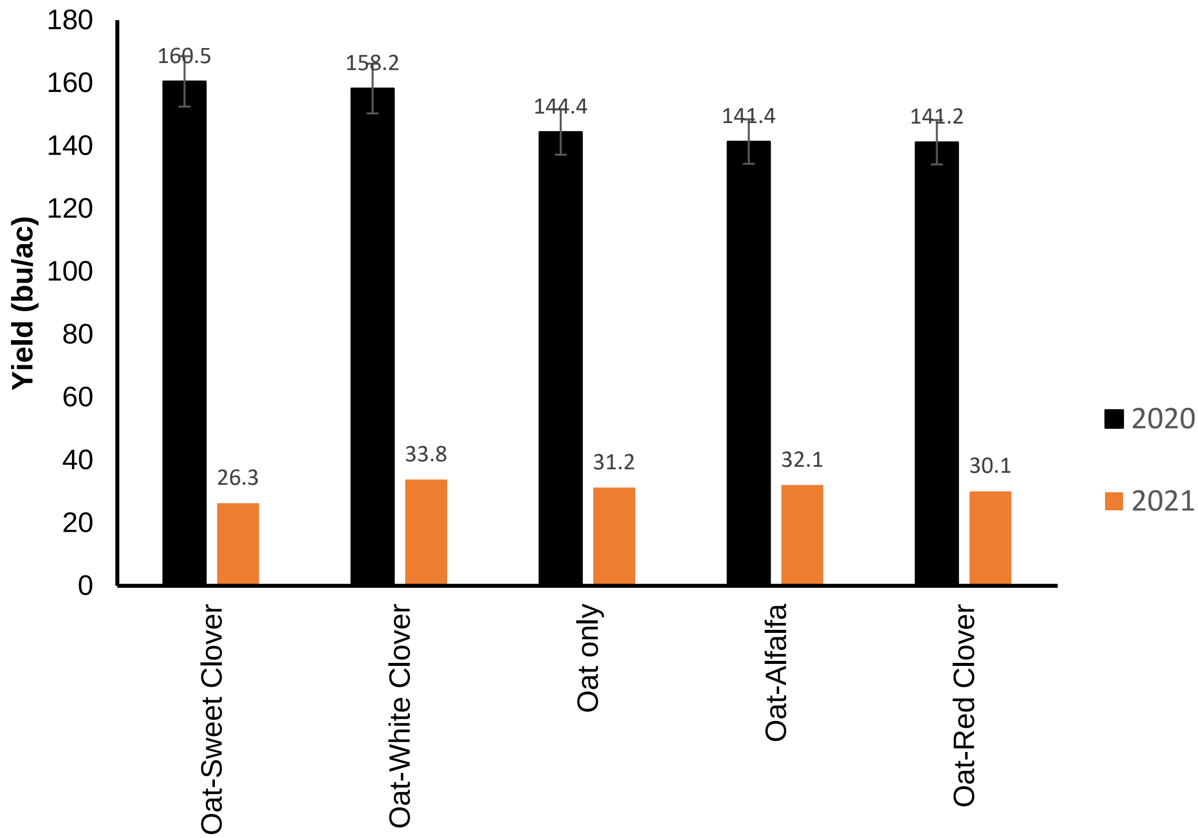

Figure 1: Oat yield (bu/ac) by treatment.

Table 1: Comparison of yield means and statistical difference for oat-cover crop entries for 2020 and 2021 (varieties connected by the same letter are statistically significant)

	Statistical significance for yield		Yield (bu/ac)	
Variety	**2020**	**2021**	**2020**	**2021**
Oat only	A	A	144.4	33.8
Oat-Alfalfa	A	A	141.4	32.1
Oat-Red Clover	A	A	141.2	31.2
Oat-Sweet Clover	A	A	160.5	30.1
Oat-White Clover	A	A	158.2	26.3
LSD			**28.6**	**13.8**
% CV			**10.7**	**27.9**

* Treatments not marked with the same letter are statistically different from other treatments.

Figure 2 shows forage July 2021 yields for cover crops seeded in 2020. Note that yields for white clover are for one rep only, and are included for reference only. All results are for one year only, and should be interpreted with caution.

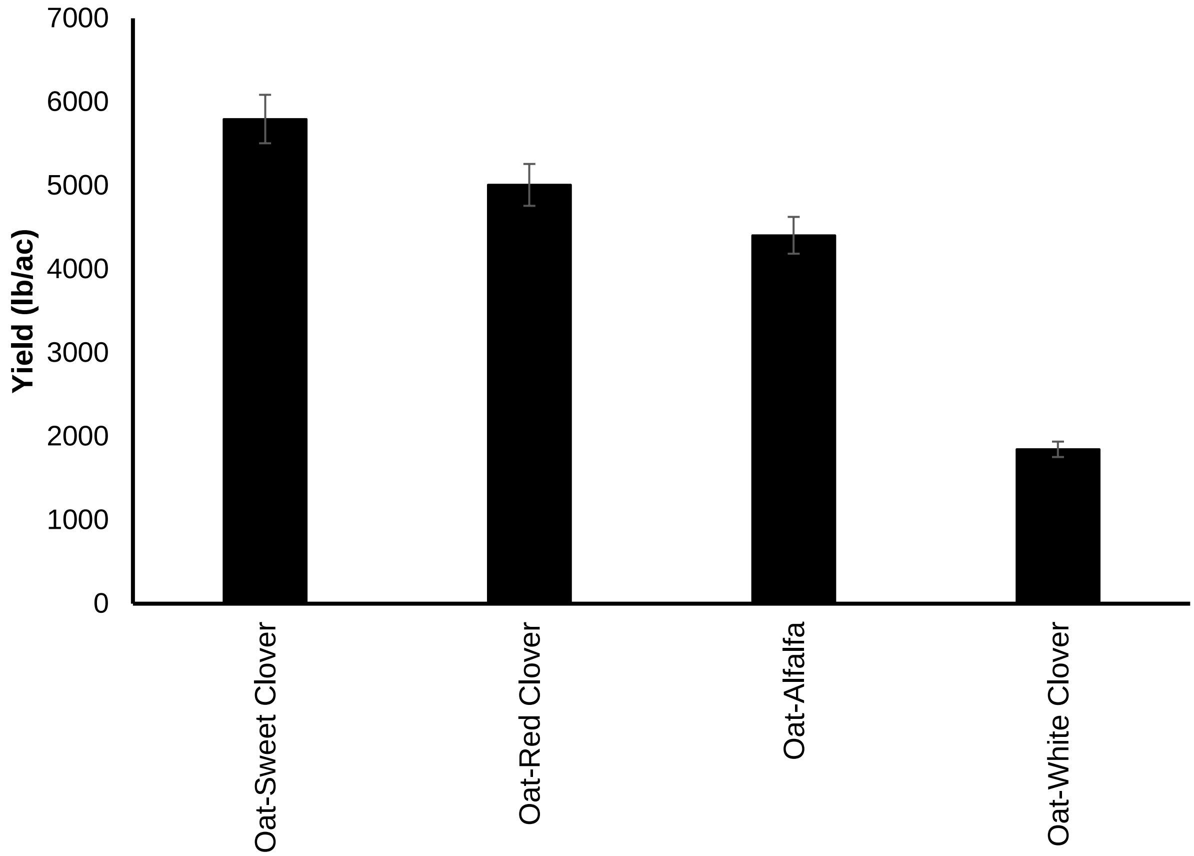

Figure 2: Average forage yield for cover crop by treatment, seeded 2020, harvested July 16, 2021 (lb/ac, 15% moisture).

Figure 3 shows the yield for cover crops in the 2021 growing season (planted with the oat crop). White clover yields were negligible and are not show. Note that yields are for one rep only, and are included for reference only. The results are for one year only, and should be interpreted with caution.

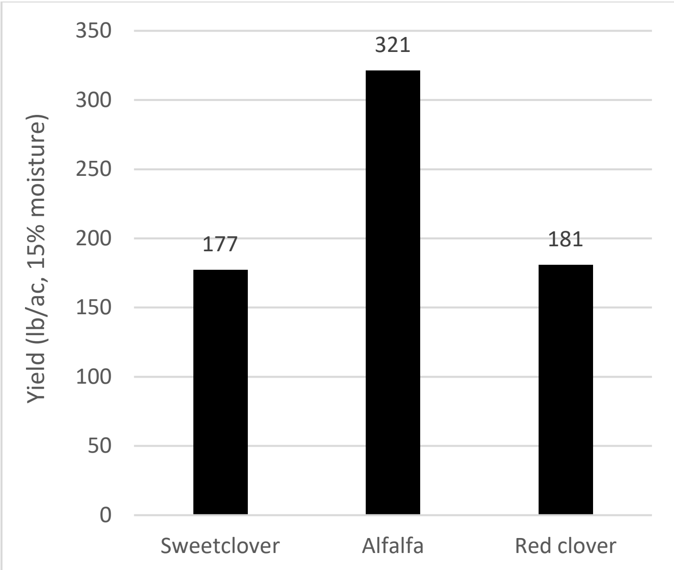

Figure 3: Figure 2: Average forage yield for cover crop by treatment, seeded 2021, harvested Sept 15, 2021 (lb/ac, 15% moisture).

<u>Observations (2020)</u>
The cover crops established slowly in the understory of the oats. At the time of harvest, the yellow sweet clover and alfalfa crops were well established, whereas the red clover and white clover crops appeared to be less successful. The oat crop was cut about 15" above the ground, and the loose straw was removed from the field so that the cover crop could continue to grow for the remainder of the season. The tall stubble appeared to trap more snow during the winter, providing better protection for the crop.

<u>Observations (2021)</u>
Despite the dry conditions in spring, all cover crop treatments produced well (including the white and red clover, which did not appear to have competed well against the canola crop in 2020). The crops broke dormancy in late April and were swathed in mid-July. Because white clover is a very short crop (less than six inches high), swathing and baling presents a challenge. A better option for use as a forage would be to graze the crop in-field. Other uses might include discing the crop into the ground as a green manure, or harvesting the crop for seed.

No herbicides were applied to the 2020 or 2021 crop. Limited herbicide options are available for oat-cover crop intercrops, and the close proximity of the plots (and danger of spray drift) made it more feasible to hand-weed the plots. On a field-scale, careful field selection and pre-emergence herbicide application would be crucial to the establishment of a successful intercrop. Consult a herbicide guide or dealer to determine the best herbicide option for each intercrop.

Materials and methods

Experimental Design:	Random Complete Block Design
Oat Variety:	AC Summit
Treatments:	5
Replications:	3
Seeding:	May 14
Harvest:	Sep 28

Table 2: Seeding rate (lb/ac)

	Oat	Red Clover	White Clover	Sweet Clover	Alfalfa
Treatment 1	105 lb/ac	-	-	-	-
Treatment 2	105 lb/ac	10lb/ac	-	-	-
Treatment 3	105 lb/ac	-	5lb/ac		
Treatment 4	105 lb/ac	-	-	5lb/ac	-
Treatment 5	105 lb/ac	-	-	-	18lb/ac

Data collected	Date Collected
Emergence:	Oat: May 21-24, Clover: May 21-31
Stand rating:	Jul 1
Vigor Rating:	Jul 1
Yield:	Sep 28
Moisture:	Sep 28

Agronomic info	
Previous year's crop:	Oat Silage
Soil Type:	Erickson Loam Clay
Landscape:	Rolling with trees to the east
Seedbed preparation:	Heavy harrowed

Table 3: Fertility Information

	Available		Added	Type
N	162	lb/ac	10 lb/ac	46-0-0
P	41	ppm	10 lb/ac	11-52-0-0
K	703	ppm		

Cover crops inoculated; no herbicide applied (hand weeded)

Spring Wheat-Cover Crop (Year 1 and 2)

Project duration: May 2020 – September 2021
Objectives: To evaluate intercropping potential for wheat and clovers
Collaborators: PCDF

Background
The Manitoba Agriculture website states that producers may plant cover crops to minimize wind and water erosion. Cover crops can play an important role after low-residue crops, such as soybean and potatoes, or in spring as a new crop is establishing. Another import function is to immobilize excess nutrients, especially nitrogen, and prevent losses. Additionally, cover crops can help to trap snow, enhancing moisture conditions in spring.

Despite these benefits, the limited growing season before or after another crop can make establishing cover crops a challenge. A common practice is to establish a cover crop in-season, with a cash crop. This trial examined the effect of establishing four cover crops with wheat (Table 1).

Results
The data presented here are for Years 1 and 2 of a multi-year study. Figure 1 shows a comparison of wheat yield (bu/ac) by treatment for 2020 and 2021.

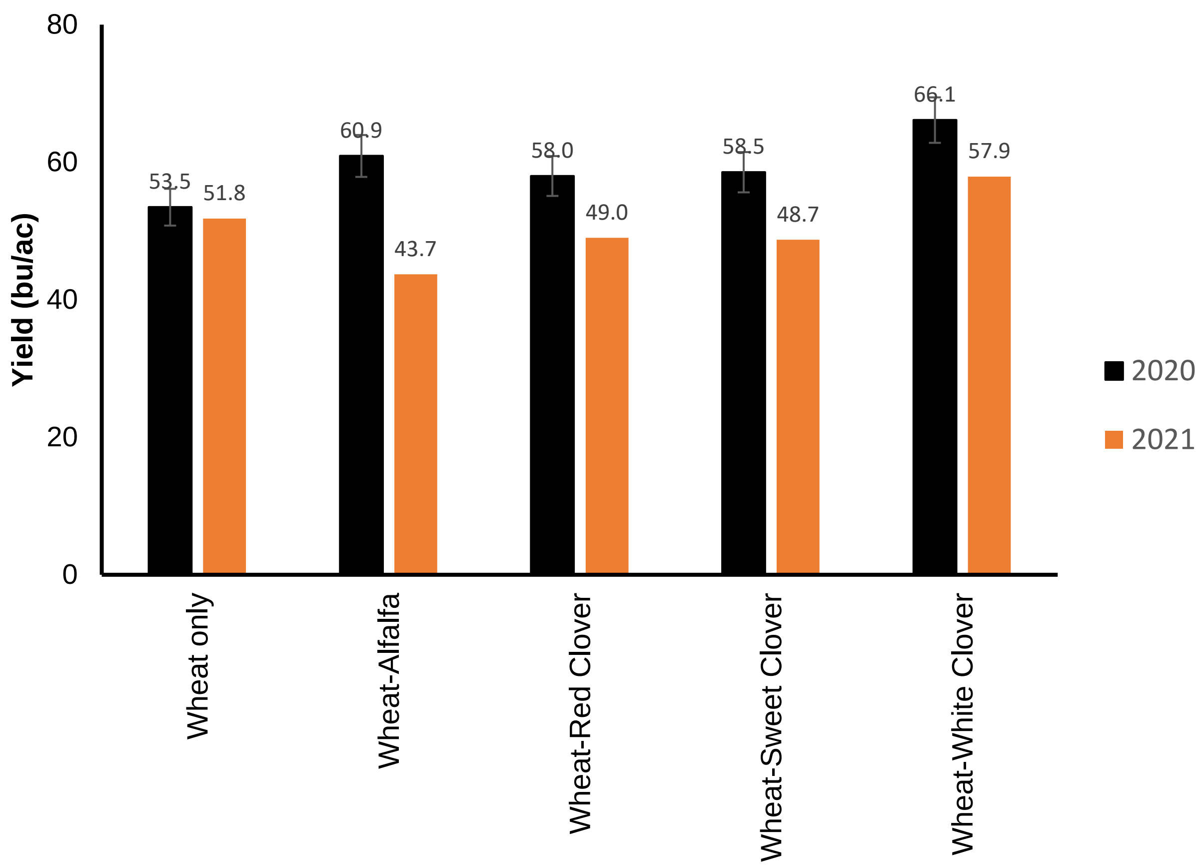

Figure 1: Wheat yield (bu/ac) by treatment.

Table 1: Comparison of yield means and statistical difference for wheat-cover crop entries for 2020 and 2021 (varieties connected by the same letter are statistically significant)

	Statistical significance				**Yield (bu/ac)**	
Variety	**2020**	**2021**			**2020**	**2021**
Wheat only	A	A			53.5	57.9
Wheat-Alfalfa	A	A	B		60.9	51.8
Wheat-Red Clover	A		B	C	58.0	49.0
Wheat-Sweet Clover	A		B	C	58.5	48.7
Wheat-White Clover	A			C	66.1	43.7
LSD					**15.1**	**7.9**
CV (%)					**13.9**	**13.3**

* Treatments not marked with the same letter are statistically different from other treatments.

Figure 2 shows forage July 2021 yields for cover crops seeded in 2020. All results are for one year only, and should be interpreted with caution.

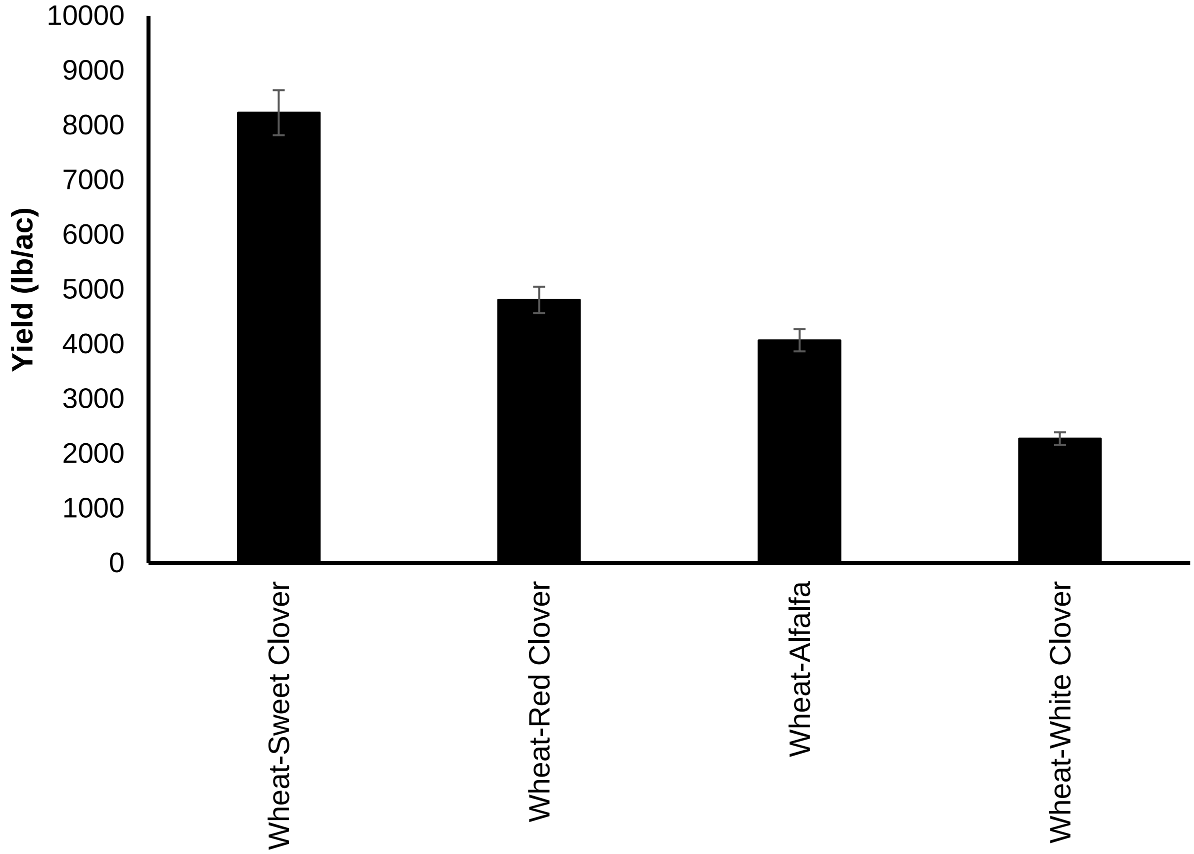

Figure 2: Average forage yield for cover crop by treatment, seeded 2020, harvested July 16, 2021 (lb/ac, 15% moisture).

Figure 3 shows the average yield for cover crops for all reps in the 2021 growing season (planted with the wheat crop). White clover yields were negligible and are not show. Note that the results are for one year only, and should be interpreted with caution.

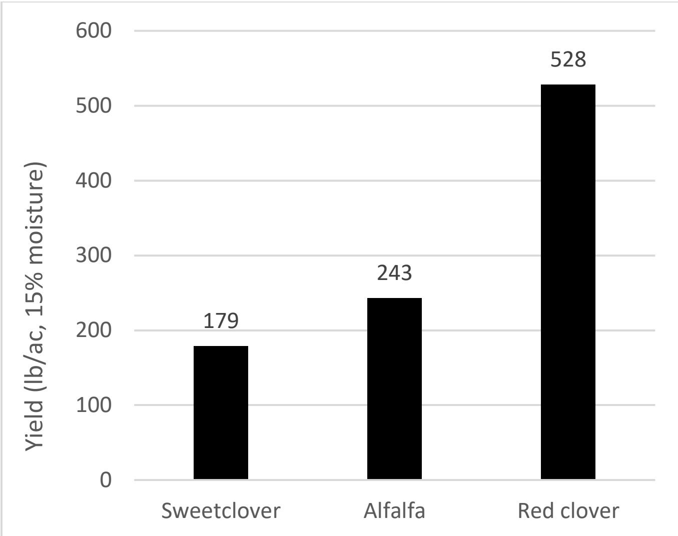

Figure 3: Figure 2: Average forage yield for cover crop by treatment, seeded 2021, harvested Sept 15, 2021 (lb/ac, 15% moisture).

<u>Observations</u>
Cover crop biomass was not collected, but qualitative assessments of the cover crops after harvest suggest that the treatments all established well. The oats were cut about 18-20" above the ground, and the loose straw was removed from the field so that the undamaged cover crop could continue to grow for the remainder of the season. Additionally, the longer stubble will trap more snow during the winter, providing better protection for the crop. Year 2 of the study will look at the winter survival and spring growth of the cover crop.

No herbicides were applied to the crop. Limited herbicide options are available for oat-cover crop intercrops, and the close proximity of the plots (and danger of spray drift) made it more feasible to hand-weed the plots. On a field-scale, careful field selection and pre-emergence herbicide application would be crucial to the establishment of a successful intercrop. Consult a herbicide guide or dealer to determine the best herbicide option for each intercrop.

Materials and methods
Experimental Design: Random Complete Block Design
Entries: 5
Seeding: May 14
Harvest: Sep 11

Table 2: Seeding rate (lb/ac)

	Wheat	Red Clover	White Clover	Sweet Clover	Alfalfa
Treatment 1	90 lb/ac	-	-	-	-
Treatment 2	90 lb/ac	10lb/ac	-	-	-
Treatment 3	90 lb/ac	-	5lb/ac	-	-
Treatment 4	90 lb/ac	-	-	5lb/ac	-
Treatment 5	90 lb/ac	-	-	-	18lb/ac

Data collected	Date Collected
Emergence:	Wheat: May 21-22, Cover crops: May 20-24
Wheat variety:	AC Goodeve VB
Wheat Heading:	Jul 1-3
Stand rating:	Jul 1
Vigor Rating:	Jul 1
Yield:	Sep 28
Moisture:	Sep 28

Agronomic info	
Previous year's crop:	Oat Silage
Soil Type:	Erickson Loam Clay
Landscape:	Rolling with trees to the east
Seedbed preparation:	Vertical Tilled

Table 3: Fertility Information

	Available		Added	Type
N	162	lb/ac	27 lb/ac	46-0-0
P	41	ppm	10 lb/ac	11-52-0-0
K	703	ppm		

Cover crops inoculated; no herbicide applied (hand weeded)

Chicory-Cereals Intercrop (Year 1)

Project duration: May 2021 – September 2023
Objectives: To evaluate intercropping potential for cereals and chicory (Year 1)
Collaborators: PCDF; Elisabeth Nernberg, Manitoba Agriculture

Background
Chicory is a short-lived, broadleaf perennial that has gained the attention of livestock producers for its high production potential, excellent nutritional qualities, and deep taproot. The crop may be seeded alone or as part of a chicory-grass or chicory-legume mixture. For a good summary of chicory cultivation see this agronomy factsheet, prepared by Penn State University. Figure 1 shows second-year chicory plants at PCDF. (Note that the taproot is broken off.)

Figure 1: Year-2 chicory plants, showing 40” of top growth and strong taproot

The trial examines the potential for establishing chicory with a cereal crop. This would provide producers with the opportunity to benefit from a cash crop during the establishment year. In Year 1, the trial measures the impact of the chicory on the cereal crop. In Years 2 and 3, the trial will examine the impact of the chicory on the performance and feed values of various forage mixtures, as detailed in Table 1. Note that the oat, barley and millet in Year 2 will function as a nurse crop for the alfalfa-grass hay crop.

Table 1: Trial treatments for 2021-2023 (4 replications each) (AG=Alfalfa-grass hay)

Treatment	Year 1 (2021)	Year 2 (2022)	Year 3 (2023)
1	Barley	AG + oat	AG only
2	Barley + chicory (3 lb/ac)	AG + oat + chicory (3 lb/ac)	AG + chicory (3 lb/ac)
3	Barley + chicory (4 lb/ac)	AG + oat + chicory (4 lb/ac)	AG + chicory (4 lb/ac)
4	Oat	AG + barley	AG only
5	Oat + chicory (3 lb/ac)	AG + barley + chicory (3 lb/ac)	AG + chicory (3 lb/ac)
6	Oat + chicory (4 lb/ac)	AG + barley + chicory (4 lb/ac)	AG + chicory (4 lb/ac)
7	Wheat	AG + millet	AG only
8	Wheat + chicory (3 lb/ac)	AG + millet + chicory (3 lb/ac)	AG + chicory (3 lb/ac)
9	Wheat + chicory (4 lb/ac)	AG + millet + chicory (4 lb/ac)	AG + chicory (4 lb/ac)

Results

For the results of the 2020 pilot year (chicory seeded to wheat at rates of 0.5, 1, 2, and 3 lb/ac), see the online report, [Intercropping: Wheat-Chicory (Pilot Year)](). The results for the pilot year suggest that the lower seeding rates for chicory (0.5-2 lb/ac) provide unsatisfactory results for establishing a chicory crop, based on the number of plants observed per plot. Consequently, the trial was redesigned (see Table 1).

Figure 2 shows yields for cereals in 2021, grouped according to crop type. Note that dry conditions and heat at flowering severely affected oat yield for all trials at PCDF. There were no statistical differences for yield for grain, which suggests that seeding chicory with a cereal crop does not meaningfully affect yield. However, the results are for one year only, and should be interpreted with caution.

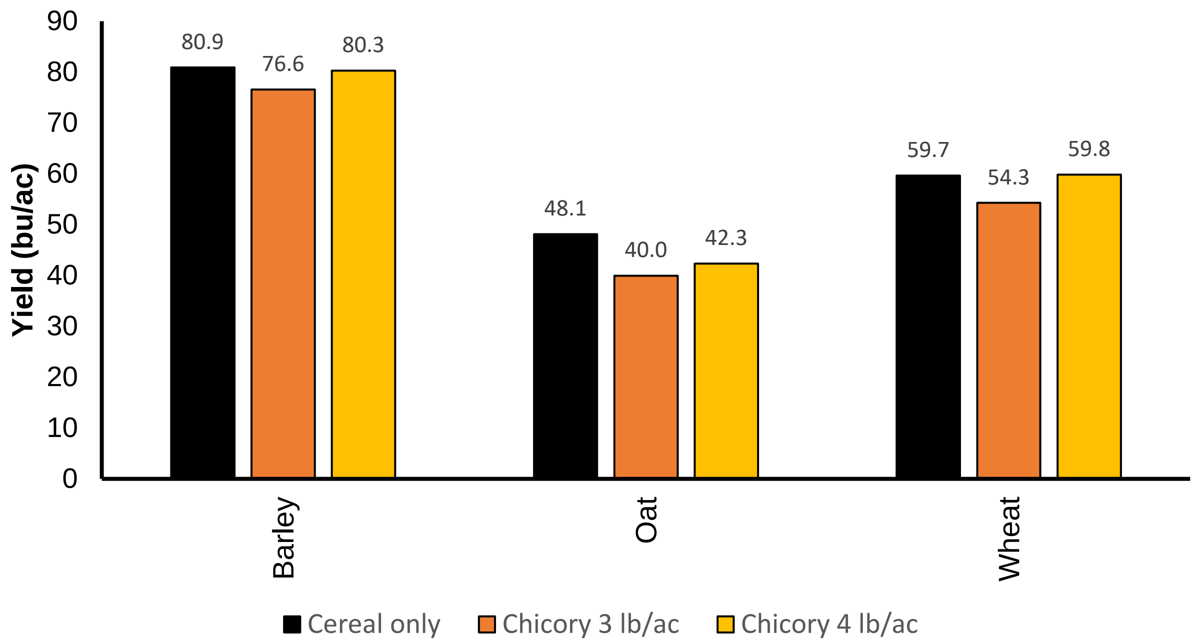

Figure 2: Barley, oat and wheat yield by treatment (bu/ac)

The stand rating for cereals is shown in Figure 3. There was no significant difference in stand rating for cereals crops, which suggests that including chicory in the crop does not meaningfully affect crop stand.

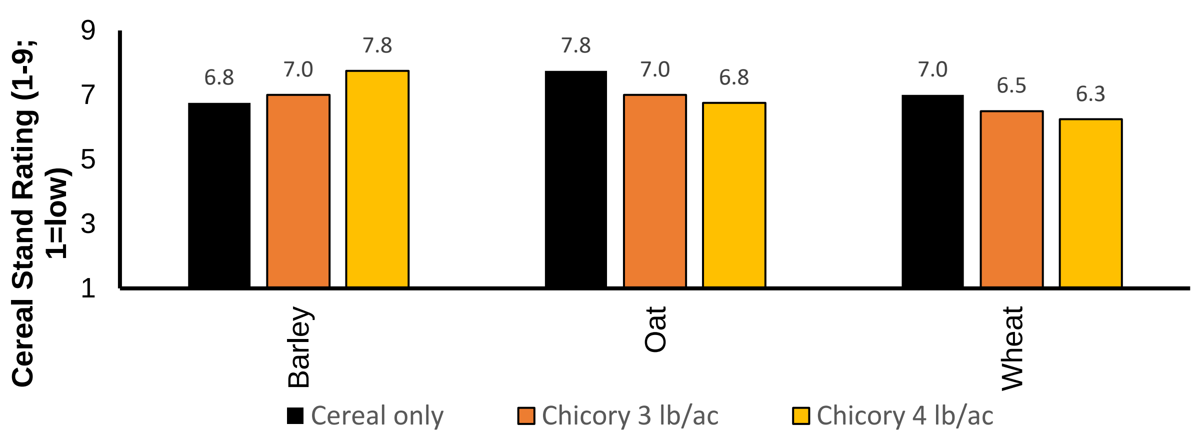

Figure 2: Barley, oat and wheat yield by treatment (bu/ac)

The straw was removed after grain harvest to allow the chicory to continue to grow. Biomass was not collected for the chicory crop, but visual estimates showed that the chicory crop for both seeding rates performed well across all crops, despite the dry growing conditions.

There are no registered herbicides for chicory, making intercropping more challenging. Good weed control prior to seeding is crucial. The trial was hand-weeded.

Table 1: Summary of statistical information for barley, oat and wheat yield

	Seeding rate				Average yield (bu/ac)		
Treatment	Barley	Oat	Wheat	Chicory	Barley	Oat	Wheat
Treatment 1	90 lb/ac	90 lb/ac	90 lb/ac	-	80.9	48.1	59.7
Treatment 2				3 lb/ac	76.6	40.0	54.3
Treatment 3				4lb/ac	80.3	42.3	59.8
CV (%)					13.3	25.8	16.6

Materials and methods

Experimental Design:	Random Complete Block Design
Cereal varieties:	Austensen (barley), Summit (oats), Landmark (wheat)
Entries:	9
Replications:	3
Seeding:	May 14
Harvest:	Sep 2

Data collected	Date Collected
Emergence:	Barley, oat, wheat: May 20-23, Chicory: Jun 2-6
Cereal Heading:	Jul 2-15
Stand rating:	Jul 1
Vigor Rating:	Jul 1
Yield:	Sep 2
Moisture:	Sep 2

Agronomic info

Previous year's crop:	Oat Silage
Soil Type:	Erickson Loam Clay
Landscape:	Rolling with trees to the east
Seedbed preparation:	Vertical Tilled

Table 3: Fertility Information

	Available		Added	Type
N	162	lb/ac	27 lb/ac	46-0-0
P	41	ppm	10 lb/ac	11-52-0-0
K	703	ppm		

No herbicide applied (hand weeded)

Wheat-Phacelia Intercrop

Project duration: May 2020 – September 2021
Objectives: To evaluate intercropping potential for wheat and phacelia
Collaborators: PCDF

Background
Phacelia is a flowering broadleaf plant that may be included in cover crops mixtures as an outstanding pollinator species with moderate soil texture-building characteristics. Honey producers prize the crop for its long flowering period and light honey quality. Conversely, cereals crops such as wheat rely on wind for pollination, and do not provide good habitat for pollinators. Intercropping wheat and phacelia increases in-crop diversity, provides pollinator habitat in cereals crops (which are usually less attractive to pollinators), and can attract beneficial predators, such as wasps that predate wheat midge. This trial evaluates the potential for intercropping wheat and phacelia, and the effect of different rates of phacelia on wheat yield in particular. For a detailed summary of phacelia cultivation, see this USDA Plant Guide.

Figure 1: (top) wheat-phacelia intercrop; (bottom) phacelia blossoms with a pollinator.

Results
The wheat yield (bu/ac) for treatments is shown in Figure 2. The phacelia yield (lb/ac) for treatments is shown in Figure 3.

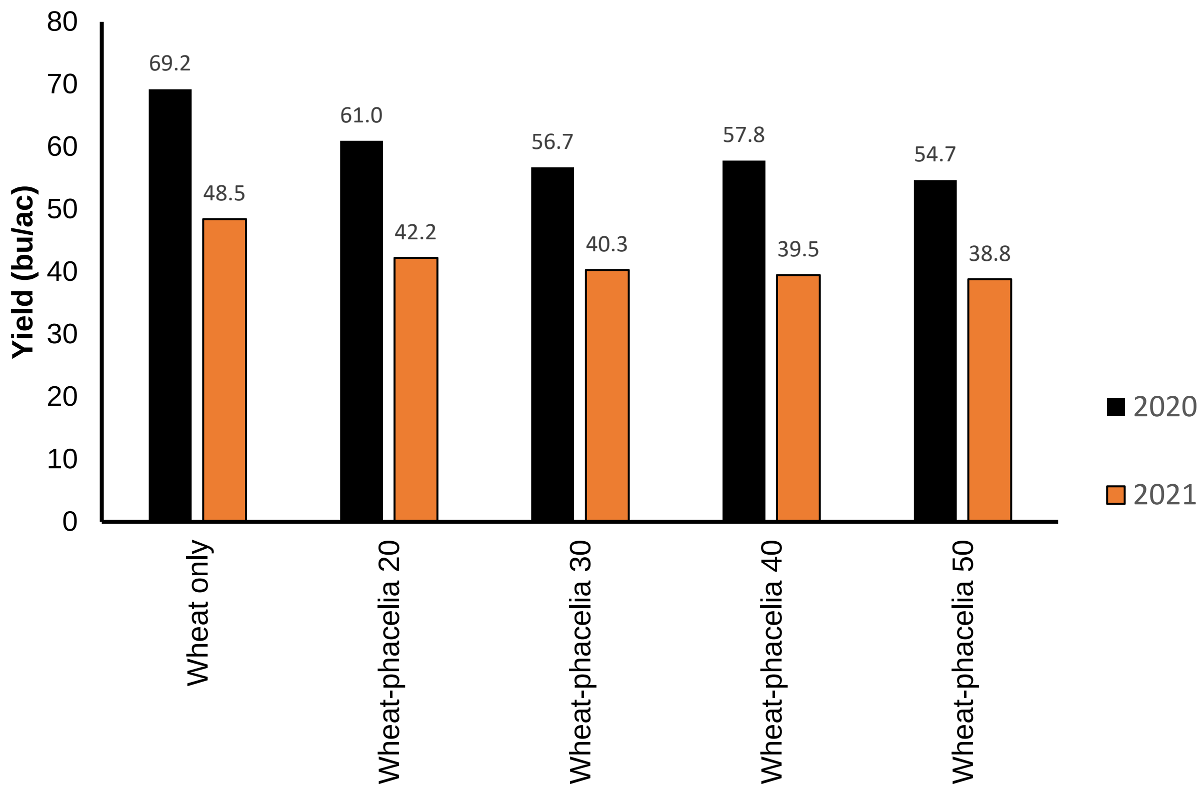

Figure 1: Wheat yield (bu/ac) by treatment.

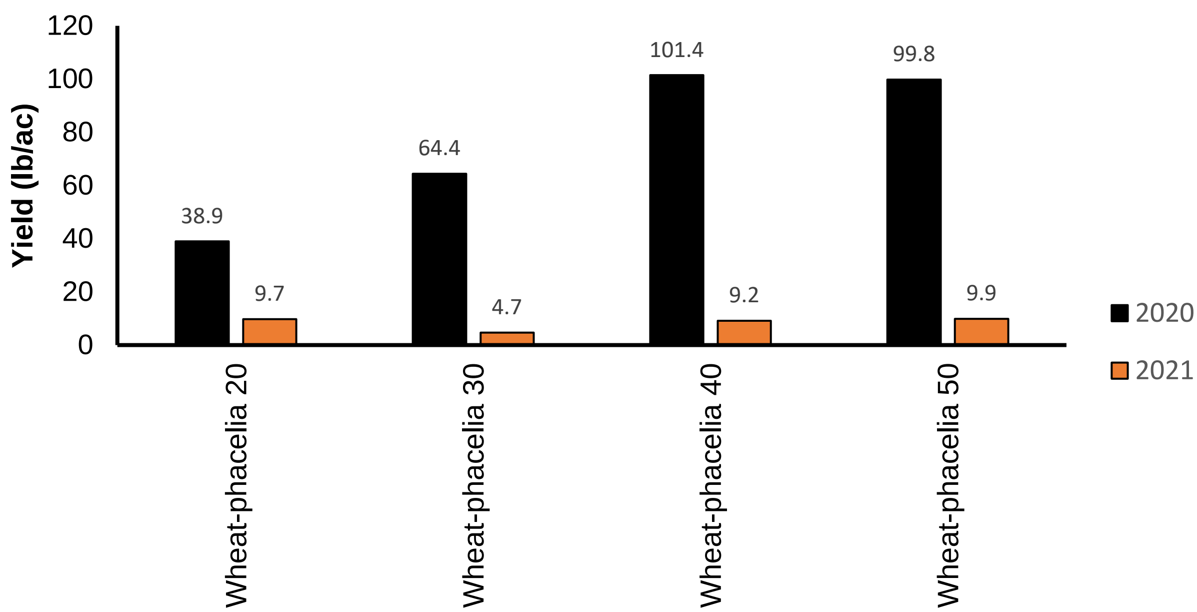

Figure 3: Phacelia yield (lb/ac) by treatment.

The results for wheat yield differ statistically by treatment (Table 1). Including phacelia treatment decreased the yield for wheat (by up to 14.5 bu/ac in 2020 and 9.7 bu/ac in 2021), likely due to increased water usage by the phacelia crop. In 2021, due to very dry field conditions, wheat yield was lower than for 2020, but the spread of yields was less.

Phacelia yield for 2020 and 2021 increased with seeding rate, but the reliability of those results is low due to high percent CVs. Additionally, due to the indeterminate nature of phacelia flowers, the seed ripens at different times and may have a low germination rate.

Table 1: Summary of statistical information for wheat and phacelia yield

Entry	Wheat yield (bu/ac)		Phacelia yield (lb/ac)		Statistical significance: Wheat*				Statistical significance: Phacelia*			
	2020	2021	2020	2021	2020		2021		2020			2021
Wheat only	69.2	48.5	-	10.0	A		A					
Wheat-Lupin 20	61.0	42.2	38.9	9.9	A	B	A	B			C	A
Wheat-Lupin 30	57.8	40.3	64.4	9.6	A	B	A	B		B		A
Wheat-Lupin 40	56.7	39.5	101.4	8.8		B	A	B	A			A
Wheat-Lupin 50	54.7	38.8	99.8	7.8		B		B	A			A
LSD (0.05)	**37.0**	**7.95**	**11.3**	**7.7**								
CV (%)	**12.6**	**14.0**	**36.4**	**52.1**								

* Treatments not marked with the same letter are statistically different from other treatments.

There are no herbicides registered for phacelia, making intercropping with wheat a challenge. Good weed control prior to seeding is crucial. The trial was hand-weeded.

Materials and methods

Experimental Design: Random Complete Block Design
Wheat variety: 2020: AC Goodeve; 2021: AC Magnet
Entries: 5
Seeding: 2020: May 22; 2021: May 14
Harvest: 2020: Sept 11; 2021: Sept 2

Table 2: Treatments

	Wheat	Phacelia
Treatment 1	90 lb/ac	-
Treatment 2	90 lb/ac	2 lb/ac
Treatment 3	90 lb/ac	3 lb/ac
Treatment 4	90 lb/ac	4 lb/ac
Treatment 5	90 lb/ac	5 lb/ac

Data collected Date Collected
Emergence: Wheat: May 20-25, Phacelia: May 26-30
Wheat Heading: Jul 1-2
Phacelia Flowering: Jul 6-12
Stand rating: Jul 1

Vigor Rating:	Jul 1
Yield:	Oct 21
Moisture:	Oct 21

Agronomic info

Previous year's crop:	Oat Silage
Soil Type:	Erickson Loam Clay
Landscape:	Rolling with trees to the east
Seedbed preparation:	Vertical tilled

Table 3: Fertility Information

	Available	Added	Type
N	61 lb/ac	128 lb/ac	46-0-0
P	47 ppm	10 lb/ac	11-52-0-0
K	393ppm		

No herbicide applied (hand weeded)

Hemp-Cereal Silage

Project duration: May 2020 – August 2022
Objectives: To evaluate intercrop mixes with hemp for silage production
Collaborators: PCDF, Canada-Manitoba Crop Diversification Centre (CMCDC)

Background
Silage plays an important part in the Manitoba livestock industry. Corn silage provides high yields, relative to barley silage (14 t/ac, over 7.5 t/ac, 2021 Silage Cost of Production, Manitoba Agriculture). In the Parkland area, the yield for corn silage is variable and many producers opt to produce a cereal silage, such as barley or oat. PCDF and CMCDC have worked together to explore intercropping options for cereals silage.

Hemp provides an interesting opportunity for silage production, due to its high production potential and good nutritional qualities. However, Canadian regulations currently prohibit the use of hemp products as a livestock feed ingredients in Canada. As such, this research is purely exploratory, and is not intended to provide recommendations to producers. The Manitoba Diversification Centres are working with the Canadian Hemp Trade Alliance to develop data in support of changes to regulations around the use of hemp in livestock feed.

Results

Figure 1: Clockwise from top-left: (1) hemp-only; (2) barley-hemp; (3) oat-hemp; (4) oat-only; (5) hemp-oat silage, chopped; (6) long fibres from over-ripe hemp plants.

The silage yields at PCDF (t/ac) for treatments is shown in Figure 2. Hay yields (1500-lb bales/ac, 15% moisture) are shown in Figure 3.

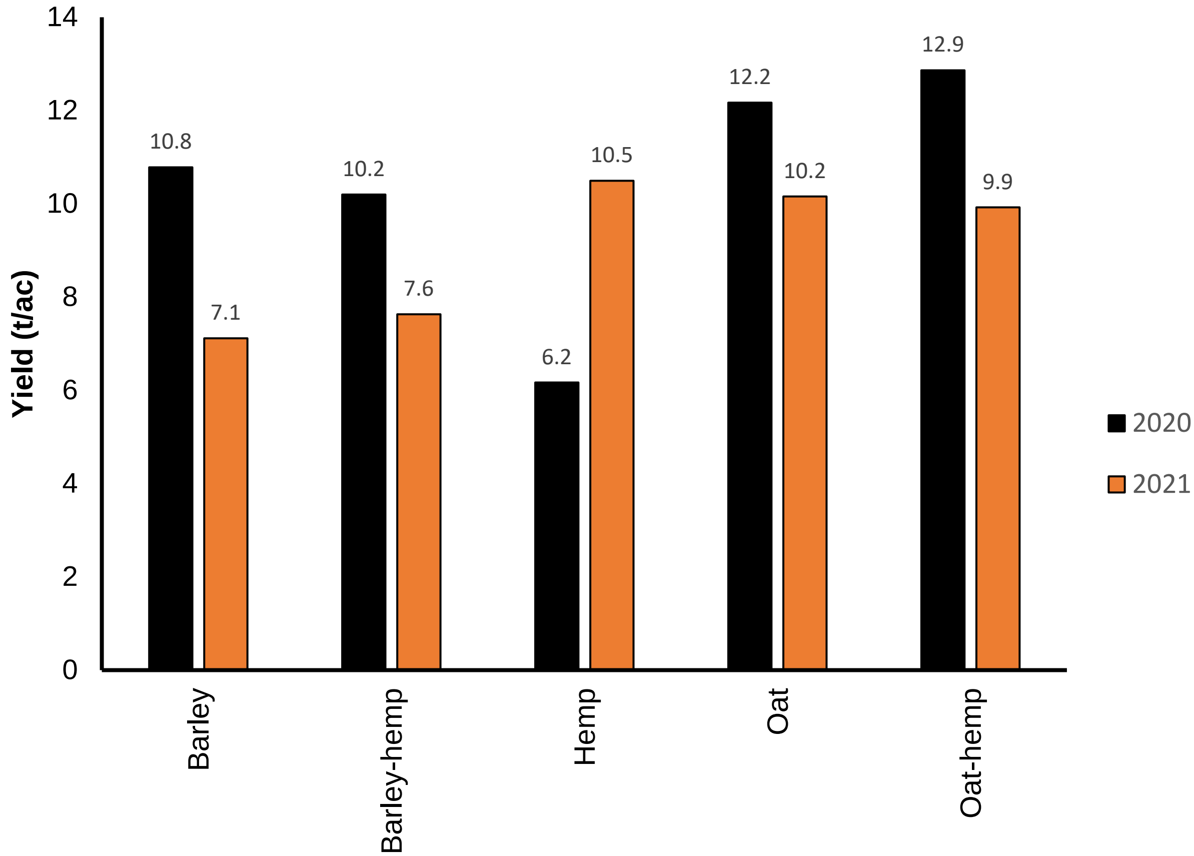

Figure 2: PCDF wet silage yield (t/ac) by treatment; all yields adjusted to 65% moisture.

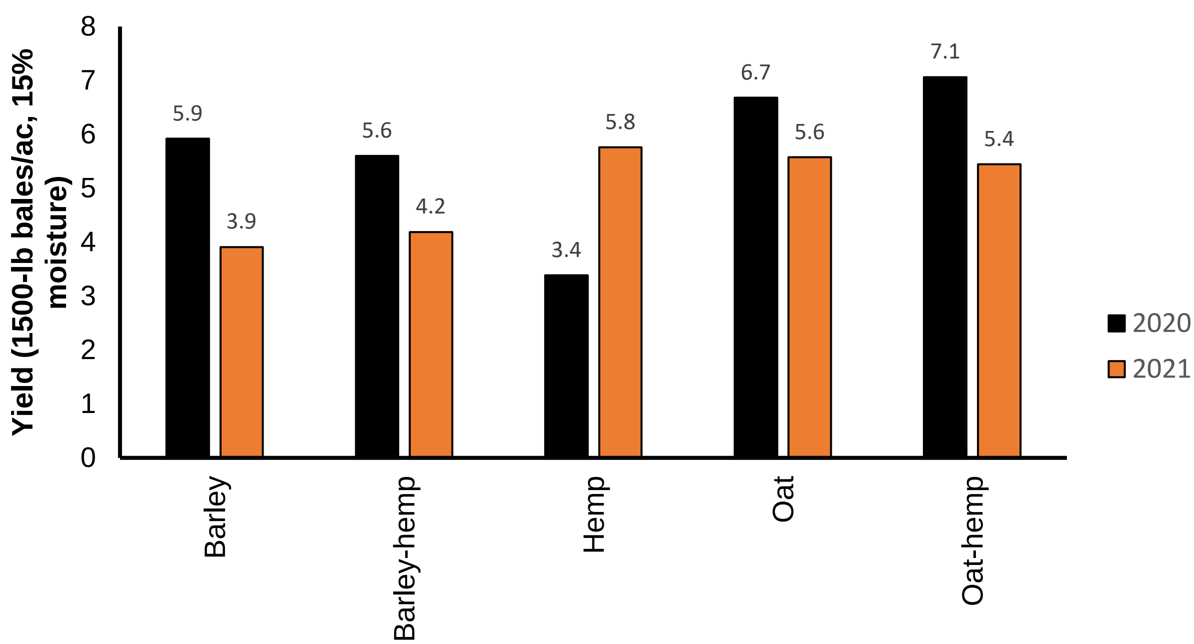

Figure 3: PCDF hay yield (1500-lb bales/ac, 15% moisture) by treatment.

The silage yields at CMCDC (t/ac) for treatments is shown in Figure 4. Hay yields (1500-lb bales/ac, 15% moisture) are shown in Figure 5.

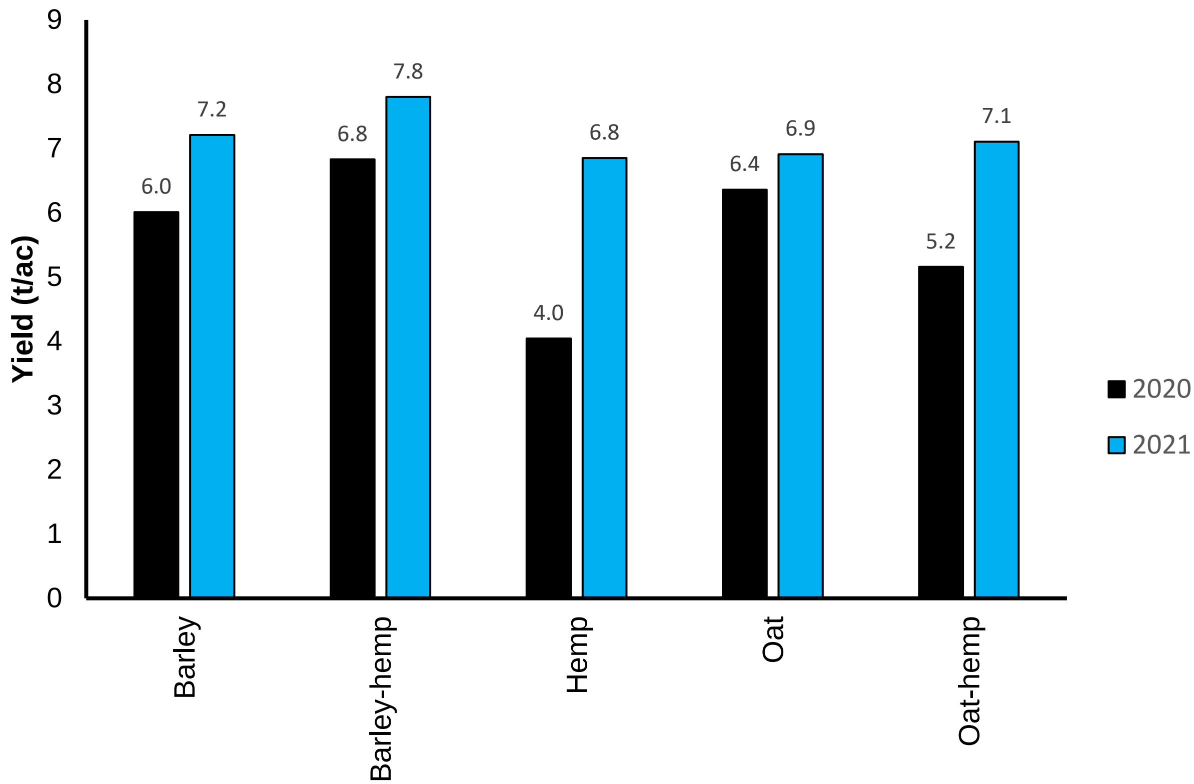

Figure 4: CMCDC wet silage yield (t/ac) by treatment; all yields adjusted to 65% moisture.

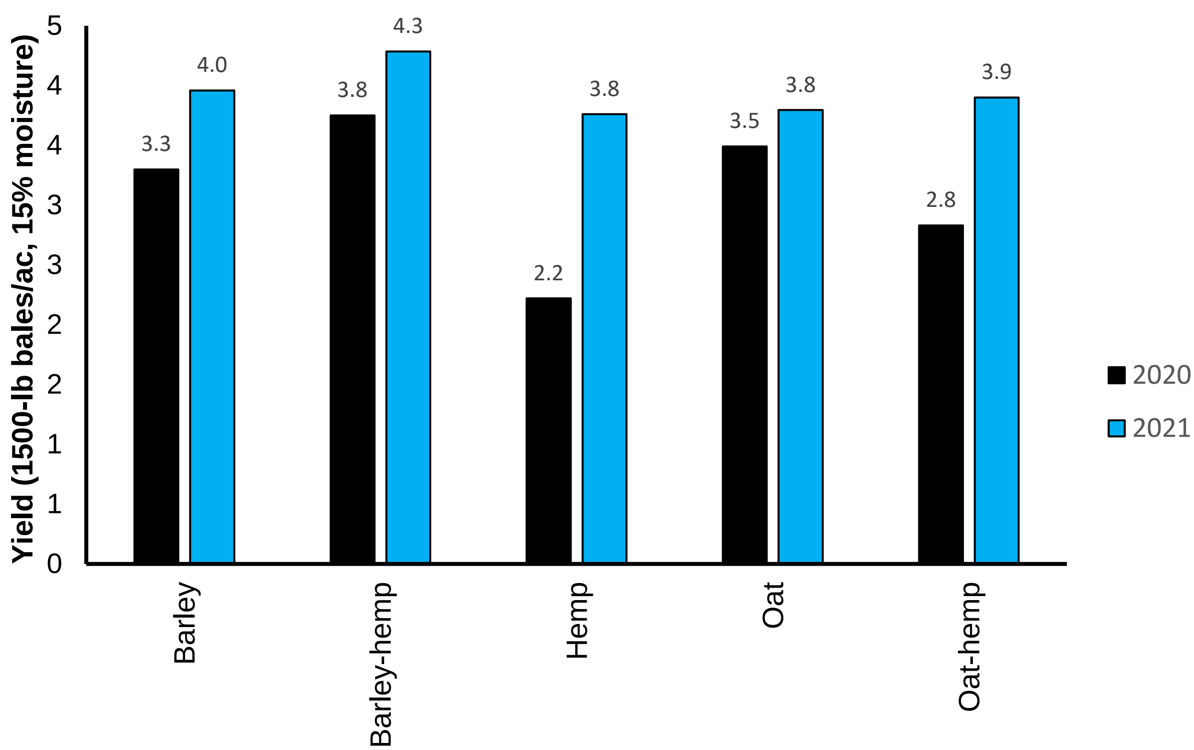

Figure 5: CMCDC hay yield (1500-lb bales/ac, 15% moisture) by treatment.

PCDF summary of statistical information and feed values

The results for silage yield differ statistically by treatment (Table 1). In 2020, the hemp-only treatment provided significantly lower silage yields than treatments including barley and oat. Further, the inclusion of hemp in the silage mixture did not significantly increase yield over barley-only or oat-only. In 2021, the yield for the barley-only treatment was significantly greater than for other treatments, and the yield for the hemp-only treatment was significantly less than for other treatments. Note that the reliability of these results is low due to a high percent CV for silage yield.

Table 1: PCDF summary of statistical information for silage yield

Entry	Silage yield (t/ac) wet yield		Statistical significance*			
	2020	2021	2020		2021	
Barley	12.9	10.5	A		A	
Barley-hemp	12.2	10.2	A		A	B
Oat	10.8	9.9	A		A	B
Oat-hemp	10.2	7.6	A		A	B
Hemp	6.2	7.1		B		B
LSD (0.05)	**3.4**	**3.2**				
% CV	**27.8**	**22.9**				

* Treatments not marked with the same letter are statistically different from other treatments.

CMCDC summary of statistical information and feed values

[See PCDF for comparative discussion: simple interpretation of yield differences.]

Table 2: CMCDC summary of statistical information for silage yield

Entry	Silage yield (t/ac) wet yield		Statistical significance*			
	2020	2021	2020		2021	
Barley	6.0	7.2			A	
Barley-hemp	6.8	7.8			A	
Oat	5.4	6.9			A	
Oat-hemp	5.2	7.1			A	
Hemp	4.0	6.8				B
LSD (0.05)		**3.4**				
% CV		**27.8**				

* Treatments not marked with the same letter are statistically different from other treatments.

The feed values and mineral content for each treatment for PCDF and CMCDC are shown in Tables 3 and 4.

Table 3: PCDF and CMCDC feed values for silage by treatment compared to animal feed requirements*

Entry	% Crude Protein			% TDN		
	2020	2021	Average	2020	2021	Average
PCDF values						
Barley	10.1	10.6	10.4	58.3	69.4	63.8
Oat	10.8	11.4	11.1	59.8	65.8	62.8
Hemp	12.6	10.2	11.4	43.7	50.5	47.1
Barley-hemp	12.2	12.0	12.1	58.7	56.1	57.4
Oat-hemp	12.2	11.4	11.8	58.9	67.2	63.1
CMCDC values						
Barley	10.8	10.3	10.6	71.9	68.2	70.0
Oat	8.4	9.8	9.1	55.5	63.4	59.4
Hemp	11.9	11.4	11.6	43.3	53.5	48.4
Barley-hemp	10.2	10.8	10.5	62.4	75.1	68.8
Oat-hemp	9.6	11.7	10.7	63.2	65.1	64.2
Animal feed requirements						
Mature cows						
Mid gestation	7			50-53		
Late gestation	9			58		
Lactating	11-12			60-65		
Replacement heifers	8-10			60-65		
Breeding bulls	7-8			48-50		
Yearling bulls	7-8			55-60		

* Animal feed requirements developed by Elisabeth Nernberg (Manitoba Agriculture).

Table 4: PCDF and CMCDC mineral content for silage by treatment

Treatment		Ca	P	Mg	Na	K	Mo	Cu	Zn	Mn	Fe
		Mineral									
PCDF values											
Barley	2020	0.35	0.19	0.12	0.39	1.25	1.29	4.23	17.3	30.24	112.85
	2021	0.30	0.22	0.16	0.13	1.73	1.05	2.96	17.23	17.36	68.24
	Average	**0.33**	**0.21**	**0.14**	**0.26**	**1.49**	**1.17**	**3.60**	**17.27**	**23.80**	**90.55**
Oat	2020	0.28	0.2	0.13	0.49	1.42	2.54	3.54	17.88	52.04	153.07
	2021	0.40	0.21	0.21	0.36	1.97	1.10	2.90	11.46	38.59	99.71
	Average	**0.34**	**0.21**	**0.17**	**0.43**	**1.70**	**1.82**	**3.22**	**14.67**	**45.32**	**126.39**
Hemp	2020	1.55	0.27	0.36	0.12	1.46	1.33	7.51	23.54	64.06	151.36
	2021	1.65	0.19	0.31	0.01	1.68	0.72	5.85	16.23	48.48	190.25
	Average	**1.60**	**0.23**	**0.34**	**0.07**	**1.57**	**1.03**	**6.68**	**19.89**	**56.27**	**170.81**
Barley-hemp	2020	0.64	0.24	0.18	0.3	1.29	1.13	5.35	21.34	36.88	145.81
	2021	1.20	0.22	0.31	0.09	1.88	1.20	4.86	19.30	44.60	239.80
	Average	**0.92**	**0.23**	**0.25**	**0.20**	**1.59**	**1.17**	**5.11**	**20.32**	**40.74**	**192.81**
Oat-hemp	2020	0.38	0.21	0.15	0.47	1.56	2.07	3.68	19.39	54.02	184.17
	2021	0.37	0.24	0.18	0.19	1.65	1.47	3.04	15.11	42.12	151.66
	Average	**0.38**	**0.23**	**0.17**	**0.33**	**1.61**	**1.77**	**3.36**	**17.25**	**48.07**	**167.92**
CMCDC Values											
Barley	2020	0.26	0.31	0.16	0.03	1.33	0.34	4.13	21.69	31.75	125.09
	2021	0.36	0.13	0.20	0.06	1.44	0.18	3.79	25.01	51.03	124.86
	Average	**0.31**	**0.22**	**0.18**	**0.05**	**1.39**	**0.26**	**3.96**	**23.35**	**41.39**	**124.98**
Oat	2020	0.25	0.18	0.16	0.14	2.31	0.52	2.75	14.79	82.19	143.81
	2021	0.26	0.14	0.17	0.16	1.65	0.81	3.18	21.41	97.59	151.66
	Average	**0.26**	**0.16**	**0.17**	**0.15**	**1.98**	**0.67**	**2.97**	**18.10**	**89.89**	**147.74**
Hemp	2020	1.46	0.26	0.51	0.04	1.64	0.44	7.98	24.24	79.26	217.14
	2021	2.20	0.13	0.77	0.02	1.24	0.29	8.54	22.70	121.52	244.91
	Average	**1.83**	**0.20**	**0.64**	**0.03**	**1.44**	**0.37**	**8.26**	**23.47**	**100.39**	**231.03**
Barley-hemp	2020	0.44	0.25	0.23	0.09	1.76	0.41	4.82	19.56	41.27	134.41
	2021	0.25	0.18	0.19	0.06	1.43	0.21	4.22	31.12	42.00	111.41
	Average	**0.35**	**0.22**	**0.21**	**0.08**	**1.60**	**0.31**	**4.52**	**25.34**	**41.64**	**122.91**
Oat-hemp	2020	0.25	0.22	0.17	0.19	1.96	0.84	3.42	16.66	76.83	164.26
	2021	0.53	0.17	0.24	0.19	1.42	1.00	3.95	24.85	99.40	188.61
	Average	**0.39**	**0.20**	**0.21**	**0.19**	**1.69**	**0.92**	**3.69**	**20.76**	**88.12**	**176.44**

Observations

The silage was prepared by running the harvested material from each plot through a plant shredder (see Figure 1.5). Hemp is a plant with long fibres that become tougher towards maturity. If the crop becomes too mature, these fibres have the potential to tangle in the chopping equipment. Further, the higher fiber content makes for lower digestibility by livestock. This is reflected in the lower percent-TDN figure for the hemp-only treatment (Table 3). Nevertheless, even a reduced rate of hemp appeared to positively increase percent-protein content for the oat-hemp and barley-hemp treatments.

Materials and methods

The experimental is a random complete block design with five entries and three reps. Seed costs for both PCDF and CMCDC are provided in Table 4. Agronomic data is summarized in Tables 5 and 6.

Table 5: Treatments, seeding rates and costs

Treatments	Percent of each monocrop seeding rate	Seeding Rate (lb/ac)	Cost per acre
Barley (Maverick)	100	90	$14.91
Oat (Haymaker)	100	90	$19.72
Hemp (Katani)	100	25	$50.00
Barley-hemp (Maverick-Katani)	75-33	68-8	$27.26
Oat-hemp (Haymaker-Katani)	75-33	68-8	$30.90

Table 6: Agronomic data

	PCDF		CMCDC	
	2020	2021	2020	2021
Seeding date	May 25	May 20	May 25	May 24
Harvest date	Aug 12	Aug 11	Aug 19	Aug 16
Previous crop	Barley silage	Oat silage	Soybean	Canola
Soil type	Erickson Loam Clay		Clay Loam	
Seedbed prep	Heavy harrow	Vertical tillage	No-till	No-till

Table 7: Fertility information

	PCDF		CMCDC	
	Available	Added	Available	Added
N				
2020	79 lb/ac	47 lb/ac	19 lb/ac	124 lb/ac
2021	151 lb/ac	10 lb/ac	24 lb/ac	113 lb/ac
P				
2020	22 ppm	10 lb/ac	14 ppm	11 lb/ac
2021	47 ppm	15 lb/ac	11 ppm	16 lb/ac
K				
2020	257 ppm	none	-	-
2021	143 ppm	none	-	-

There are some herbicides registered for use with hemp, and there are no herbicides registered for both hemp and barley or oats, making silage intercropping for hemp and cereals a challenge. Good weed control prior to seeding is crucial. The trials were hand-weeded.

Pea-Cereal Silage

Project duration: May 2019 – August 2022
Objectives: To evaluate pea-cereal intercrop mixes for silage production
Collaborators: PCDF, Canada Manitoba Crop Diversification Centre (CMCDC)

Background
Silage plays an important part in the Manitoba livestock industry. Corn silage provides high yields, relative to barley silage (14 t/ac, over 7.5 t/ac, 2021 Silage Cost of Production, Manitoba Agriculture). In the Parkland area, the yield for corn silage is variable and many producers opt to produce a cereal silage, such as barley or oat. Some producers have explored pea-cereals mixtures as a means to increase silage protein content. PCDF is eager to explore options for cereals silage production.

Results
The silage was harvested at soft-dough stage (approximately 65% moisture). The PCDF 2019-2021 wet silage yields (t/ac) are shown in Figure 1, and dry yields (lb/ac at 15% moisture) are shown in Figure 2. The CMCDC 2020-2021 silage yields (t/ac) for treatments is shown in Figure 4, and dry yields (1500-lb bales/ac, 15% moisture) are shown in Figure 5.

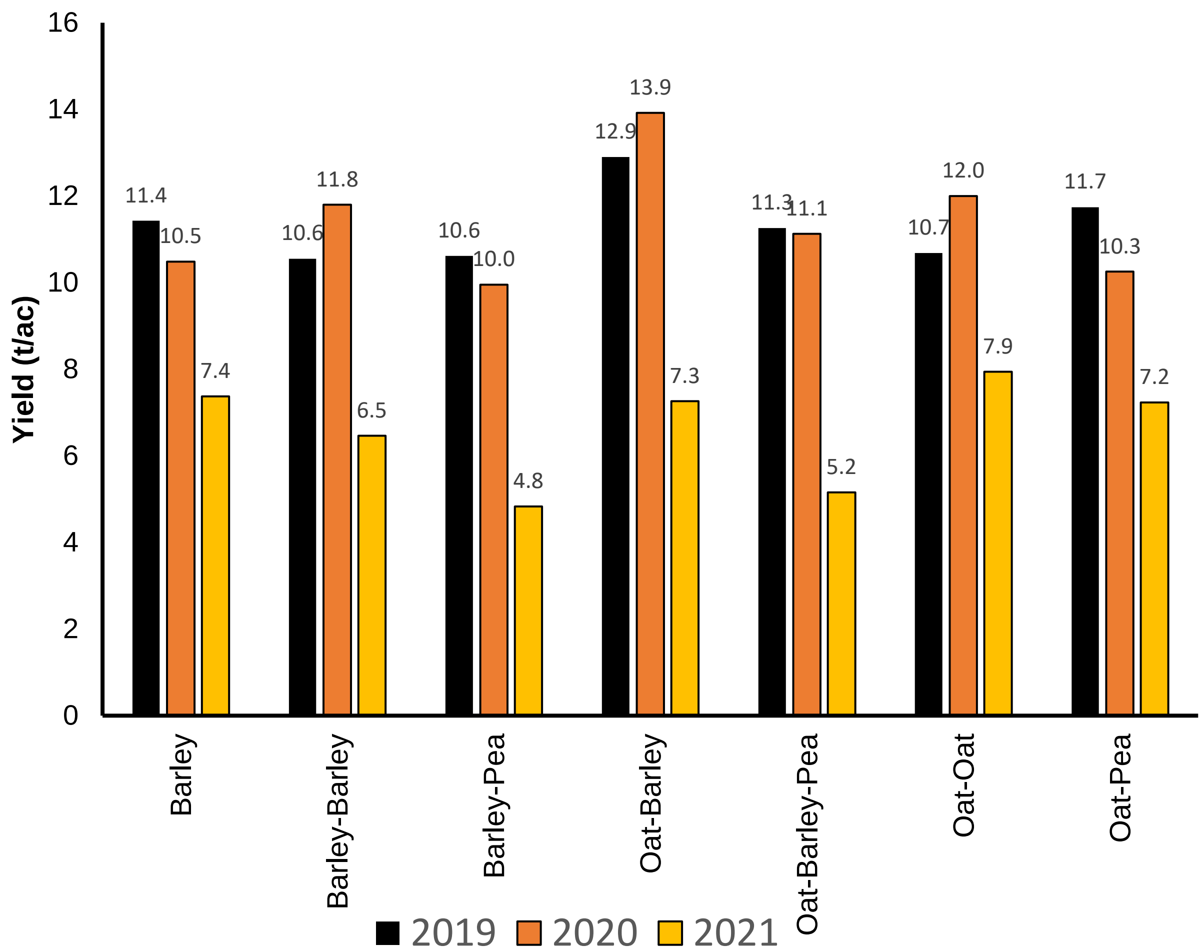

Figure 1: PCDF wet silage yield (t/ac, 65% moisture) by treatment.

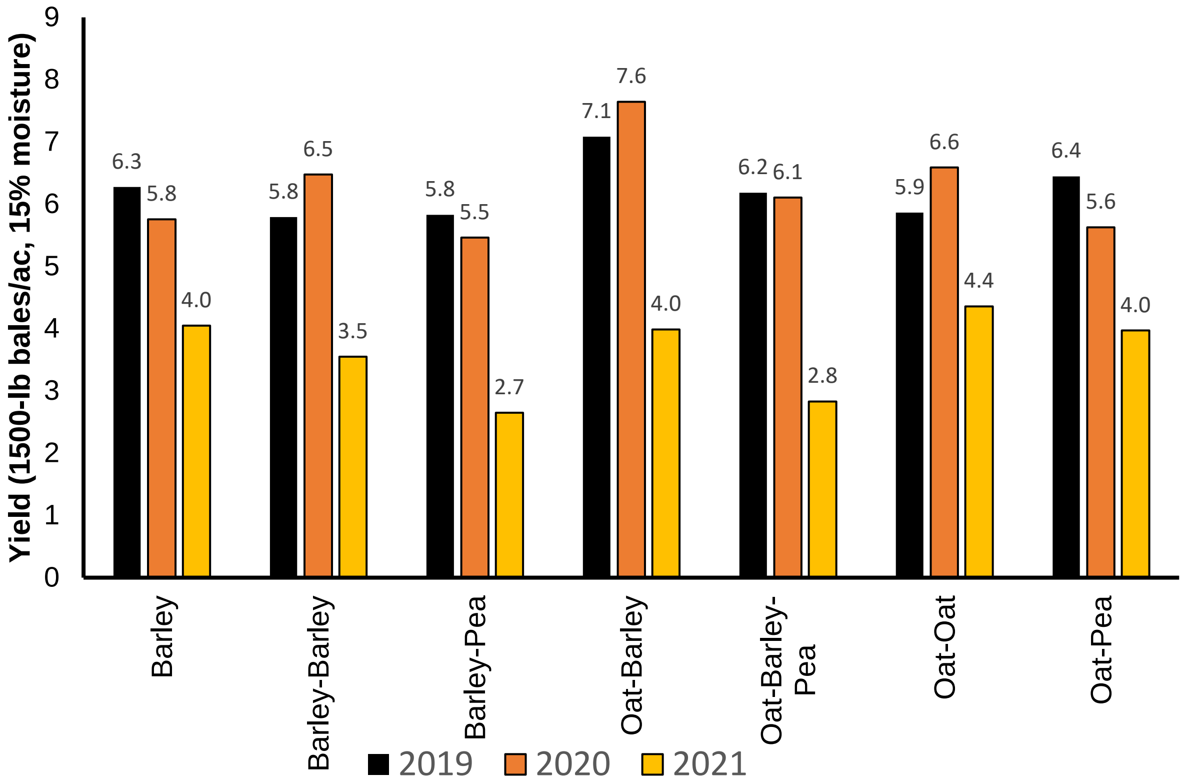

Figure 2: PCDF hay yield (1500-lb bales/ac, 15% moisture) by treatment.

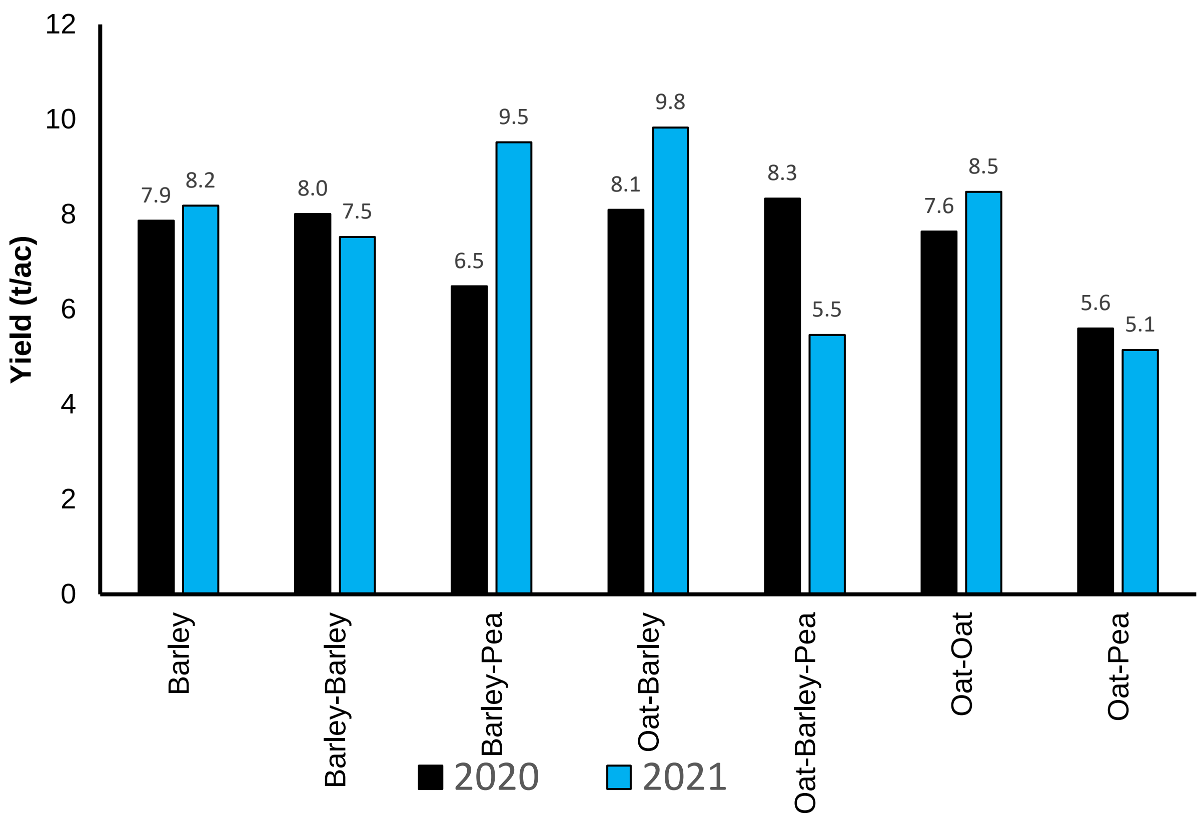

Figure 3: CMCDC wet silage yield (t/ac, 65% moisture) by treatment.

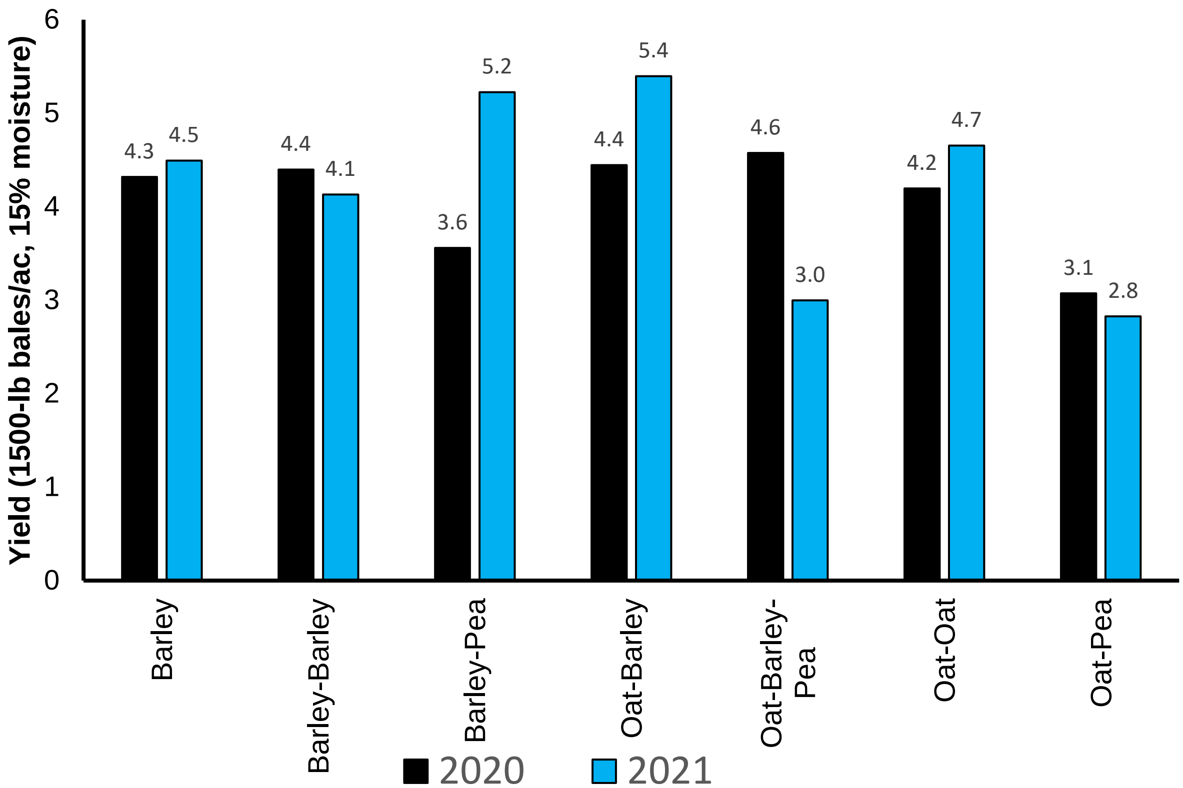

Figure 4: CMCDC hay yield (1500-lb bales/ac, 15% moisture) by treatment.

Table 1: PCDF summary of statistical information for silage yield

Entry	Silage yield (t/ac) wet yield			Statistical significance*				
	2019	**2020**	**2021**	**2019**	**2020**			**2021**
Barley	11.4	10.5	7.4		A	B		A
Barley-Barley	10.5	11.8	6.5		A			A
Barley-Pea	10.6	10.0	4.8			B		A
Oat-Barley	12.9	13.9	7.3				C	A
Oat-Barley-Pea	11.3	11.1	5.2		A	B		A
Oat-Oat	10.7	12.0	7.9		A			A
Oat-Pea	11.7	10.3	7.2		A	B		A
LSD (0.05)		**1.8**	**4.1**					
% CV		**13.8**	**34.1**					

* Treatments not marked with the same letter are statistically different from other treatments.

Table 2: CMCDC summary of statistical information for silage yield

Entry	Silage yield (t/ac) wet yield		Statistical significance*			
	2020	**2021**	**2020**	**2021**		
Barley	7.9	8.2			B	C
Barley-Barley	8.0	7.5			B	
Barley-Pea	6.5	9.5				C
Oat-Barley	8.1	9.8		A		
Oat-Barley-Pea	8.3	5.5			B	C
Oat-Oat	7.6	8.5			B	
Oat-Pea	5.6	5.1			B	C
LSD (0.05)		**1.8**				
% CV		**13.8**				

* Treatments not marked with the same letter are statistically different from other treatments.

The feed values and mineral content for each treatment for PCDF and CMCDC are shown in Table 3.

Table 3: PCDF and CMCDC feed values for silage by treatment compared to animal feed requirements*

Entry	% Crude Protein				% TDN			
	2019	2020	2021	Average	2019	2020	2021	Average
PCDF values								
Barley	10.2	8.2	10.7	9.7	67.6	58.9	70.3	65.6
Barley-Barley	11.0	8.2	11.0	10.1	68.6	60.5	71.2	66.8
Barley-Pea	10.6	10.9	11.4	11.0	72.9	60.7	70.0	67.9
Oat-Barley	12.1	7.1	11.2	10.1	71.3	63.2	70.1	68.2
Oat-Barley-Pea	12.2	8.8	11.7	10.9	69.0	60.4	62.9	64.1
Oat-Oat	10.8	7.8	10.9	9.8	69.8	61.5	65.8	65.7
Oat-Pea	13.4	9.1	12.8	11.8	66.0	59.3	60.0	61.8
CMCDC values								
Barley	-	10.4	10.1	10.3	-	66.7	73.3	70.0
Barley-Barley	-	10.7	10.7	10.7	-	73.1	77.5	75.3
Barley-Pea	-	12.0	12.2	12.1	-	54.9	72.7	63.8
Oat-Barley	-	9.4	11.0	10.2	-	61.1	72.1	66.6
Oat-Barley-Pea	-	12.8	11.3	12.1	-	60.3	65.6	63.0
Oat-Oat	-	9.0	10.2	9.6	-	58.2	67.5	62.9
Oat-Pea	-	12.5	13.8	13.2	-	61.1	69.9	65.5
Animal feed requirements								
Mature cows								
Mid gestation	7				50-53			
Late gestation	9				58			
Lactating	11-12				60-65			
Replacement heifers	8-10				60-65			
Breeding bulls	7-8				48-50			
Yearling bulls	7-8				55-60			

* Animal feed requirements developed by Elisabeth Nernberg (Manitoba Agriculture).

Summary of statistical information and feed values

- At PCDF, yield for all silage mixtures fell in 2021, due to dry growing conditions (Table 4). However, yield at CMCDC did not drop substantially, or even increased, during the 2021 season.
- In 2021, the yields at PCDF did not differ significantly by treatment. At CMCDC, oat-barley silage provided significantly higher yields than other treatments.
- The trend across all years and sites is for crude protein to increase in mixtures containing pea. However, total digestible nutrients (TDN) tends to be less for these mixtures.

Table 4: Seasonal precipitation

Site	PCDF			CMCDC	
Year	2019	2020	2021	2020	2021
Precipitation*	156 (73%)	219 (100%)	160 (73%)	224 (102%)	148 (68%)

* mm (% normal), May 1 – August 15

Observations

The silage was prepared with a plant shredder. The oat-barley treatment appears to be a promising option, both for higher yields relative to other treatments (Tables 1 and 2) and high TDN values (Table 3). Oat-barley silage allows for good weed control, but there are no herbicides registered for barley-oat-pea silage intercrops. Good weed control prior to seeding is crucial. The trial was hand-weeded.

Materials and methods

The experimental is a random complete block design with seven entries and three reps. Seed costs for both PCDF and CMCDC are provided in Table 4. Agronomic data is summarized in Tables 5 and 6. Barley-barley and oat-oat treatments combine a forage- and grain-type variety to maximize biomass and energy production.

Table 4: Treatments, seeding rates and seeding costs

Treatments	Percent of Monocrop Seeding Rate	Seeding Rate (lb/ac)	Cost per acre
Barley (Maverick)	100	90	$14.91
Barley-barley (Maverick-Austenson)	75-75	68-68	$22.53
Barley-pea (Maverick-Lacombe)	25-100	22-150	$34.89
Oats-oats (Haymaker-Summit)	75-75	68-68	$28.40
Oats-barley (Haymaker-Maverick)	75-75	22-150	$26.16
Oat-pea (Haymaker-Lacombe)	25-100	22-150	$36.07
Oats-barley-pea (Haymaker-Maverick-Lacombe)	12.5-12.5-100	11-11-150	$35.48

Table 5: Agronomic data

	PCDF			CMCDC	
	2019	2020	2021	2020	2021
Seeding date	May 16	May 25	May 20	May 25	May 24
Harvest date	Aug 9	Aug 12	Aug 11	Aug 19	Aug 16
Previous crop	Barley Silage	Barley silage	Oat silage	Soybean	Canola
Soil type	Erickson Loam Clay			Clay Loam	
Seedbed prep	Heavy harrow	Heavy harrow	Vertical tillage	No-till	No-till

Table 6: Fertility information

	PCDF		CMCDC	
	Available	Added	Available	Added
N				
2019	156 lb/ac	-		
2020	79 lb/ac	47 lb/ac	19 lb/ac	124 lb/ac
2021	151 lb/ac	10 lb/ac	24 lb/ac	113 lb.ac
P				
2019	9 ppm	20 lb/ac		
2020	22 ppm	10 lb/ac	14 ppm	11 lb/ac
2021	47 ppm	15 lb/ac	11 ppm	16 lb/ac
K				
2019	170	none		
2020	257 ppm	none	-	-
2021	143 ppm	none	-	-

Teff Forage Evaluation

Project duration: May 2021 – September 2021
Objectives: To evaluate teff by seeding rates for forage production potential
Collaborators: PCDF

Background
Teff is a warm-season annual grass that originates in northeast Africa, where it is grown for grain and forage production. As a forage, the crop is notable for its high protein content and palatability, as well as its potential for high yields. The crop is relatively new to Manitoba. For a detailed examination of teff forage nitrogen and irrigation requirements, see this Pacific Northwest Extension Publication.

This test examined the yield potential for teff forage, seeded at 5 lb/ac and 7 lb/ac, and compared it with the yield of barley greenfeed. The teff treatments were cut on July 15 (1st cut) and Sept 28 (2nd cut). All treatments were tested for nutrient values.

Figure 1: (a) 1st cut teff hay (July 15) (b) 2nd cut teff hay (Sept 28)

Figure 2: (a) 2nd cut teff hay (Sept 28) (b) 1st cut teff hay (left) and 2nd cut teff hay (right)

Results

Total hay yields (15% moisture) for each cut are shown in Figure 2, along with the average barley green feed (single-cut) yield. Table 1 shows the statistical summary for both cuts.

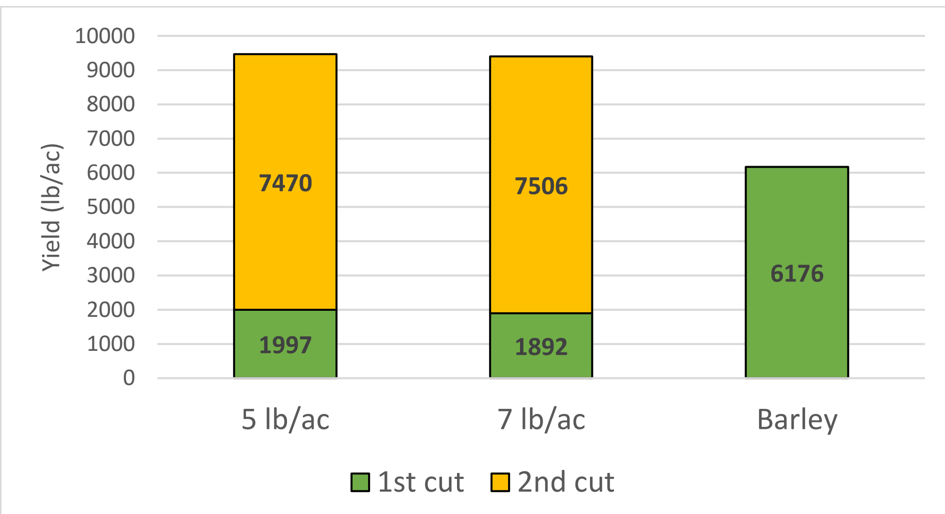

Figure 3: Yield (lb/ac, 15% moisture) for 1st cut and 2nd cut teff, seeded at 5 and 7 lb/ac, plus yield for barley greenfeed comparison.

Table 1: Average yield, % yield of barley greenfeed, % CV, and average yield 1500-lb bales/ac

Treatment (seeding rate)	Average yield (lb/ac, 15% moisture)	% Yield	% CV	1500-lb bales/ac
Teff (5-lb/ac)				
1st cut	1996.8	-	29.3	1.1
2nd cut	7470.0	-	21.9	5.8
2-cut total	9466.9	153.3	13.5	6.9
Teff (7-lb/ac)				
1st cut	1892.1	-	21.9	1.0
2nd cut	7506.4	-	10.8	5.7
2-cut total	9398.6	152.2	7.2	6.7
Barley (108 lb/ac)	6176.5	100.0	-	4.1

The variances between teff plot yield for 1st and 2nd cut are high, but when the yield per plot for both cuts is combined, the variances are low. There are no statistical differences in yield between teff seeded at 5-lb/ac and 7-lb/ac, which suggests that seeding at the lower rate will provide the same yield as at the higher rate. Promisingly, the average yield for both teff treatments was higher than the average yield for barley greenfeed. However, the results are for one year only, and should be interpreted with caution.

Table 2 shows the cost per treatment, including the cost of cutting the hay. Table 3 shows the feed values for teff and barley treatments by cut, as well as animal feed requirements for beef. Table 4 shows mineral content by treatment.

Table 2: Cost of production by treatment for teff and barley by seeding rate and cut

Treatment	Seeding cost ($/lb)	Seeding rate (lb/ac)	Cutting cost ($/ac)*	Seeding plus cutting cost ($/ac)
Teff (2 cuts)	4.99	5	35.10	60.05
		7		70.03
Barley (1 cut)	0.29	108	17.55	49.05

*Based on an average of costs for disc bine and sickle mower cuts from the Manitoba Agriculture Cost of Production for Farm Machinery.

Table 3: Feed values for teff and barley by cut compared to animal feed requirements*

Entry	% Crude Protein	% TDN
Teff 1st cut	20.9	69.2
Teff 2nd cut	11.4	59.9
Barley	10.5	69.9
Animal feed requirements		
Mature cows		
Mid gestation	7	50-53
Late gestation	9	58
Lactating	11-12	60-65
Replacement heifers	8-10	60-65
Breeding bulls	7-8	48-50
Yearling bulls	7-8	55-60

* Animal feed requirements developed by Elisabeth Nernberg (Manitoba Agriculture).

Table 4: Mineral content for feed by treatment

Treatment	Mineral									
	(%)					(ppm)				
	Ca	P	Mg	Na	K	Mo	Cu	Zn	Mn	Fe
Teff (1st cut)	0.77	0.22	0.16	0.04	2.25	2.41	9.00	21.36	26.10	138.15
Teff (2nd cut)	0.51	0.23	0.24	0.02	1.62	1.20	4.72	20.05	22.82	110.44
Barley	0.33	0.21	0.14	0.26	1.49	1.17	3.60	17.27	23.80	90.55

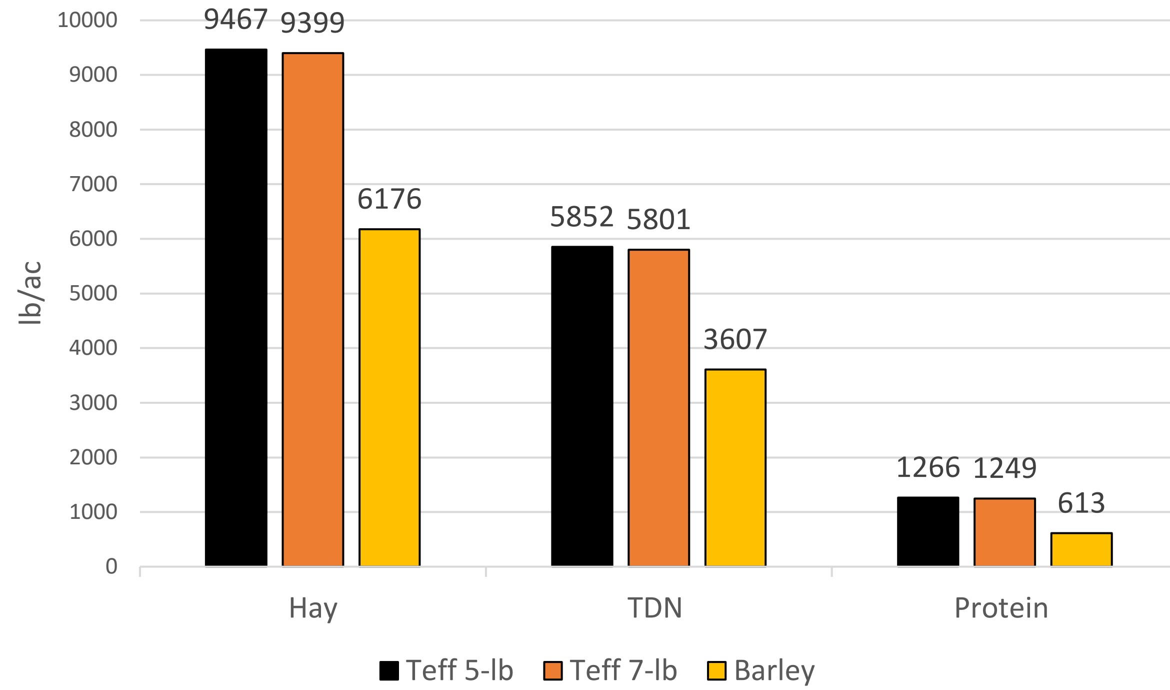

Figure 4: Total hay yield, TDN and protein by treatment (lb/ac)

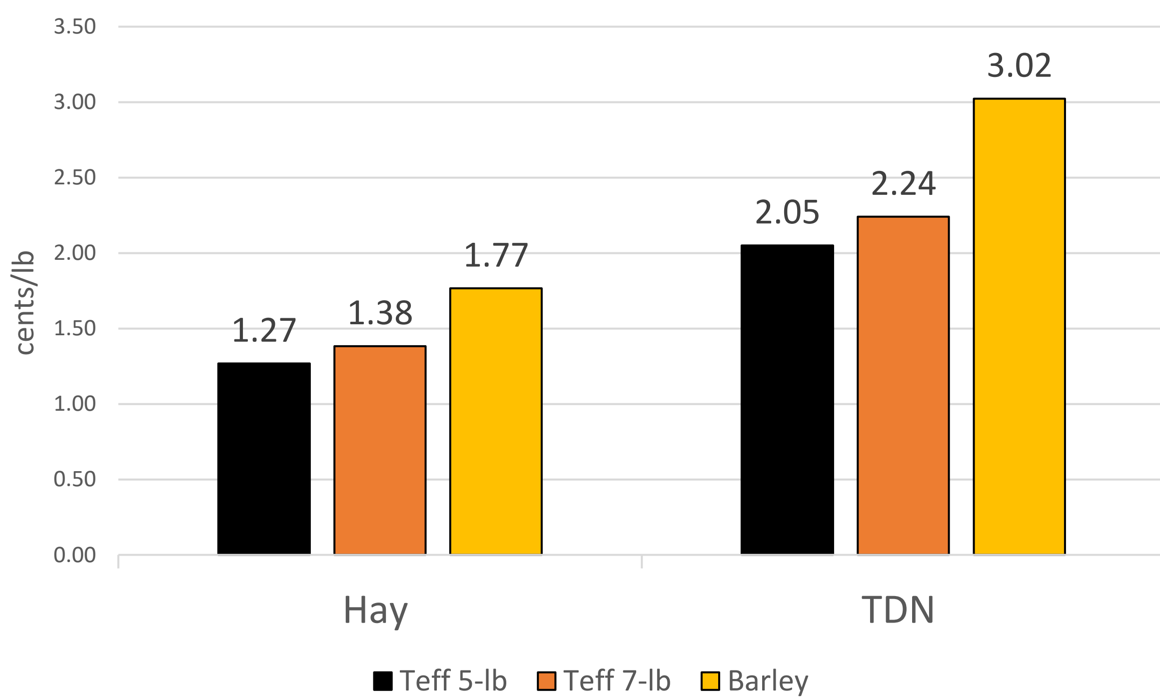

Figure 5: Cost of hay and TDN, including cost of seed and cutting ($/lb). Cost includes seed, cutting (x2 for teff, x1 for barley greenfeed) and land rental (estimated at $60/acre).

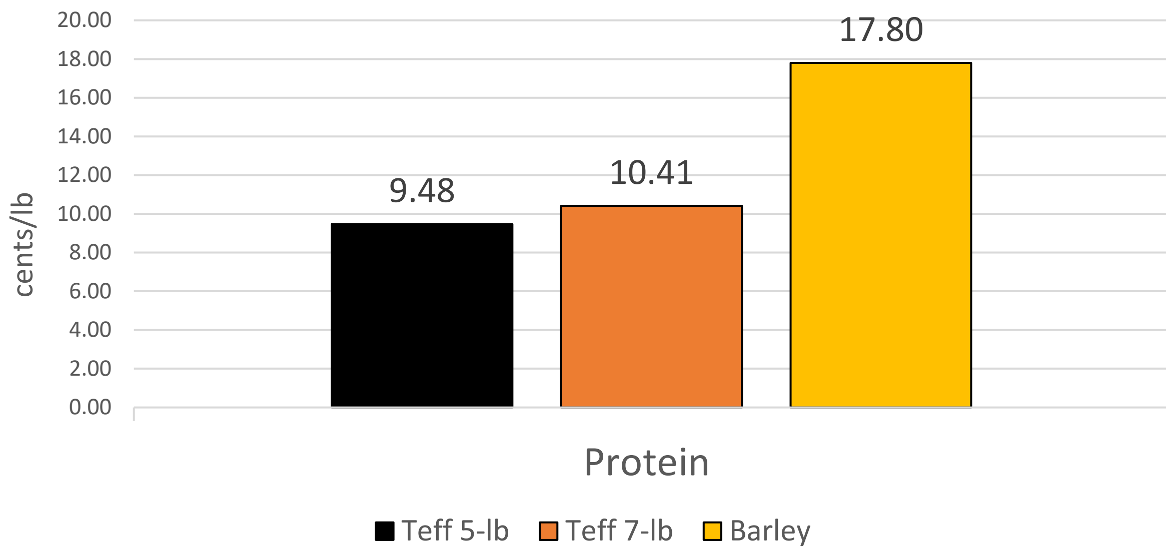

Figure 6: Cost of protein by treatment, including cost of seed and cutting ($/lb). Cost includes seed, cutting (x2 for teff, x1 for barley greenfeed) and land rental (estimated at $60/acre).

<u>Observations</u>

Despite higher seed and cutting costs for teff hay over barley greenfeed, the lower yield for barley greenfeed suggests that teff may provide good economic returns. Figure 7 shows the relative cost factor* associated with teff for both seeding rates and for barley greenfeed.

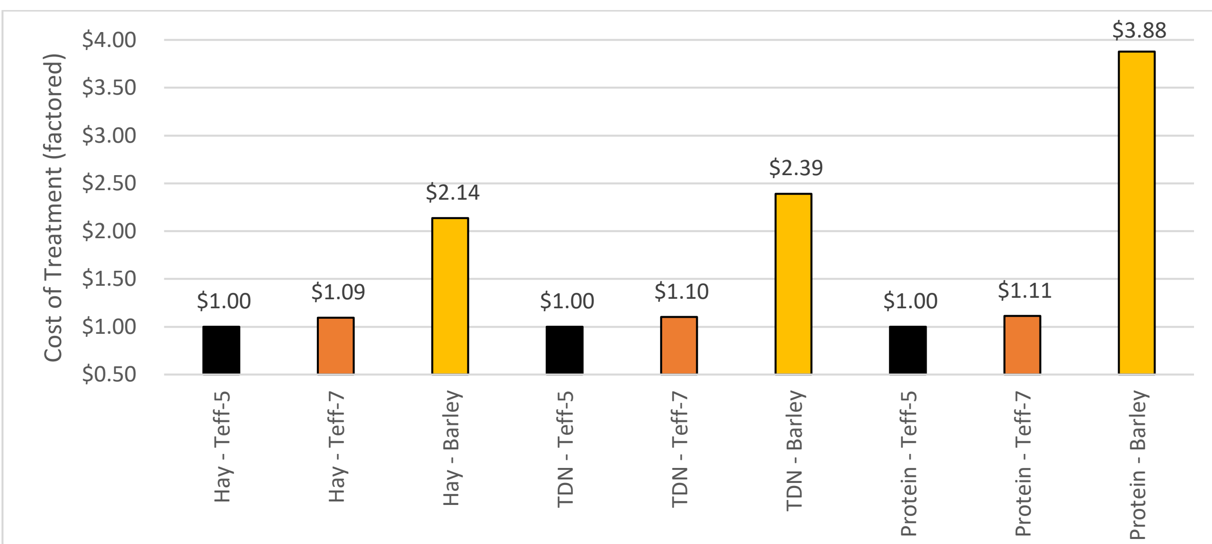

Figure 7: Relative cost factor for each treatment for hay yield, TDN, and protein. Cost includes seed, cutting (x2 for teff, x1 for barley greenfeed) and land rental (estimated at $60/acre).**

* <u>Relative cost factor shows the cost in dollars to produce the same amount of hay, TDN and protein</u>. The cost is factored to show the lowest cost treatment (teff seeded at 5 lb/ac) as $1.00. For example, to achieve the hay yield obtained from spending $1.00 on teff seeded at 5 lb/ac, a producer would need to spend $1.09 for teff seeded at 7 lb/ac, and $2.14 for barley greenfeed.

** The relative cost factor includes the cost per acre of seeding, cutting and land rental, as well as the yield for each treatment. Note that more land is required for barley greenfeed to achieve the same results as for teff seeded at 5 lb/ac. The additional cost of land is accounted for here; however, other costs, such as the fuel and fertilizer required to seed additional acres would further increase the relative cost of barley greenfeed.

<u>Despite the apparent advantages of teff for hay production, the results shown here are for one year only, and should be interpreted with caution. More years of site data are required to better understand the performance and economic potential of teff as a forage crop.</u>

Agronomic info

Previous year's crop:	Oat Silage
Soil Type:	Erickson Loam Clay
Landscape:	Rolling with trees to the east
Seedbed preparation:	Vertical Tilled

Table 5: Agronomic data

Seeding date	May 14
Teff 1st cut date	July 25
Teff 2nd cut date	Sept 28
Barley cut date	Aug 11
Previous crop	Oat silage
Soil type	Erickson Loam Clay
Seedbed prep	Vertical tillage

Table 6: Fertility Information (all treatments)

	Available		Added	Type
N	162	lb/ac	10 lb/ac	46-0-0
P	41	ppm	10 lb/ac	11-52-0-0
K	703	ppm	-	-

No herbicide applied (hand weeded)

Multi-Crop Intercrop trial (Pea-Oat-Canola-Wheat-Flax-Mustard)

(Adapted from a report written by Scott Chalmers, WADO)

Project duration: 2019-2021

Objectives: Evaluate agronomic performance of peas in a monocrop or when intercropped with oats, canola, spring wheat, flax or mustard

Collaborators: Manitoba Pulse & Soybean Growers Association - Daryl Domitruk
PCDF (Roblin), WADO (Melita)

Background

Choice of an intercropping system depends on many factors including: weather, machinery available for seeding, harvesting and separation of seed, economics and compatibility of the crops involved. Many organic agriculture farmers have turned to various intercropping systems to address weed and disease pressure, which often inhibits organic systems under monoculture situations (Pridham and Entz, 2007). Intercropping systems can help address climate change in ways such as biological control of insect pests, weeds and diseases. Biological control allows for less use of synthetic chemicals hence addressing the chemical resistance issues. Another benefit of intercropping is improving soil health at low cost considering residual nitrogen if a legume is included. In other studies, pea-wheat intercropping systems have been shown to be efficient in the use of nitrogen due to their spatial self-regulating dynamics, which allows pea to improve its interspecific competitive ability in fields with lower soil nitrogen and vice versa for wheat (Andersen et al., 2004 and Ghaley et al., 2005). This enables future options to reduce synthetic nitrogen inputs and negative environmental impacts of crop production. Compared to pea sole crop, pea-oats intercrop results in reduced pea lodging because of the support provided by oats to the pea crop, this also helps reduce harvesting difficulties and increase economic returns (Kontturi et al., 2010). This study evaluated various intercrop combinations that can be utilized by producers.

Materials and Methods

The trials were at Melita, Reston and Roblin in 2021. Soil tests were conducted to determine nutrient status before seeding at all sites (Table I). A randomized complete block design with 11 treatments and 4 replicates was used at each site. Fertilizer was applied according to soil test results during seeding, along with inoculant (Table I). Site description, agronomy and weather information for each trial is presented in Table II. Data collected from each site included: Counts at emergence and flowering, weed counts and biomass at flowering, grain yield, percentage of pea splits, and protein content. Disease severity data collected was for mycosphaerella, powdery mildew, rust, sclerotinia and fusarium wilt. Data were analyzed using Minitab 18 and means were separated using Fisher's LSD at 95% confidence.

Table I. Soil test results for Melita, Reston, and Roblin sites in 2021.

Soil Test:	**Nutrient**						
Location	**N** lb ac^{-1}	**P** **ppm**	**K** **Ppm**	**S** lb ac^{-1}	**Zn** **ppm**	**Organic Matter (%)**	**pH**
Melita	18	5	279	208	0.64	3.3	7.0
Reston	102	9	252	92	1.07	4.7	6.7
Roblin	120	52	670				

Applied:	**Nutrient**				
Location	**N**	**P**	**K**	**S**	**Zn**
	lb ac^{-1}				
Melita	12	28	20	12	1.6
Reston	15	28	20	12	1.6
Roblin	0	15	0	0	0

Table II. Agronomy and weather data from intercrop trial sites in Reston, Melita, and Roblin, MB in 2021.

Location	Reston, MB	Melita, MB	Roblin, MB
Legal Land Location	SE 11-7-27 W1	NW 27-3-27	NE 20-25-28 W1
Soil Series	Ryerson Loam	Alexander Loam	Erickson Clay Loam
Previous Crop	Spring Wheat	Spring wheat	Oat silage
Field Preparation	Harrowed, No-till	Harrowed, No-till	Vertical tillage
Pre-Emergent Herbicides	May 12: 0.65 L ac^{-1} Rival on canola, peas, flax and mustard, Authority on peas and flax	May 10: 0.65 L ac^{-1} Rival on Pea, Flax, mustard, and canola, 0.1 L ac^{-1} Authority in Pea and Flax	May 26: 0.54 L ac^{-1} Liberty
Soil Moisture at Seeding	Fair	Fair	Very poor
Seed Date	May 11	May 7	May 19
Seed Depth (inch)	1”	0.75”	0.75”
Herbicides	June 9: Basagran, Arrow, Axial, Odyssey	June 8: Basagran, Arrow, Odyssey	None
Insecticides	Flea beetles – June 1: 75 ml ac^{-1} Pounce, 10 gal June 10: 34 ml/ac Matador	Flea beetles - June 2: 75 ml ac^{-1} Pounce, 10 gal Blister beetles – June 28: 0.4 L ac^{-1} Cygon (15 gal ac^{-1}) on canola	None
Desiccation	August 6 – Roundup 0.5 L ac^{-1} + Reglone 0.5 L ac^{-1} + LI700 1 L ac^{-1}	August 10 – Roundup 0.5 L ac^{-1} + Heat 22 ml ac^{-1} + Reglone L ac^{-1} + LI700 @ 0.1%	None
Harvest Date	August 13, flax August 26	August 16 (Canola slightly too early)	September 24
Combine Settings			
Rotor	760	600 (1000 for flax)	800
cleaning fan	780	820	930
rotor-concave space	8 mm	12 mm	10 mm
Growing Season Report (Seeding – Harvest)			
Precipitation (mm)	154	175	246
Normal (mm)	259	260	265
Growing Degree Days	1252	1374	1466
Normal GDDs	1248	1213	1302

Results and Discussion

At the Melita site, peas intercropped with canola or mustard yielded significantly ($P<0.001$) greater than other intercrop combinations (Table a). Partial land equivalence ratio (PLER) of pea component crops followed the same trend, with peas from the pea-canola (0.54) and pea-mustard (0.51) intercrops having significantly ($P<0.001$) greater PLERs than the other intercrop combinations. However, the only intercrop with an average TLER greater than 1 was the pea-canola intercrop. While the pea-mustard intercrop produced high pea yields, PLER of the mustard component crop was lowest. This highlights a potential competition effect of pea on mustard.

Pea yields at the Reston site followed a similar trend as the Melita site, with the pea-canola and pea-mustard intercrops resulting in the greatest pea yields (Table b). In terms of pea PLER, the pea-canola intercrop resulted in a significantly ($P<0.001$) greater PLER than all other intercrops. The pea-flax intercrop resulted in the lowest pea yield (28 kg ha-1) and PLER (0.07) of all intercrop combinations. The Reston pea-canola intercrop also resulted in the greatest average TLER (1.46), though this result was not significantly (P<0.001) different from that of the pea-mustard (1.13) or pea-oat (1.35) intercrop. The Reston pea-flax intercrop was the only combination which did not over-yield, though the TLER from this intercrop combination was not significantly (P<0.001) different from that of the pea monocrop.

Intercrops in Roblin displayed similar results as the Melita and Reston sites (Table c), with the pea-canola intercrop resulting in the greatest pea yield (432 kg ha-1), though this yield was not significantly (P = 0.003) different from that of the pea-mustard intercrop (270 kg ha-1). While analysis of variance for pea PLER of Roblin intercrops indicated a significant treatment effect (P = 0.038), Fishers LSD test was unable to separate means, indicating no significant difference between pea PLERs. The greatest TLER resulted from the pea-canola intercrop in Roblin, though this TLER was not significantly different from that of the pea-mustard, pea-oat, or pea-wheat intercrops. Like in the Reston trial, the lowest TLER resulted from the pea-flax intercrop. While TLERs observed at the Roblin site were much greater than those observed at the Reston or Melita sites, it is important to note that the pea monocrops in Roblin yielded much lower than the pea monocrops in Melita and Reston, therefore leading to greater pea partial land equivalence ratios.

Overall, pea yield at all sites was much lower than 2020 yields. However, similar trends were observed, with pea-canola and pea-mustard intercrops also consistently producing high pea yields and TLERs in 2020 as well. The flax-pea intercrop did perform much better in 2020 than in 2021, and poor performance of this intercrop combination in 2021 could be due to less accumulated precipitation in the 2021 growing season. Results from 2019, 2020, and 2021 sites will be combined and analyzed in a separate report, and may better illustrate which intercrop combinations perform best throughout both wet and dry years.

Table a. Mean Yield and Land Equivalence Ratio of various crops grown in monocrop or intercropped with pea at Melita, MB in 2021.

Crop	**Yield (kg/ha)**			**LER**		
	Sole	**Crop-IC**	**Pea-IC**	**Partial Crop-IC**	**Partial Pea-IC**	**TLER**
Pea	2209	-	-	-	-	1.00**b**
Flax	1314	1049	430**b**	0.80	0.19**b**	1.00**b**
Oat	2259	1768	464**b**	0.79	0.21**b**	1.00**b**
Wheat	1688	1171	618**b**	0.69	0.28**b**	0.98**b**
Canola	1278	788	1195**a**	0.63	0.54**a**	1.17**a**
Mustard	629	338	1118**a**	0.54	0.51**a**	1.00**b**
P value			**<0.001**		**<0.001**	**<0.001**
CV (%)			**12**		**11**	**5**
Values followed by the same letter are not significantly different by Fishers LSD method at 95% confidence.						

Table b. Mean yield and Land Equivalence Ratio of various crops grown in monocrop or intercropped with pea at Reston, MB in 2021.

Crop	Yield (kg/ha)			LER		
	Sole	Crop-IC	Pea-IC	Partial Crop-IC	Partial Pea-IC	TLER
Pea	415	-	-	-	-	1.00**cd**
Flax	192	145	28**c**	0.71	0.07**c**	0.78**d**
Oat	3643	3346	175**b**	0.93	0.42**b**	1.35**ab**
Wheat	3198	2242	178**b**	0.71	0.42**b**	1.13**bc**
Canola	1806	1268	312**a**	0.72	0.75**a**	1.46**a**
Mustard	1387	835	216**ab**	0.62	0.52**b**	1.13**abc**
P value			**<0.001**		**<0.001**	**<0.001**
CV (%)			**22**		**19**	**13**
Values followed by the same letter are not significantly different by Fishers LSD method at 95% confidence.						

Table c. Mean yield and Land Equivalence Ratio of various crops grown in monocrop or intercropped with pea at Roblin, MB in 2021.

Crop	Yield (kg/ha)			LER		
	Sole	Crop-IC	Pea-IC	Partial Crop-IC	Partial Pea-IC	TLER
Pea	274	-	-	-	-	1.00**b**
Flax	537	111	156**b**	0.21	0.60**a**	0.81**b**
Oat	1874	1754	162**b**	0.93	0.61**a**	1.55**ab**
Wheat	3068	2184	163**b**	0.72	0.71**a**	1.42**ab**
Canola	2000	1513	432**a**	0.76	1.80**a**	2.56**a**
Mustard	1364	1041	270**ab**	0.77	1.16**a**	1.93**ab**
P value			**0.003**		**0.038**	**0.004**
CV (%)			**36**		**55**	**35**
Values followed by the same letter are not significantly different by Fishers LSD method at 95% confidence.						

Plant counts were conducted at emergence and at flowering to assess plant stand changes during the growing season, though plant stand change between these two stages was minimal. Average plants per square meter for the pea monocrop was adjusted prior to analysis of variance to reflect the reduced pea seeding rate in intercrop treatments. Analysis of variance of average peas per square meter revealed no significant difference between the monocrop pea stand (adjusted) and the intercrop pea stand at Melita, indicating no significant effect of intercropping on pea stand compared to monocropping (Table d). While weed biomass differences were observed between treatments, weed count was generally similar, so only weed biomass results are summarized here. In the Melita trial, average weed biomass in intercrops was greatest in the pea-mustard intercrop, though this was not significantly different than the average weed biomass of pea-oat and pea-wheat intercrops. Low weed biomass was observed in pea-flax (7 g m^{-2}) and pea-canola (5 g m^{-2}) treatments, though this biomass was not significantly different than that overserved in pea-oat intercrops (41 g m^{-2}). Pea grain quality was assessed by measuring the amount of split peas in a harvest grain sample as well as the protein content of harvested peas. A significant ($P < 0.001$) treatment effect was observed in pea split incidence at the Melita site, with the highest pea split incidence observed in pea-flax intercrops (32.2%), and the lowest in pea-oat intercrops (5.2%). Pea protein was not significantly different across pea intercrop and monocrop treatments.

No significant difference was observed in pea stand across treatments at the Reston site, indicating that intercropping had little effect on pea stand compared to monocropping (Table e). Weed biomass in Reston was lowest in the pea monocrop (1041 g m^{-2}), though this biomass was not significantly different from that of pea-flax, pea-oat, pea-canola, or pea-mustard intercrops. This result indicates that, like in 2020, weed biomass was not effectively reduced by intercropping in 2021. Analysis of variance on pea split incidence and pea grain protein content was not done for the Reston site in 2021, as not enough sample from some pea-flax intercrop plots was collected to measure these variables.

Like other sites, no significant treatment effect on pea stand was observed at the Roblin site. Weed biomass data was unable to be collected across all replicates in 2021 at the Roblin site, so weed biomass data is not presented here. Pea split incidence and pea grain protein content was also not measured for the Roblin site.

Overall, no consistent reduction in weed biomass was observed in intercrops compared to the pea monocrop. Weed biomass of intercrops was significantly higher than that of the monocrop in some cases. A more consistent trend may emerge by analyzing data from all three trial years, and these results will be presented in a separate summary report.

Table d. Mean plant stand density at flowering, weed biomass per square meter, and grain quality of monocrops and pea intercrops grown at Melita, MB in 2021.

Crop	**Final Emergence ppms**			**Weeds (g m^{-2})^**		**Pea splits**	**Pea protein**
	Sole	**Crop-IC**	**Pea-IC**	**Sole**	**Pea-IC**	**(%/500 seeds)**	**(% DM basis)**
Pea	34	-	17 (adj.)	17**bc**	**-**	16.0**b**	25.6
Flax	239	109	30	9	7**c**	32.2**a**	24.7
Oat	131	72	35	147	268**ab**	5.2**c**	25.3
Wheat	100	45	33	11	41**abc**	17.5**b**	25.0
Canola	37	20	32	12	5**c**	20.3**b**	25.5
Mustard	32	26	36	417	512**a**	18.8**b**	25.4
P value			0.931		**<0.001**	**<0.001**	0.074
CV (%)			29		**11**	**15**	2

Values followed by the same letter are not significantly different by Fishers LSD method at 95% confidence.
^Johnson transformation prior to ANOVA

Table e. Mean plant stand density at flowering and weed biomass per square meter of monocrops and pea intercrops grown at Reston, MB in 2021.

Crop	Final Emergence ppms			Weeds (g m^{-2})^	
	Sole	Crop-IC	Pea-IC	Sole	Intercrop
Pea	62	-	31 (adj)	1041**b**	-
Flax	274	146	26	2388	1870**ab**
Oat	143	71	31	2088	2593**ab**
Wheat	160	60	31	2755	2596**a**
Canola	43	23	37	2660	1549**b**
Mustard	38	17	37	3674	2490**ab**
P value			0.300		**0.005**
CV (%)			22		**4**
Values followed by the same letter are not significantly different by Fishers LSD method at 95% confidence. ^Johnson transformation prior to ANOVA					

Table f. Mean plant stand density at flowering of monocrops and pea intercrops grown at Roblin, MB in 2021.

Crop	Final Emergence ppms		
	Sole	Crop-IC	Pea-IC
Pea	66	-	33 (adj.)
Flax	188	122	28
Oat	122	94	38
Wheat	129	98	34
Canola	104	39	25
Mustard	53	25	31
P value			0.214
CV (%)			24

Though net revenue was negative in almost all intercrops, significant net revenue differences were observed at all trial locations. In Melita, the pea-wheat intercrop resulted in the greatest mean net revenue loss (-$134), though this loss was not significantly (P<0.001) different from that of the pea-mustard intercrop (Table g). Mean net losses of the pea-flax, pea-oat, and pea-canola intercrops were not significantly different from that of the pea monocrop. While all intercrop combinations at this trial resulted in revenue loss, these results illustrate that of the intercrop combinations tested here, pea-flax, pea-oat, and pea-canola intercrops may be the most economically feasible.

Economic analysis of the Reston site revealed much different results, with the pea monocrop (-$260) and the pea-flax intercrop (-$292) resulting in the greatest loss in revenue (Table h). The pea-oat intercrop was the only intercrop treatment to result in positive net revenue ($49), though statistically this revenue was not different from that of the pea-wheat, pea-canola, and pea-mustard intercrops.

Net revenues of the Roblin intercrops followed a similar trend as the Reston intercrops, with the pea monocrop (-$275) and the pea-flax intercrop (-$286) resulting in the greatest revenue losses (Table i). The greatest intercrop revenue was observed in the pea-mustard intercrop ($45), though this revenue was not significantly (P < 0.001) different from that of the pea-canola intercrop ($2).

In general, pea intercrops resulted in less revenue loss than pea monocrops in 2021, though revenue generated from each intercrop treatment varied among sites. Analysis of economic results across all three years of the trial may reveal an intercrop treatment which consistently results in higher revenues than pea monocrops, and these results will be presented in a separate summary report.

Table g. Economic analysis of various crops in monocrop and in intercrop with pea grown at Melita, MB in 2021.

Crop	Economics per acre					
	Sole-COP	IC – COP	Mean Gross Revenue		Mean Net Revenue	
			Sole	IC	Sole	IC
Pea	$303	-	$230	-	-$74**a**	-
Flax	$289	$325	$267	$257	-$23	-$67**a**
Oat	$292	$318	$236	$233	-$56	-$86**ab**
Wheat	$308	$316	$169	$182	-$139	-$134**c**
Canola	$328	$339	$250	$279	-$77	-$61**a**
Mustard	$317	$336	$213	$231	-$104	-$105**bc**
P value						**<0.001**

Values followed by the same letter are not significantly different by Fishers LSD method at 95% confidence.

Table h. Economic analysis of various crops in monocrop and in intercrop with pea grown at Reston, MB in 2021.

Crop	Economics per acre					
	Sole-COP	IC – COP	Mean Gross Revenue		Mean Net Revenue	
			Sole	IC	Sole	IC
Pea	$303	-	$43	-	-$260**b**	
Flax	$289	$325	$39	$32	-$251	-$292**b**
Oat	$292	$318	$380	$367	$89	$49**a**
Wheat	$308	$316	$321	$243	$12	-$73**a**
Canola	$328	$339	$354	$281	$26	-$58**a**
Mustard	$317	$336	$470	$305	$153	-$31**a**
P value						**<0.001**

Values followed by the same letter are not significantly different by Fishers LSD method at 95% confidence.

Table i. Economic analysis of various crops in monocrop and in intercrop with pea grown at Roblin, MB in 2021.

Crop	Economics per acre					
	Sole-COP	IC – COP	Mean Gross Revenue		Mean Net Revenue	
			Sole	IC	Sole	IC
Pea	$303	-	$28	-	-$275**c**	
Flax	$289	$325	$109	$39	-$181	-$286**c**
Oat	$292	$318	$196	$200	-$96	-$118**b**
Wheat	$308	$316	$307	$236	-$1	-$80**b**
Canola	$328	$339	$392	$342	$64	$2**a**
Mustard	$317	$336	$462	$380	$145	$45**a**
P value						**<0.001**

References

Andersen, M.K., Hauggaard-Nielsen, H., Ambus, P., and Jensen, E.S. 2004. Biomass production, symbiotic nitrogen fixation and inorganic N use in dual and tri-component annual intercrops. *Plant and Soil* 266: 273–287.

Ghaley, B. B., Hauggaard-Nielsen, H., Høgh-Jensen, H., and Jensen E. S. 2005. Intercropping of Wheat and Pea as influenced by Nitrogen Fertilization. *Nutrient Cycling Agroecosystems* 73 (2005): 201-212. https://link.springer.com/article/10.1007/s10705-005-2475-9.

Kontturi, M., Laine, A., Niskanen, M., Hurme, T., Hyövelä, M., and Peltonen-Sainio, P. 2005. Pea-oat intercrops to sustain lodging resistance and yield formation in northern European conditions. *Soil and Plant Science* 61 (7): 612-621. https://doi.org/10.1080/09064710.2010.536780.

Pridham, J. C and Entz, M. H. 2007. Intercropping Spring Wheat with Cereal Grains, Legumes, Oilseeds Fails to Improve Productivity under Organic Management. *Agronomy Journal* 100 (5): 1436-1442. doi:10.2134/agronj2007.0227.

Organic Trials

Organic Oats Variety Evaluation

Project duration: May 2021 – October 2021
Objective: To evaluate oat varieties for organic production.
Collaborators: Kirby Nilsen, Agriculture and Agri-Food Canada, Brandon

Background
Research suggests that selection of cereal crops specific to organic agriculture should be conducted on organically managed land [1,2]. Conventional management systems may mask or confound certain plant characteristics, resulting in selection of sub-optimal cultivars for organic production systems. The trial was grown on certified organic land belonging to a local organic producer.

Results
The majority of the entries in this test are unregistered varieties. The yield and plant heights (Table 1) are provided for reference and to allow interested producers to track the entries in the future. The low yields and short plant heights are due to low precipitation and high competition resulting from regrowth of the alfalfa green manure crop. The variability between replications was high and results should be interpreted with caution.

Table 1: Varieties, mean yield (bu/ac), mean height (cm), LSD and %CV

Variety	Mean (bu/ac)	Height (cm)
CDC Endure	11.43	34.33
17P01-BA	11.08	40.00
CDC Arborg	8.78	43.00
17P12-BT	8.70	36.67
16P02-AJ	8.18	38.67
17P12-AZ	8.04	39.00
AC Morgan	7.74	42.00
Summit	7.72	38.33
AAC Oravena	7.21	43.00
CS Camden	6.55	38.00
17P03-BJ	6.04	40.67
17P04-BL	5.89	37.33
17P12-BQ	5.60	35.67
17P12-BS	5.34	30.67
CDC Skye	5.25	35.67
17P03-BA	5.20	30.67
17P05-AU	4.97	39.33
17P03-BS	4.68	35.33
17P03-BL	4.56	40.33
17P03-BV	4.20	31.33
AAC Kongsore	4.05	41.67
17P12-BZ	4.01	36.00
17P04-BJ	2.89	33.00
13P13-AQ	2.55	32.67
16P02-AM	2.30	33.33
LSD	**6.13**	**7.46**
% CV	**63.52**	**14.24**

Materials and methods

Experimental Design:	Random Complete Block Design
Entries:	25 varieties
Seeding:	May 12
Harvest:	Aug 26

Data collected	Date collected
Height:	Aug 20
Lodging:	Aug 26
Yield:	Aug 27
Moisture:	Aug 27

Agronomic info	
Previous year's crop:	Alfalfa
Soil Type:	Erickson Clay Loam
Landscape:	Rolling with trees to the south
Seedbed preparation:	Hoe tillage in fall and spring

Table 3: Spring 2021 Soil Test

	Available
N	103 lb/ac
P	16 ppm
K	305 ppm

References

[1] Reid, T., Yang, R.-C., Salmon, D. and Spaner, D. (2009). Should spring wheat breeding for organically managed systems be conducted on organically managed land? Euphytica 169:239-252.
[2] Dalhousie University, Organic Agriculture Centre of Canada. The crafting of organic oats. https://www.dal.ca/faculty/agriculture/oacc/en-home/about/about-oacc/documents/newpaper-articles/newsarticles-2012/newsarticles-2012-fetch.html

Western Organic Oats Participatory Plant Breeding

Project duration: May 2021 – August 2021
Objective: To evaluate oat varieties for organic production.
Collaborators: Katherine Stanley, University of Manitoba

Background
Research suggests that selection of cereal crops specific to organic agriculture should be conducted on organically managed land [1,2]. Conventional management systems may mask or confound certain plant characteristics, resulting in selection of sub-optimal cultivars for organic production systems. The trial was grown on certified organic land belonging to a local organic producer.

Results
The majority of the entries in this test are unregistered varieties. The yield and plant heights (Table 1) are provided for reference and to allow interested producers to track the entries in the future. The low yields and short plant heights are due to low precipitation and high competition resulting from regrowth of the alfalfa green manure crop. The variability between replications was high and results should be interpreted with caution.

Table 1: Varieties, mean yield (bu/ac), mean height (cm), LSD and %CV

Variety	Mean (bu/ac)	Height (cm)
Summit	19.03	43.00
11P17-16-JM	12.68	45.00
11P07-16-KS	12.57	46.00
11P17-16-FB	11.79	45.33
11P19-16-FB	11.72	47.33
CDC Dancer	10.91	37.33
11P22-16-FB	10.04	46.67
11P22-16-JM	9.93	41.33
11P01-15-AS	9.66	47.33
11P13-15-IG	9.39	45.67
09P02-15-TM	9.24	47.00
11P13-15-ML	7.98	44.67
AC Morgan	7.85	40.00
11P19-16-JM	7.62	39.67
11P05-15-ML	7.29	47.00
11P06-15-KS	7.23	47.33
11P20-15-TM	5.86	45.67
11P06-16-MW	5.77	49.33
11P02-15-IG	5.76	47.67
11P10-16-KS	5.32	43.00
11P21-16-AS	5.03	41.33
11P20-15-ML	4.89	44.67
11P15-16-MW	3.81	50.33
AAC Kongsore	3.60	44.00
LSD	**4.89**	**9.42**
% CV	**50.38**	**12.62**

Materials and methods

Experimental Design:	Random Complete Block Design
Entries:	24 varieties
Seeding:	May 12
Harvest:	Aug 26

Data collected	Date collected
Weekly Maturity:	early Aug
Height:	early Aug
Lodging:	Aug 26
Yield:	Aug 27
Moisture:	Aug 27

Agronomic info

Previous year's crop:	Organic wheat
Soil Type:	Erickson Clay Loam
Landscape:	Rolling with trees to the south
Seedbed preparation:	Cultivated and harrowed

Table 3: Spring 2021 Soil Test

	Available
N	103 lb/ac
P	16 ppm
K	305 ppm

(Organic trial: no fertilizer or herbicide applied)

Organic Wheat Participatory Plant Breeding

Project duration: May 2021 – August 2021
Objective: To evaluate oat varieties for organic production.
Collaborators: Martin Entz, Michelle Carkner, University of Manitoba

Background
The Participatory Plant Breeding project has been led by the Natural Systems Agriculture Laboratory, University of Manitoba. The project's objective is to develop cultivars that are relevant to farmers' needs by conducting selection in the farm environment. A second aim is to give farmers more control over seed resources by helping them to develop and maintain their own varieties. The project is coming to an end in March 2022. Several promising lines have been identified by farmers that will be brought to commercial production.

Results
The majority of the entries in this test are unregistered varieties. The yield and plant heights (Table 1) are provided for reference and to allow interested producers to track the entries in the future. The low yields and short plant heights are due to low precipitation and high competition resulting from regrowth of the alfalfa green manure crop. The variability between replications was high and results should be interpreted with caution.

Table 1: Varieties, mean yield (bu/ac), mean height (cm), LSD and %CV

Variety	Mean (bu/ac)	Height (cm)
BJ10A-SC	15.16	53.67
AAC Brandon	14.67	29.67
BJ11A-CG	14.21	48.00
BL34A-WM	14.07	48.00
Jake	13.76	55.00
BL41A-MS	13.58	53.00
BL39A-WM	13.50	48.67
BJ15-GW	13.49	51.00
BL28-JM	13.48	47.33
BJ08A-IG	13.41	47.00
BL28-WM	13.27	50.00
BL23-AS	13.17	48.00
BJ11A-SC	13.02	49.00
CDC Kernen	13.00	50.00
BL34-SW	13.00	47.33
BL41A-AS	12.59	46.00
BJ08A-CG	12.11	54.33
BL22A-SW	11.89	50.33
BL43C-TM	11.73	45.67
BJ10A-KB	11.60	48.33
BL23-JM	11.09	47.67
BL28-TM	10.80	50.33
Vesper	10.56	51.67
AAC Tradition	10.46	52.00
BJ15A-GM	10.25	47.33

BJ11A-KB	9.96	43.33
BL34A-JM	9.12	44.67
PWA10B-LD	8.95	47.00
BJ13-GW	8.22	46.00
BJ13-HRE	6.61	44.33
Zealand	6.49	45.00
LSD	**12.02**	**14.80**
% CV	**58.34**	**18.50**

Materials and methods

Experimental Design: Random Complete Block Design
Entries: 31 varieties
Seeding: May 12
Harvest: Aug 26

Data collected Date collected
Weekly Maturity: Every Monday, Wednesday, and Friday from the beginning of August
Height: Aug 14
Lodging: Aug 26
Yield: Aug 27
Moisture: Aug 27
Agronomic info
Previous year's crop: Alfalfa
Soil Type: Erickson Clay Loam
Landscape: Rolling with trees to the south
Seedbed preparation: Hoe tillage in fall and spring

Table 3: Spring 2021 Soil Test

	Available
N	103 lb/ac
P	16 ppm
K	305 ppm

(Organic trial: no fertilizer or herbicide applied)

Oats Trials

University of Saskatchewan Standard Oat Yield Trial

Project duration: May 2021 – September 2021
Objective: To evaluate oat entries for the Crop Development Centre, University of Saskatchewan
Collaborators: Aaron Beattie

Background
Adapted from the Crop Development Centre (CDC) website: The CDC was established in 1971 to improve economic returns for farmers and the agriculture industry in western Canada by improving existing crops, creating new uses for traditional crops, and developing new crops.

Results
The average yield for oat entries is shown in Figure 1. The percent CV for the trial is 33.0. Numbered, non-registered varieties are provided for tracking purposes only. The results are for one site-year only, and should be interpreted with caution. Consult a seed guide for multi-site-year data for available varieties.

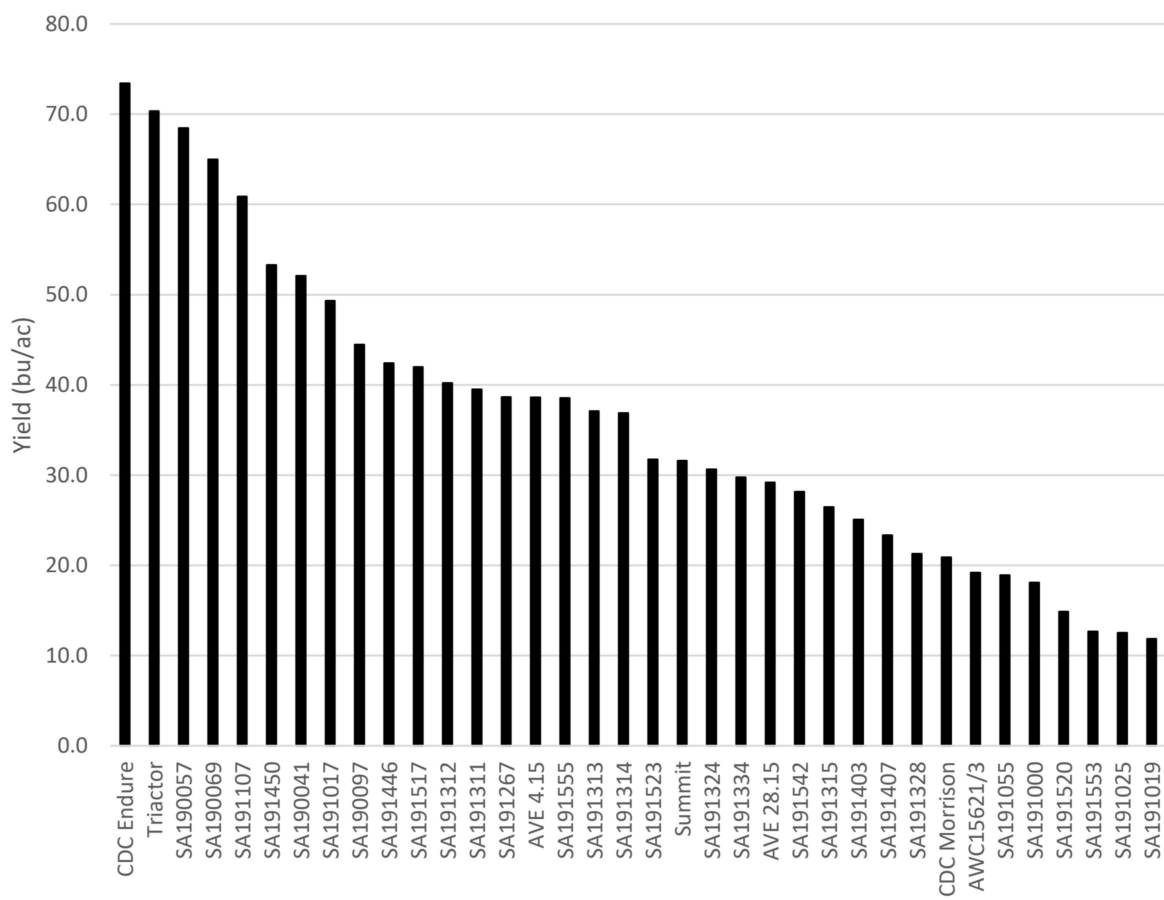

Figure 1: Average yield (bu/ac) for oat entries.

Materials and methods

Experimental Design:	Random Complete Block Design
Entries:	36 varieties
Seeding:	May 4
Harvest:	Sep 15

Data collected	Date collected
Rust:	Throughout season
Height:	Aug 14
Lodging:	Sep 15
Yield:	Sep 15
Moisture:	Sep 15

Agronomic info	
Previous year's crop:	Oat silage
Soil Type:	Erickson Clay Loam
Landscape:	Rolling with trees to the south
Seedbed preparation:	Vertical tilled

Table 2: Spring 2021 Soil Test

	Available		Added	Type
N	162	lb/ac	10 lb/ac	46-0-0
P	41	ppm	15 lb/ac	11-52-0-0
K	703	ppm		

Table 3: Spraying Information

Crop stage	Date	Product	Rate	
Pre-emerge	Sep 12	Heat LQ	35	ml/ac
		Amigo	750	ml/ac
In-crop	Jun 14	Curtail M	810	ml/ac
		Dicamba	117	ml/ac
Desiccant	Sep 9	Roundup	640	ml/ac

University of Saskatchewan Oat Yield Variety Trial

Project duration: May 2021 – September 2021
Objective: To evaluate oat entries for the Crop Development Centre, University of Saskatchewan
Collaborators: Aaron Beattie

Background
Adapted from the Crop Development Centre (CDC) website: The CDC was established in 1971 to improve economic returns for farmers and the agriculture industry in western Canada by improving existing crops, creating new uses for traditional crops, and developing new crops.

Results
The average yield for oat entries is shown in Figure 1. The percent CV for the trial is 20.6. Numbered, non-registered varieties are provided for tracking purposes only. The results are for one site-year only, and should be interpreted with caution. Consult a seed guide for multi-site-year data for available varieties.

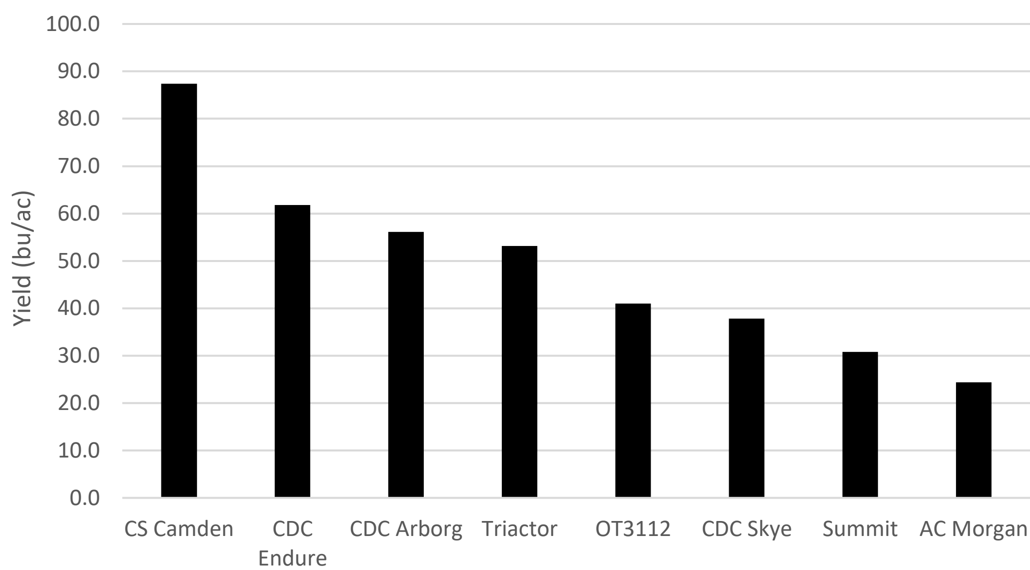

Figure 1: Average yield (bu/ac) for oat entries.

Materials and methods

Experimental Design:	Random Complete Block Design
Entries:	8 varieties
Seeding:	May 4
Harvest:	Sep 15

Data collected	Date collected
Height:	Aug 14
Lodging:	Sep 15
Yield:	Sep 15
Moisture:	Sep 15

Agronomic info

Previous year's crop:	Oat Silage
Soil Type:	Erickson Clay Loam
Landscape:	Rolling with trees to the south
Seedbed preparation:	Vertical tilled

Table 2: Spring 2021 Soil Test

	Available		Added	Type
N	162	lb/ac	10 lb/ac	46-0-0
P	41	ppm	15 lb/ac	11-52-0-0
K	703 ppm			

Table 3: Spraying Information

Crop stage	Date	Product	Rate	
Pre-emerge	Sep 12	Heat LQ	35	ml/ac
		Amigo	750	ml/ac
In-crop	Jun 14	Curtail M	810	ml/ac
		Dicamba	117	ml/ac
Desiccant	Sep 9	Roundup	640	ml/ac

SVPG Oat Variety Evaluation

Project duration: May 2021 – September 2021
Objectives: To evaluate oat varieties for the Saskatchewan Variety Performance Group
Collaborators: SVPG, Saskatchewan Agriculture

Background

(From the Saskatchewan Wheat Development Commission website): The Saskatchewan Variety Performance Group (SVPG) is an informal group made up of stakeholders who are interested in variety performance testing in Saskatchewan. SVPG has coordinated the post-registration regional performance testing of spring wheat, durum, barley, oats, and flax varieties since 2006. The data collected from these trials is entered into annual publications "Varieties of Grain Crops" and the Saskatchewan Seed Guide.

Results

The yield results (bu/ac) for the Roblin site are shown in Figure 1. The results are for one site-year only, and should be interpreted with caution. Consult a seed guide for multi-site-year data for available varieties.

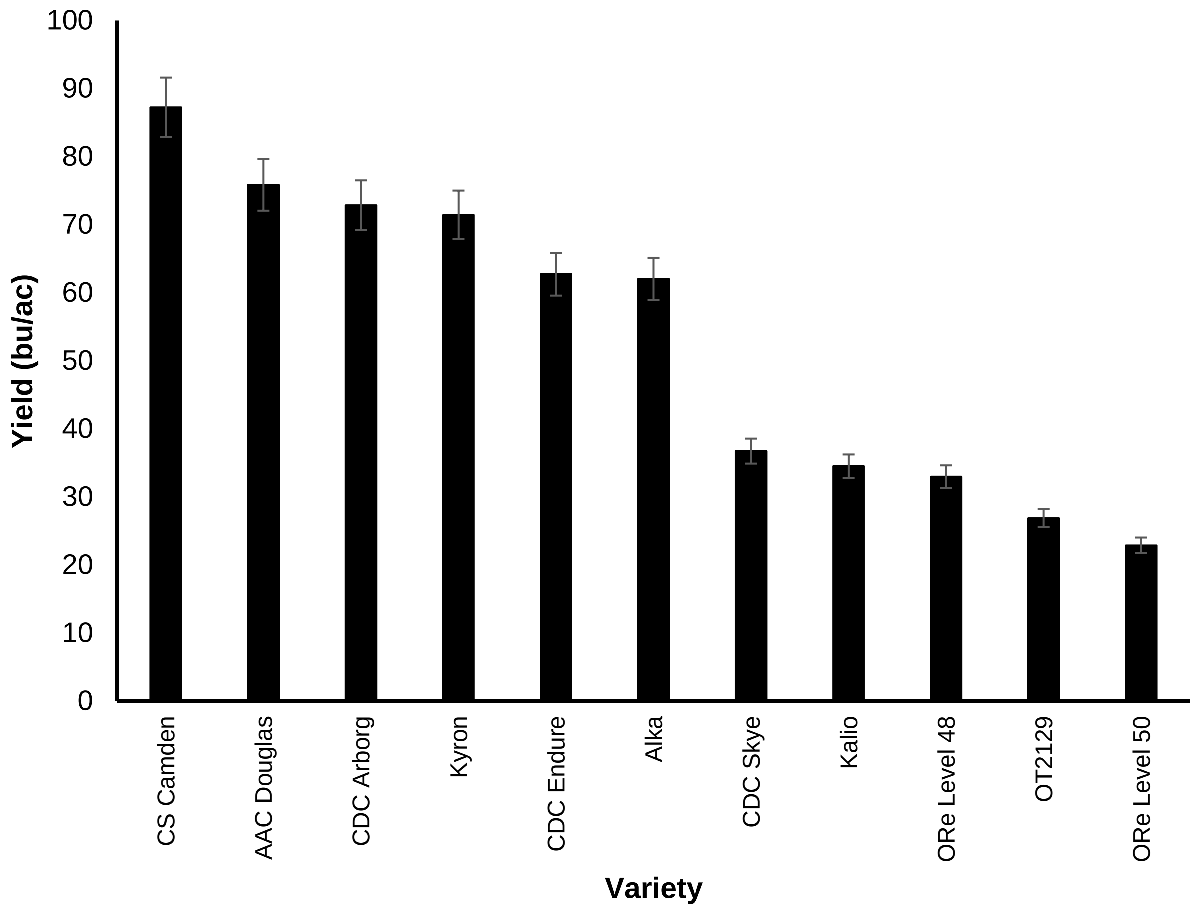

Figure 1: Average yield for oat entries

Table 1: Comparison of yield means and statistical difference for oat entries (varieties connected by the same letter are statistically significant)

Variety	Statistical significance for yield			Yield (bu/ac)
CS Camden	A			87.25
AAC Douglas	A			75.84
CDC Arborg	A			72.86
Kyron	A			71.44
CDC Endure	A	B		62.71
Alka	A	B		62.04
CDC Skye		B	C	36.72
Kalio		B	C	34.50
ORe Level 48		B	C	32.98
OT2129			C	26.87
ORe Level 50			C	22.88
LSD	**31.40**			
% CV	**50.51**			

Materials & Methods

Experimental Design:	Random Complete Block Design
Entries:	11 entries, 3 replications
Seeding:	May 4
Harvest:	Sep 15

Agronomic information

Previous year's crop:	Oat Silage
Soil Type:	Erickson Loam Clay
Landscape:	Rolling with trees to the east
Seedbed preparation:	Vertical tilled

Data collected	**Date collected**
Yield:	Sep 15
Moisture:	Sep 15

Table 2: 2021 Fertility Information

	Available		Added	Type
N	162	lb/ac	10 lb/ac	46-0-0
P	41	ppm	10 lb/ac	11-56-0-0
K	703	ppm	-	-

Table 3: Pesticide Application

Crop stage	Date	Product	Rate
Pre-emerge	May 10	Heat LQ	35 ml/ac
		Amigo	750 ml/ac
In-crop	Jun 14	Curtail M	810 ml/ac
		Dicamba	117 ml/ac
Desiccant	Sep 7	Roundup	640 ml/ac

Pulse Trials

Saskatchewan Pulse Growers Pea Variety Trial

Project duration: May 2021 – October 2021
Objectives: To evaluate pea entries for the Saskatchewan Pulse Growers (SPG)
Collaborators: Laurie Friesen, SPG

Background
(Adapted from the SPG website): The SPG works to boost yield of established pulse crops, develop new crops, connect with growers, expand the utilization of pulse crops, and decrease barriers to market access. The projects further on-farm yield gains through the identification and enhancement of genetic yield potential.

Results
The average yield for pea entries is shown in Figure 1. The average height for entries is shown in Figure 2. Numbered, non-registered varieties are provided for tracking purposes only. The results are for one site-year only, and should be interpreted with caution. Consult a seed guide for multi-site-year data for available varieties.

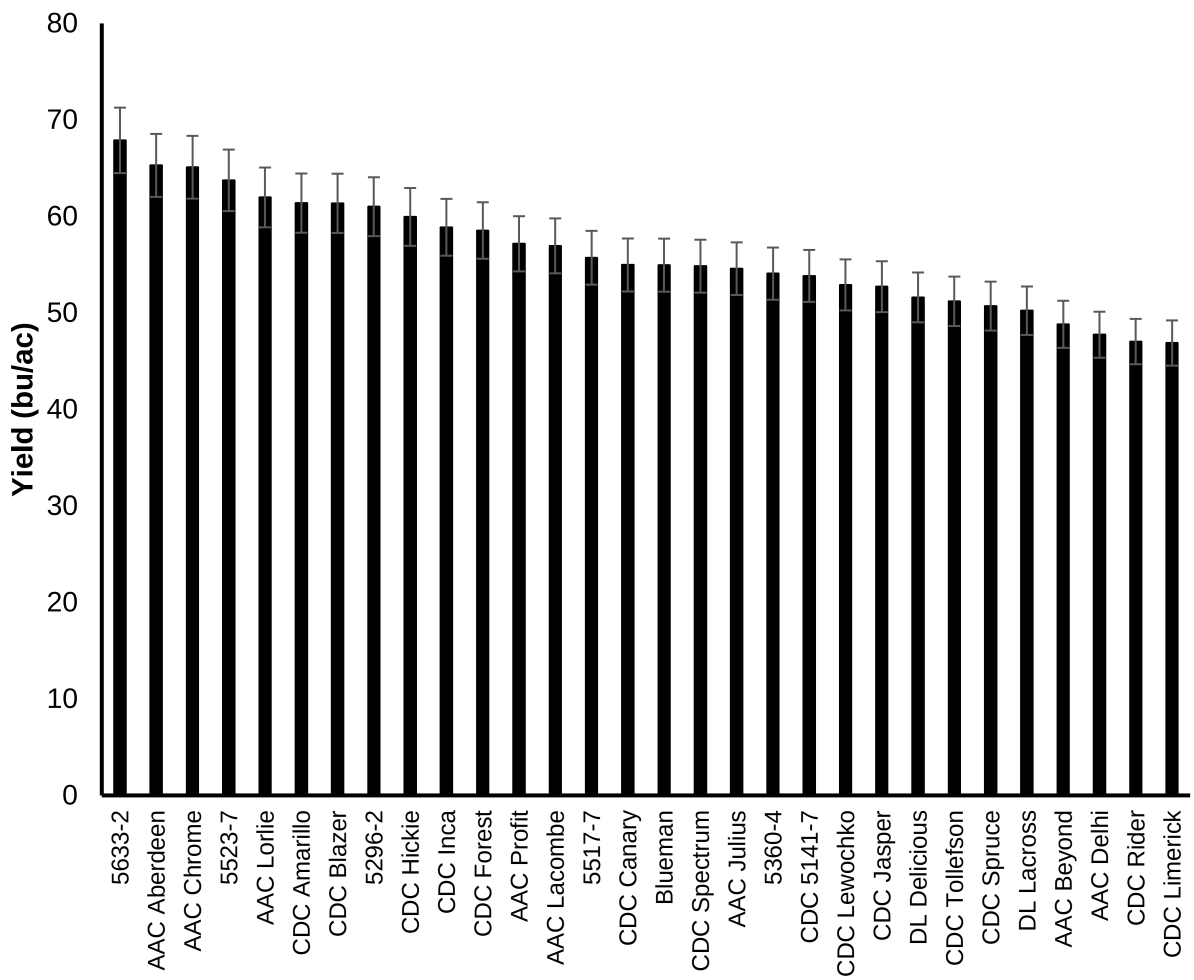

Figure 1: Average yield for pea entries

Table 1: Comparison of yield means and statistical difference for pea entries (varieties connected by the same letter are statistically significant)

Variety	**Statistical significance for yield**				**Yield (bu/ac)**
1363484	A				67.88
AAC Aberdeen	A	B			65.29
AAC Chrome	A	B			65.10
1323456	A	B			63.74
AAC Lorlie	A	B	C		61.97
CDC Amarillo	A	B	C	D	61.38
CDC Blazer	A	B	C	D	61.36
1240397	A	B	C	D	61.01
DL Lacross	A	B	C	D	60.55
CDC Hickie	A	B	C	D	59.95
CDC Inca	A	B	C	D	58.87
CDC Forest	A	B	C	D	58.54
AAC Profit	A	B	C	D	57.16
AAC Lacombe	A	B	C	D	56.95
1321265	A	B	C	D	55.72
CDC Canary	A	B	C	D	54.97
Blueman	A	B	C	D	54.95
AAC Julius	A	B	C	D	54.58
CDC Spectrum	A	B	C	D	54.37
CDC Rider	A	B	C	D	54.18
1263832	A	B	C	D	54.07
CDC 5141-7	A	B	C	D	53.84
CDC Tollefson	A	B	C	D	53.14
CDC Lewochko		B	C	D	52.90
CDC Jasper		B	C	D	52.72
CDC Spruce		B	C	D	51.77
DL Delicious		B	C	D	50.97
AAC Beyond			C	D	48.82
AAC Delhi			C	D	47.74
CDC Limerick				D	46.88
LSD	**14.80**				
% CV	**16.07**				

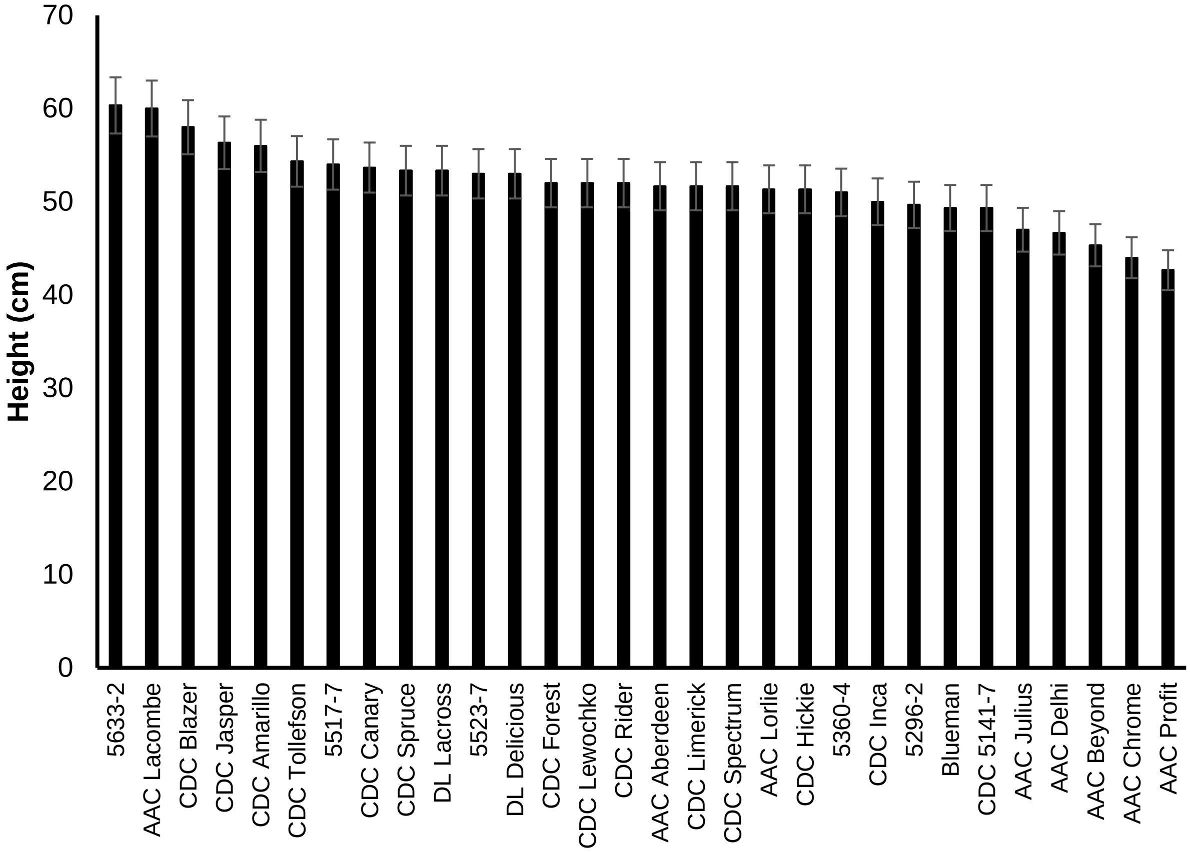

Figure 2: Plant heights for pea entries

Materials and methods

Experimental Design:	Random Complete Block
Entries:	30 entries; 3 replications
Seeding:	May 4
Harvest:	Aug 17

Table 1 (Long Season): Varieties included in trial

CDC Amarillo	AAC Chrome	CDC Inca	5360-4	CDC Limerick
5296-2	AAC Julius	CDC Lewochko	5523-7	AAC Lorlie
5517-7	AAC Profit	CDC Spectrum	CDC Forest	CDC Blazer
5633-2	CDC 5141-7	CDC Tollefson	CDC Rider	CDC Jasper
AAC Aberdeen	CDC Canary	AAC Delhi	CDC Spruce	DL Delicious
AAC Beyond	CDC Hickie	AAC Lacombe	Blueman	DL Lacross

Data collected	Date collected
% Plant Stand:	Jun 2
Yield:	Aug 17
Moisture:	Aug 17

Agronomic info

Previous year's crop:	Oat Silage
Soil Type:	Erickson Clay Loam
Landscape:	Rolling with trees to the east
Seedbed preparation:	Vertical tilled

Table 2: Spring 2021 Soil Test

	Available		Added	Type
N	151	lb/ac	-	-
P	47	ppm	10 lb/ac	11-52-0-0
K	743	ppm	-	-

Inoculant added with seed; P banded with seed

Table 3: Pesticide Application

Crop stage	Date	Product	Rate
Pre-emerge	May 10	Authority	118 ml/ac
In-crop	Jun 14	UAN 28%	810 ml/ac
		Viper	400 ml/ac

Agriculture and Agri-Food Canada Conventional Soy Protein Variety Evaluation

Project duration: May 2021 – October 2021
Objectives: Examine 20 varieties of conventional soybean to determine protein differences between eastern and western Canada sites
Collaborators: Elroy Cober – Research Scientist, soybean breeding and genetics, AAFC
Simon Lackey – Soybean breeding AAFC

Background
This project is part of a long-term 5-year multi-site study across Canada, led by Elroy Cober.

Results
The soybean entries from Roblin were submitted to Elroy Cober's team for protein analysis. The protein results are shown in Figure 1. Average soybean yield by variety is shown in Table 1.

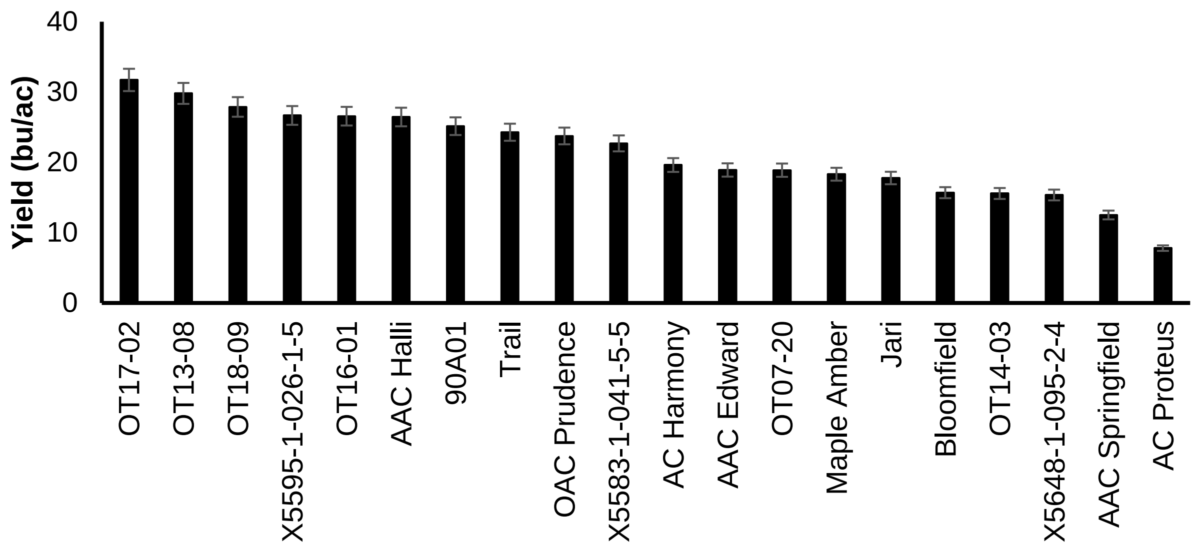

Figure 1: Average yield for soybean by variety

Table 1: Comparison of yield means and statistical difference for soybean entries (varieties connected by the same letter are statistically significant)

Variety	Statistical significance for yield						Yield (bu/ac)
OT17-02	A						31.72
OT13-08	A	B					29.81
OT18-09	A	B	C				27.88
X5595-1-026-1-5	A	B	C	D			26.67
OT16-01	A	B	C	D			26.56
AAC Halli	A	B	C	D			26.45
90A01	A	B	C	D			25.14
Trail	A	B	C	D			24.28
OAC Prudence	A	B	C	D	E		23.75
X5583-1-041-5-5	A	B	C	D	E		22.69
AC Harmony		B	C	D	E		19.62

AAC Edward		B	C	D	E	F	18.91
OT07-20		B	C	D	E	F	18.88
Maple Amber		B	C	D	E	F	18.31
Jari			C	D	E	F	17.77
Bloomfield				D	E	F	15.69
OT14-03				D	E	F	15.57
X5648-1-095-2-4				D	E	F	15.36
AAC Springfield					E	F	12.51
AC Proteus						F	7.80
LSD	**11.57**						
% CV	**44.10**						

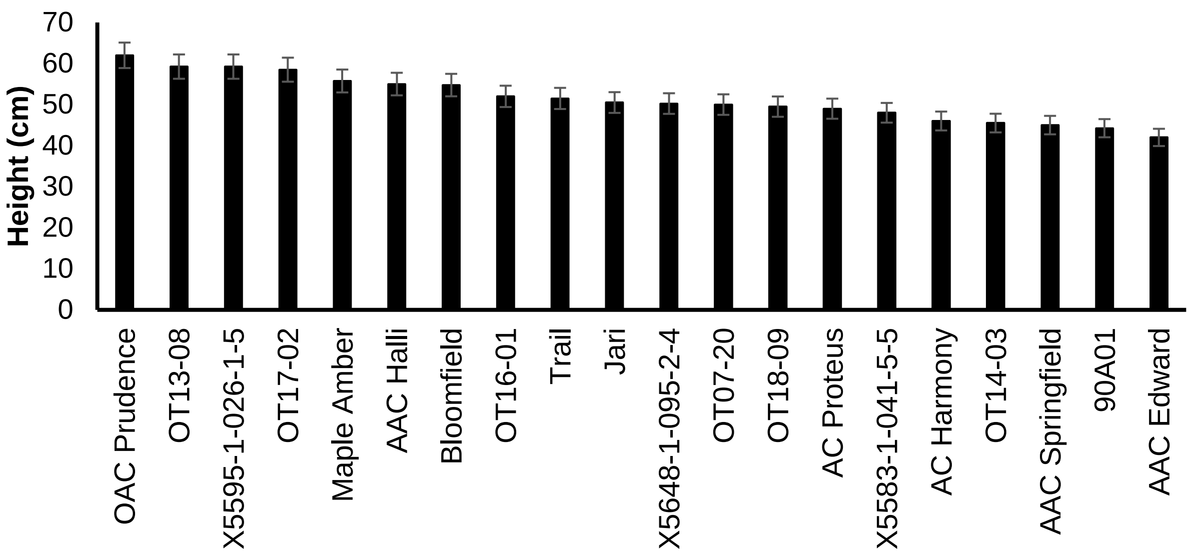

Figure 2: Plant heights for soybean entries

Table 2: Comparison of height means and statistical difference for soybean entries (varieties connected by the same letter are statistically significant)

Variety	**Statistical significance for yield**							**Height (cm)**
OAC Prudence	A							62.00
OT13-08	A	B						59.25
X5595-1-026-1-5	A	B						59.25
OT17-02	A	B	C					58.50
Maple Amber	A	B	C	D				55.75
AAC Halli	A	B	C	D	E			55.00
Bloomfield	A	B	C	D	E			54.75
OT16-01		B	C	D	E	F		52.00
Trail		B	C	D	E	F		51.50
Jari		B	C	D	E	F	G	50.50
X5648-1-095-2-4		B	C	D	E	F	G	50.25
OT07-20			C	D	E	F	G	50.00
OT18-09			C	D	E	F	G	49.50
AC Proteus				D	E	F	G	49.00

X5583-1-041-5-5				D	E	F	G	48.00
AC Harmony					E	F	G	46.00
OT14-03						F	G	45.50
AAC Springfield						F	G	45.00
90A01						F	G	44.25
AAC Edward							G	42.00
LSD	**9.23**							
% CV	**15.41**							

Materials and methods

Experimental Design:	Rectangular lattice
Entries:	20 entries; 4 replications
Seeding:	May 19
Harvest:	Oct 15

Data collected	Date collected
Population Score:	Jun 16
Flowering:	Jul 17-20
Heights:	Aug 14
Lodging:	Oct 25
Yield:	Oct 26
Moisture:	Oct 26
Seed Weight g/100:	Oct 27

Agronomic info

Previous year's crop:	Oat Silage
Soil Type:	Erickson Clay Loam
Landscape:	Rolling with trees to the east
Seedbed preparation:	Vertical Tilled

Table 2: Spring 2021 Soil Test

	Available	Added	Type
N	120 lb/ac	-	-
P	48 ppm	10 lb/ac	
K	674 ppm	-	-

Inoculant added with seed; P banded with seed

Table 3: Pesticide Application

Crop stage	Date	Product	Rate
Pre-emerge	May 26	Authority	188 ml/ac
In crop	Jun 14	Viper ADV	400 ml/ac
		UAN 28%	810 ml/ac
In-crop	Jul 15	Bentazon	910 ml/ac
		Centurion	150 ml/ac
		Amigo	1.0 L/ac

Saskatchewan Pulse Growers Long Season and Short Season Soy Variety Trial

Project duration: May 2021 – October 2021
Objectives: To evaluate long and short season soybean entries for the Saskatchewan Pulse Growers (SPG)
Collaborators: Laurie Friesen, SPG

Background
(Adapted from the SPG website): Soybeans are photosensitive and latitude greatly affects day length. For this reason, varieties are bred for specific north-south ranges of adaptation, typically in a range of 150 to 250 kilometres. Growing a variety north of its maturity band may delay maturity and it will be at a great risk of not reaching full maturity prior to frost. The test examines long and short season (i.e., most northern-adapted) glyphosate-tolerant soybean lines.

Results
The average yield for long-season soybean entries is shown in Figure 1 and the average yield for short-season soybean entries is shown in Figure 2. The average height for long-season soybean entries is shown in Figure 3 and the average height for short-season soybean entries is shown in Figure 4. Numbered, non-registered varieties are provided for tracking purposes only. The results are for one site-year only, and should be interpreted with caution. Consult a seed guide for multi-site-year data for available varieties.

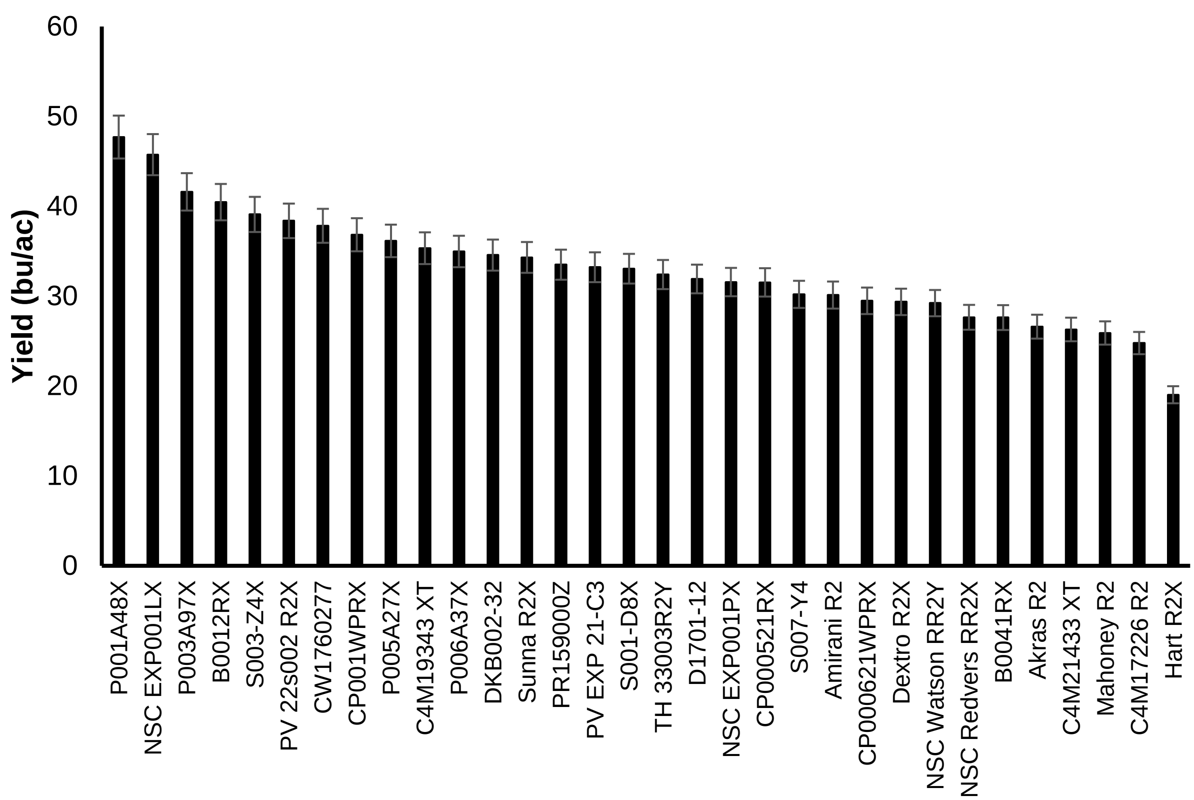

Figure 1: Average yield for long season soybean

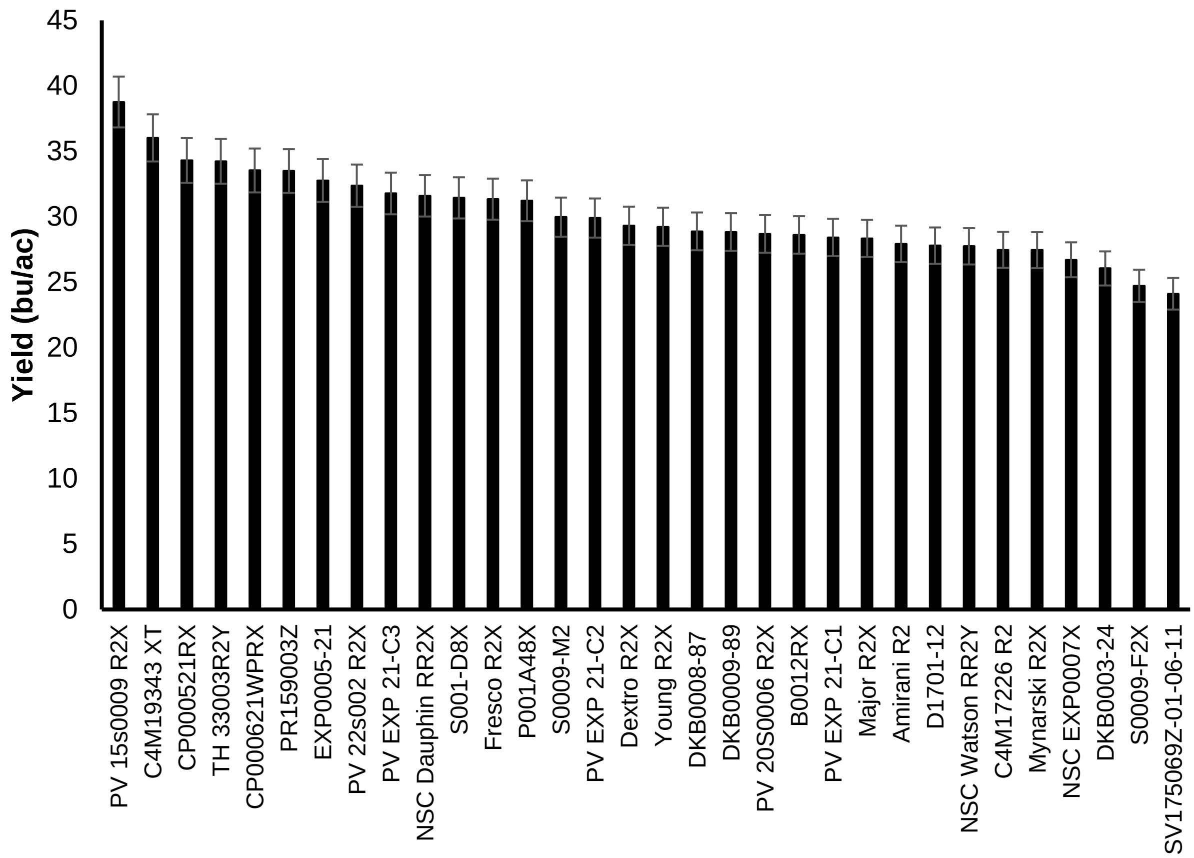

Figure 2: Average yield for short season soybean entries

Table 1: Comparison of yield means and statistical difference for long season soybean entries (varieties connected by the same letter are statistically significant)

Variety	Statistical significance for yield							Yield (bu/ac)
P001A48X	A							47.70
NSC EXP001LX	A	B						45.74
TH 33003R2Y	A	B	C					42.19
P003A97X	A	B	C	D				41.60
S001-D8X	A	B	C	D	E			40.60
B0012RX	A	B	C	D	E			40.46
CW1760277	A	B	C	D	E	F		37.82
CP001WPRX	A	B	C	D	E	F		36.83
P005A27X	A	B	C	D	E	F		36.15
S007-Y4	A	B	C	D	E	F		36.01
C4M19343 XT	A	B	C	D	E	F		35.34
P006A37X	A	B	C	D	E	F		34.97
PV EXP 21-C3	A	B	C	D	E	F	G	34.62
DKB002-32	A	B	C	D	E	F	G	34.57
PV 22s002 R2X	A	B	C	D	E	F	G	32.76
D1701-12		B	C	D	E	F	G	31.91
S003-Z4X		B	C	D	E	F	G	31.77
NSC EXP001PX		B	C	D	E	F	G	31.56

PR159000Z		B	C	D	E	F	G	31.54
CP000521RX		B	C	D	E	F	G	31.53
Sunna R2X		B	C	D	E	F	G	31.13
Amirani R2			C	D	E	F	G	30.12
CP000621WPRX			C	D	E	F	G	29.48
Dextro R2X			C	D	E	F	G	29.36
NSC Watson RR2Y			C	D	E	F	G	29.22
NSC Redvers RR2X			C	D	E	F	G	27.65
B0041RX			C	D	E	F	G	27.62
Akras R2			C	D	E	F	G	26.61
C4M21433 XT				D	E	F	G	26.29
Mahoney R2					E	F	G	25.90
C4M17226 R2						F	G	24.78
Hart R2X							G	19.03
LSD	15.62							
% CV	30.24							

Table 2: Comparison of yield means and statistical difference for short season soybean entries (varieties connected by the same letter are statistically significant)

Variety	**Statistical significance for yield**								**Yield (bu/ac)**
PV 15s0009 R2X	A								38.76
C4M19343 XT	A	B							36.03
PV EXP 21-C3	A	B	C						35.48
S001-D8X	A	B	C	D					35.26
Young R2X	A	B	C	D	E				34.95
CP000521RX	A	B	C	D	E	F			34.30
CP000621WPRX	A	B	C	D	E	F	G		33.53
PR159003Z	A	B	C	D	E	F	G		33.49
EXP0005-21	A	B	C	D	E	F	G	H	32.76
TH 33003R2Y	A	B	C	D	E	F	G	H	32.62
PV 22s002 R2X	A	B	C	D	E	F	G	H	32.37
NSC Dauphin RR2X	A	B	C	D	E	F	G	H	31.59
Fresco R2X	A	B	C	D	E	F	G	H	31.34
P001A48X	A	B	C	D	E	F	G	H	31.22
S0009-M2	A	B	C	D	E	F	G	H	31.20
Dextro R2X		B	C	D	E	F	G	H	29.30
DKB0008-87		B	C	D	E	F	G	H	28.88
DKB0009-89		B	C	D	E	F	G	H	28.83
PV 20S0006 R2X		B	C	D	E	F	G	H	28.69
B0012RX		B	C	D	E	F	G	H	28.61
PV EXP 21-C1		B	C	D	E	F	G	H	28.41
Major R2X		B	C	D	E	F	G	H	28.34
Amirani R2			C	D	E	F	G	H	27.93
S0009-F2X			C	D	E	F	G	H	27.82
D1701-12			C	D	E	F	G	H	27.79
NSC Watson RR2Y			C	D	E	F	G	H	27.74

SV175069Z-01-06-11				D	E	F	G	H	27.73
C4M17226 R2					E	F	G	H	27.47
Mynarski R2X					E	F	G	H	27.45
NSC EXP0007X						F	G	H	26.71
DKB0003-24							G	H	26.05
PV EXP 21-C2								H	25.67
LSD	7.75								
% CV	16.75								

Materials and methods

Experimental Design: Random Complete Block
Entries: 32 long season entries and 32 short season entries; 3 replications
Seeding: May 4
Harvest: Sept 22

Data collected — Date collected
% Plant Stand: Jun 16
Maturity: Sep 22
Yield: Oct 26
Moisture: Oct 26

Agronomic info
Previous year's crop: Oat Silage
Soil Type: Erickson Clay Loam
Landscape: Rolling with trees to the east
Seedbed preparation: Vertical tilled

Table 3: Spring 2021 Soil Test

	Available		Added	Type
N	120	lb/ac	-	-
P	48	ppm	10 lb/ac	11-52-0-0
K	674	ppm	-	-

Inoculant added with seed; P banded with seed

Table 4: Pesticide Application

Crop stage	Date	Product	Rate
Pre-emerge	May 26	RoundUp	640 ml/ac
		Heat	28.0 g/ac
In-crop	Jul 22	UAN 28%	800 ml/ac
		Viper	400 ml/ac
Desiccant	Sep 22	Reglone	670 ml/ac
		LI700	250 ml/ac

University of Saskatchewan Fababean A&B Variety Evaluations

Project duration: May 2021 – October 2021
Objectives: To evaluate coloured and white fababean entries for the Crop Development Centre, University of Saskatchewan
Collaborators: Jaret Horner, University of Saskatchewan

Background
Adapted from the Crop Development Centre (CDC) website: The CDC was established in 1971 to improve economic returns for farmers and the agriculture industry in western Canada by improving existing crops, creating new uses for traditional crops, and developing new crops.

Results
The average yield for white fababean entries is shown in Figure 1. The average yield for coloured fababean entries is shown in Figure 2. Numbered, non-registered varieties are provided for tracking purposes only. The results are for one site-year only, and should be interpreted with caution. Consult a seed guide for multi-site-year data for available varieties.

Materials and methods
Experimental Design: Random Complete Block
Entries: 10 Trial A entries, 5 Trial B entries; 3 replications
Seeding: May 4
Harvest: Sep 22

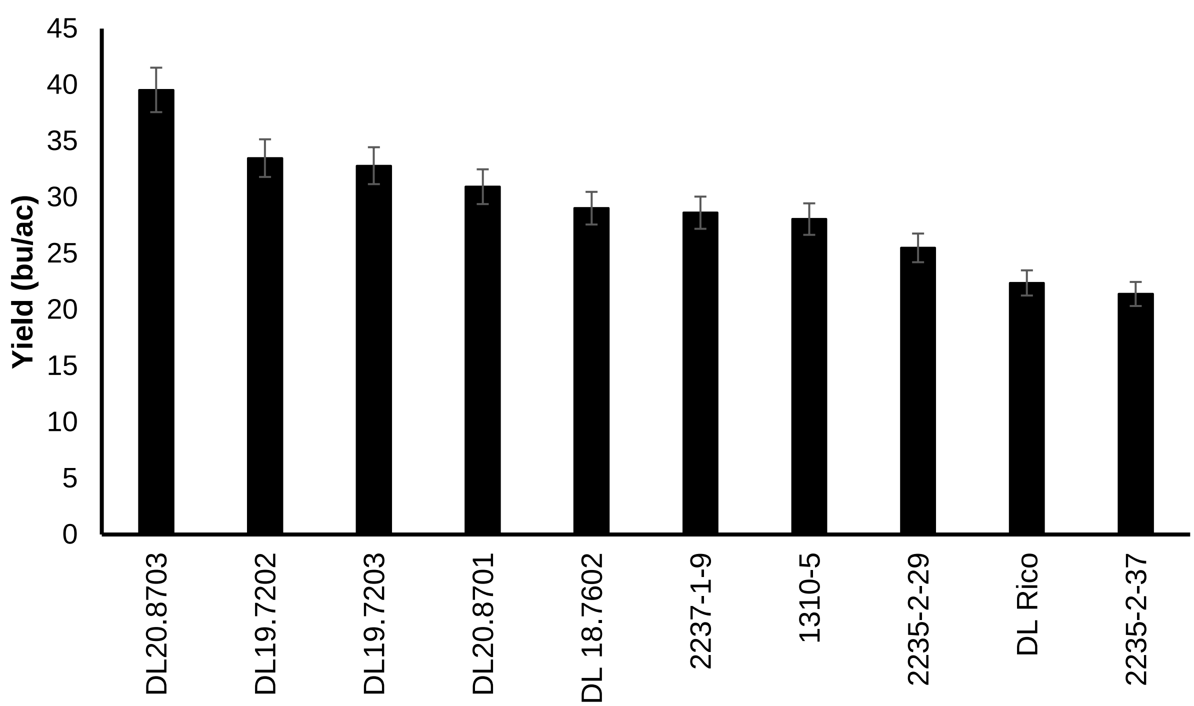

Figure 1: Average yield for white fababean entries

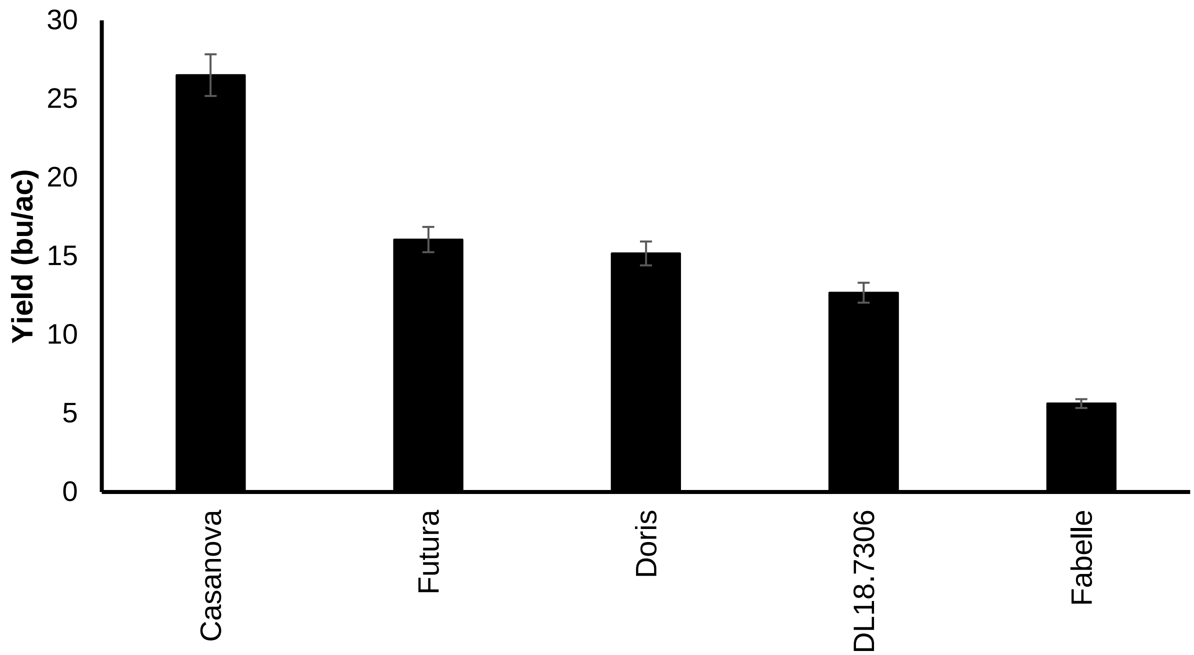

Figure 2: Average yield for coloured fababean entries

Table 1: Comparison of yield means and statistical difference for white fababean entries (varieties connected by the same letter are statistically significant)

Variety	Statistical significance for yield	Yield (bu/ac)
DL20.8703	A	39.55
DL19.7202	A	33.48
DL19.7203	A	32.81
DL20.8701	A	30.94
DL 18.7602	A	29.03
2237-1-9	A	28.62
1310-5	A	28.06
2235-2-29	A	25.50
DL Rico	A	22.38
2235-2-37	A	21.40
LSD	**19.94**	
% CV	**37.84**	

Table 2: Comparison of yield means and statistical difference for coloured fababean entries (varieties connected by the same letter are statistically significant)

Variety	Statistical significance for yield	Yield (bu/ac)
DL18.7306	A	21.06
Casanova	A	18.13
Futura	A	16.06
Doris	A	15.17
Fabelle	A	5.62
LSD	**17.24**	
% CV	**63.46**	

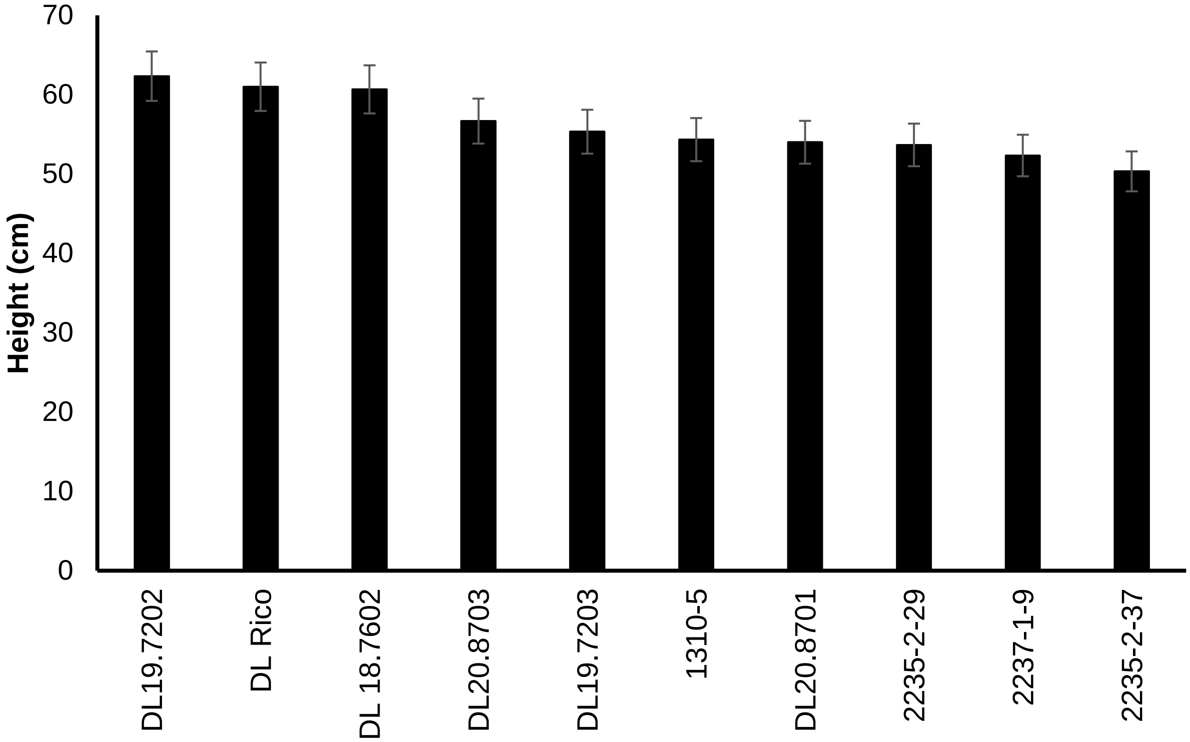

Figure 3: Plant heights for white fababean varieties

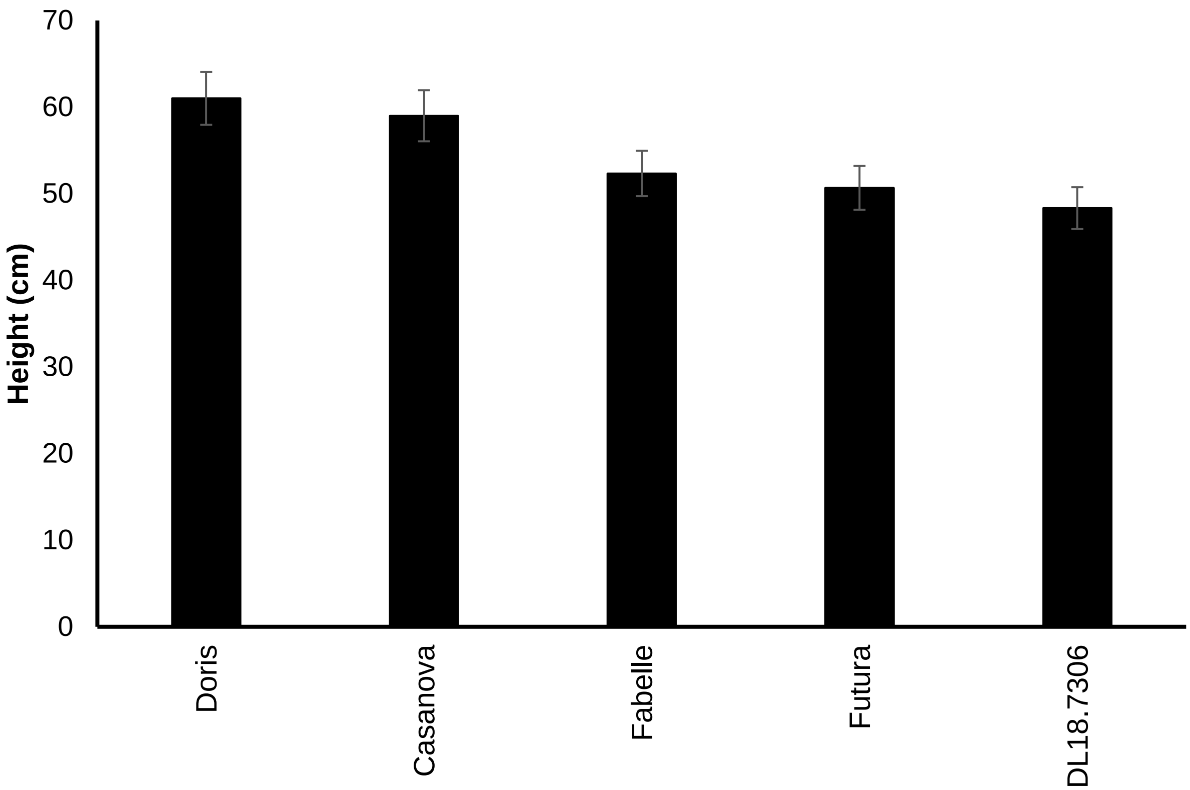

Figure 4: Plant heights for coloured fababean entries

Table 3: Comparison of height means and statistical difference for white fababean entries (varieties connected by the same letter are statistically significant)

Variety	Statistical Significance for Height		Height (cm)
DL19.7202	A		62.33
DL Rico	A	B	61.00
DL 18.7602	A	B	60.67
DL20.8703	A	B	56.67
DL19.7203	A	B	55.33
1310-5	A	B	54.33
DL20.8701	A	B	54.00
2235-2-29	A	B	53.67
123097	A	B	52.33
2235-2-37		B	50.33
LSD	**11.53**		
% CV	**12.19**		

Table 4: Comparison of height means and statistical difference for coloured fababean entries (varieties connected by the same letter are statistically significant)

Variety	Statistical significance for yield	Height (cm)
DL18.7306	A	61.00
Casanova	A	55.67
Futura	A	52.33
Doris	A	51.67
Fabelle	A	50.67
LSD	**13.53**	
% CV	**14.30**	

Data collected	Date collected
% Plant Stand:	May 19
Maturity:	Sep 9
Yield:	Sep 24
Moisture:	Sep 24

Agronomic info	
Previous year's crop:	Oat Silage
Soil Type:	Erickson Clay Loam
Landscape:	Rolling with trees to the east
Seedbed preparation:	Vertical tilled

Table 3: Spring 2021 Soil Test

	Available		Added	Type
N	151	lb/ac	-	-
P	47	ppm	10 lb/ac	11-52-0-0
K	743	ppm	-	-

Inoculant added with seed; P banded with seed

Table 4: Pesticide Application

Crop stage	Date	Product	Rate
Pre-emerge	May 26	RoundUp	640 ml/ac
		Heat	28.0 g/ac
In-crop	Jul 22	UAN 28%	800 ml/ac
		Viper	400 ml/ac
Desiccant	Sep 22	Reglone	670 ml/ac
		LI700	250 ml/ac

Saskatchewan Pulse Growers Coloured and White Fababean Variety Evaluations

Project duration: May 2021 – September 2021
Objectives: To evaluate coloured and white fababean entries for the Saskatchewan Pulse Growers (SPG)
Collaborators: Laurie Friesen, SPG

Background
(Adapted from the SPG website): The SPG works to boost yield of established pulse crops, develop new crops, connect with growers, expand the utilization of pulse crops, and decrease barriers to market access. The projects further on-farm yield gains through the identification and enhancement of genetic yield potential.

Results
The average yield for coloured fababean entries is shown in Figure 1. The average yield for white fababean entries is shown in Figure 2. Numbered, non-registered varieties are provided for tracking purposes only. The results are for one site-year only, and should be interpreted with caution. Consult a seed guide for multi-site-year data for available varieties.

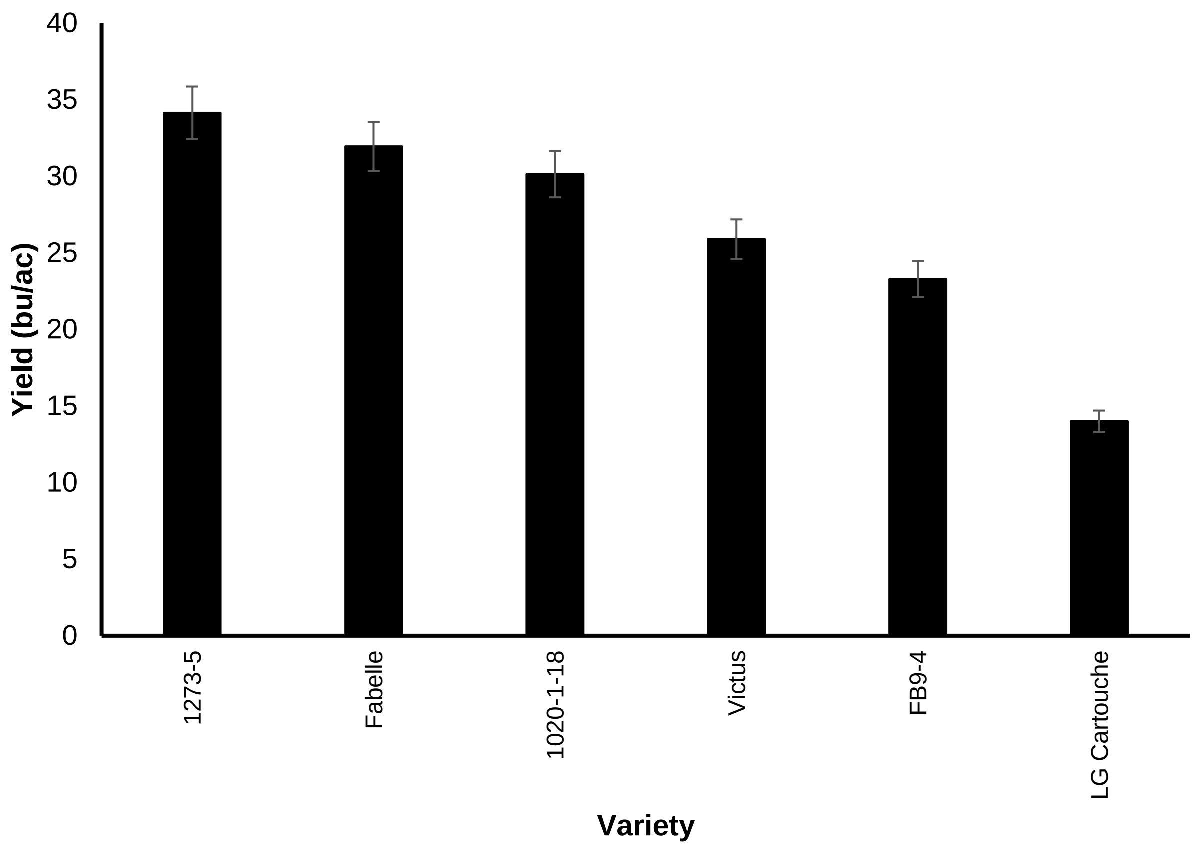

Figure 1: Average yield for coloured fababean entries

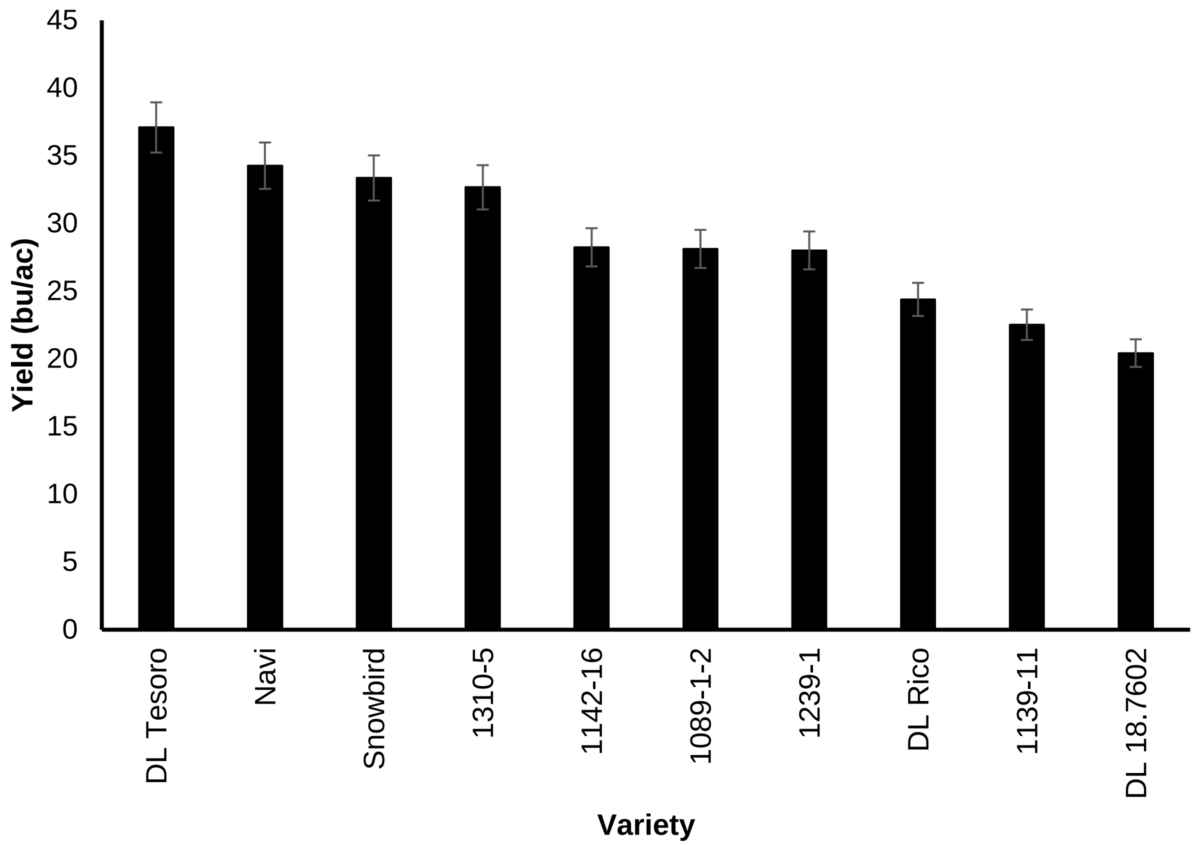

Figure 2: Average yield for white fababean entries

Table 1: Comparison of yield means and statistical difference for coloured fababean entries (varieties connected by the same letter are statistically significant)

Variety	Statistical significance for yield			Yield (bu/ac)
1273-5	A			34.15
Fabelle	A	B		31.95
1020-1-18	A	B		30.13
Victus	A	B		25.89
FB9-4		B	C	23.29
LG Cartouche			C	14.00
LSD	10.00			
% CV	31.41			

Table 2: Comparison of yield means and statistical difference for white fababean entries (varieties connected by the same letter are statistically significant)

Variety	Statistical Significance for Yield			Mean
DL Tesoro	A			37.09
Navi	A	B		34.26
Snowbird	A	B		33.36
1310-5	A	B	C	32.67
1142-16	A	B	C	28.24
1089-1-2	A	B	C	28.12
1239-1	A	B	C	28.01

DL Rico	A	B	C	24.39
1139-11		B	C	22.52
DL 18.7602			C	20.43
LSD	12.81			
% CV	28.18			

Plant heights for coloured fababean entries are shown in Figure 3, and for white fababean entries in Figure 4.

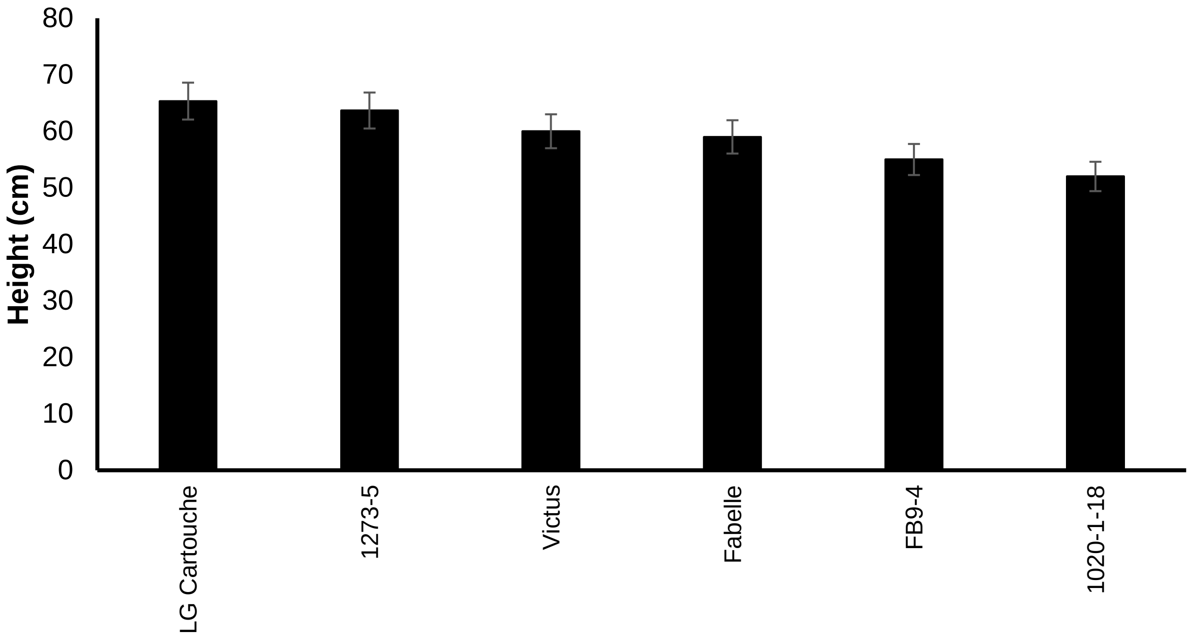

Figure 3: Plant heights for coloured fababean entries

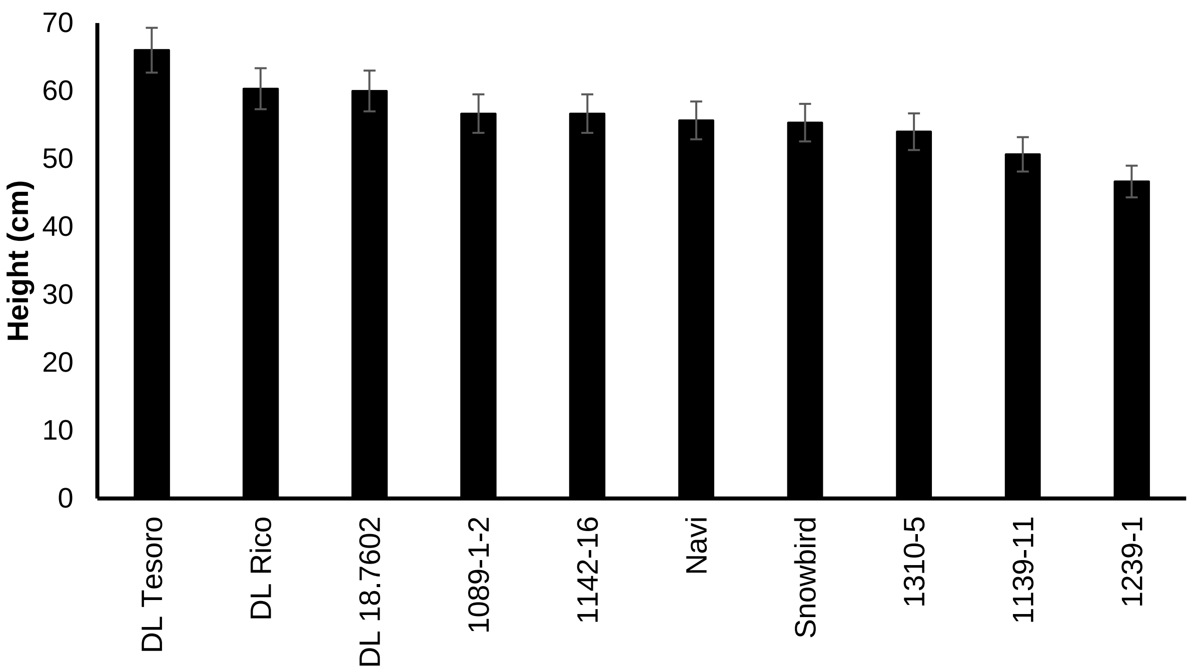

Figure 4: Plant heights for spring wheat entries in Evaluation 2 (High Yielding)

Table 3: Comparison of height means and statistical difference for coloured fababean entries (varieties connected by the same letter are statistically significant)

Variety	Statistical significance for yield		Height (cm)
LG Cartouche	A		65.33
1273-5	A	B	63.67
Victus	A	B	60.00
Fabelle	A	B	59.00
FB9-4	A	B	55.00
1020-1-18		B	52.00
LSD	**13.09**		
% CV	**13.17**		

Table 4: Comparison of height means and statistical difference for white fababean entries (varieties connected by the same letter are statistically significant)

Variety	Statistical Significance for Height			Height (cm)
DL Tesoro	A			66.00
DL Rico	A	B		60.33
DL 18.7602	A	B		60.00
1089-1-2	A	B	C	56.67
1142-16	A	B	C	56.67
Navi	A	B	C	55.67
Snowbird	A	B	C	55.33
1310-5		B	C	54.00
1139-11		B	C	50.67
1239-1			C	46.67
LSD	**11.84**			
% CV	**13.75**			

Materials and methods

Experimental Design: Random Complete Block
Entries: 10 white entries; 6 coloured entries; 3 replications
Seeding: May 4
Harvest: Sep 22

Data collected — Date collected
% Plant Stand: May 19
Maturity: Sep 24
Yield: Sep 25
Moisture: Sep 25

Agronomic info
Previous year's crop: Oat Silage
Soil Type: Erickson Clay Loam
Landscape: Rolling with trees to the east
Seedbed preparation: Vertical tilled

Table 3: Spring 2021 Soil Test

	Available		Added	Type
N	151	lb/ac	-	-
P	47	ppm	10 lb/ac	11-52-0-0

Inoculant added with seed; P banded with seed

Table 4: Pesticide Application

Crop stage	Date	Product	Rate	
Pre-emerge	May 10	Authority	188	ml/ac
In-crop	Jun 14	Bentazon	910	ml/ac
		Quizalafop	200	ml/ac
		Merge	700	ml/ac
Desiccant	Sep 9	Reglone	650	ml/ac
		LI700	250	ml/ac

Wheat Trials

Parkland Coop Wheat Variety Evaluation

Project duration: May 2021 – August 2021
Objectives: To evaluate spring wheat varieties for the Parkland Coop
Collaborators: Dean Spanner – Coordinator, University of Alberta Research Station
Klaus Strenzke – Research Technician, University of Alberta Research Station

Background
The Parkland Cooperative wheat trial is conducted across the Prairies as a resource for wheat breeders to generate data in support of registration of new Canada Western Red Spring varieties. Additional samples taken to test for wheat midge were sent away at the end of July.

Results
The average yield for wheat entries is shown in Figure 1. Numbered (coded) entries are provided for reference only. For more information on the Parkland Coop trial, contact Klaus Strenzke, University of Alberta. The results are for one site-year only, and should be interpreted with caution. Consult a seed guide for multi-site-year data for available varieties.

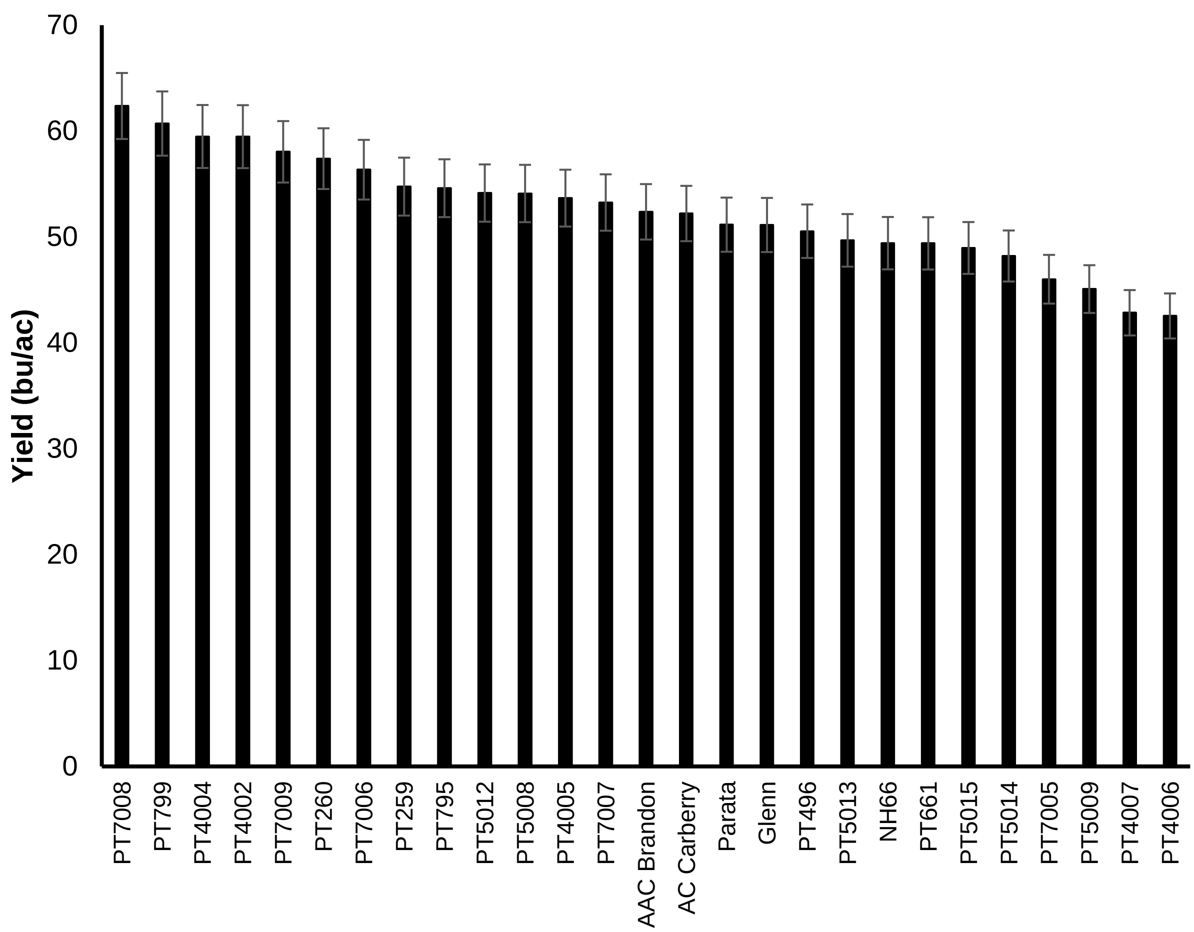

Figure 1: Average yield for wheat entries

Table 1: Comparison of yield means and statistical difference for wheat entries (varieties connected by the same letter are statistically significant)

Variety	Statistical significance for yield									Yield (bu/ac)
PT7008	A									62.36
PT4004	A	B								59.48
PT4002	A	B								59.47
PT7009	A	B	C							58.04
PT260	A	B	C	D						57.39
PT7006	A	B	C	D	E					56.35
PT795	A	B	C	D	E	F				54.77
PT259	A	B	C	D	E	F				54.75
PT5012		B	C	D	E	F				54.14
PT5008		B	C	D	E	F				54.10
PT799		B	C	D	E	F	G			53.80
PT4005		B	C	D	E	F	G			53.66
PT7007		B	C	D	E	F	G			53.25
AAC Brandon		B	C	D	E	F	G	H		52.37
AC Carberry		B	C	D	E	F	G	H		52.21
Parata			C	D	E	F	G	H		51.16
Glenn			C	D	E	F	G	H		51.13
PT496			C	D	E	F	G	H	I	50.54
PT5013				D	E	F	G	H	I	49.68
NH66				D	E	F	G	H	I	49.41
PT661				D	E	F	G	H	I	49.39
PT5015					E	F	G	H	I	48.96
PT5014						F	G	H	I	48.20
PT7005							G	H	I	46.01
PT5009								H	I	45.08
PT4007									I	42.84
PT4006									I	42.54
LSD	**8.04**									
% CV	**12.13**									

Materials and methods

Experimental Design: Rectangular Lattice
Entries: 27 varieties
Repetitions: 3
Seeding: May 6
Harvest: Aug 31

Agronomic information
Previous year's crop: Oat Silage
Soil Type: Erickson Clay Loam
Landscape: Rolling with trees to the east
Seedbed preparation: Vertical tilled

Data collected	Date collected
Height:	Aug 5
Lodging:	Aug 31
Yield:	Aug 31
Moisture:	Aug 31

Table 2: 2021 Fertility Information

	Available	Added	Type
N	93 lb/ac	96 lb/ac	46-0-0
P	46 ppm	15 lb/ac	11-56-0-0
K	709 ppm	-	-

Table 3: Pesticide Application

Crop stage	Date	Product	Rate
Pre-emerge	May 10	Heat LQ	35 ml/ac
		Amigo	750 ml/ac
In-crop	Jun 14	Curtail M	810 ml/ac
		Puma	271 ml/ac

SVPG Wheat Variety Evaluation 1 (CWRS) and Evaluation 2 (HY)

Project duration: May 2021 – August 2021
Objectives: Two tests to evaluate spring wheat varieties for the Saskatchewan Variety Performance Group
Collaborators: SVPG, Saskatchewan Agriculture

Background
(From the Saskatchewan Wheat Development Commission website): The Saskatchewan Variety Performance Group (SVPG) is an informal group made up of stakeholders who are interested in variety performance testing in Saskatchewan. SVPG has coordinated the post-registration regional performance testing of spring wheat, durum, barley, oats, and flax varieties since 2006. The data collected from these trials is entered into annual publications "Varieties of Grain Crops" and the Saskatchewan Seed Guide. In this project, SVPG collects data on priority traits including maturity, height, lodging, test weight, thousand kernel weight, protein, ergot and wheat midge.

Results
The average yield for spring wheat entries in Evaluation 1 (Canadian Western Red Spring) is shown in Figure 1. The average yield for entries in Evaluation 2 (High Yielding) is shown in Figure 2. The results are for one site-year only, and should be interpreted with caution. Consult a seed guide for multi-site-year data for available varieties.

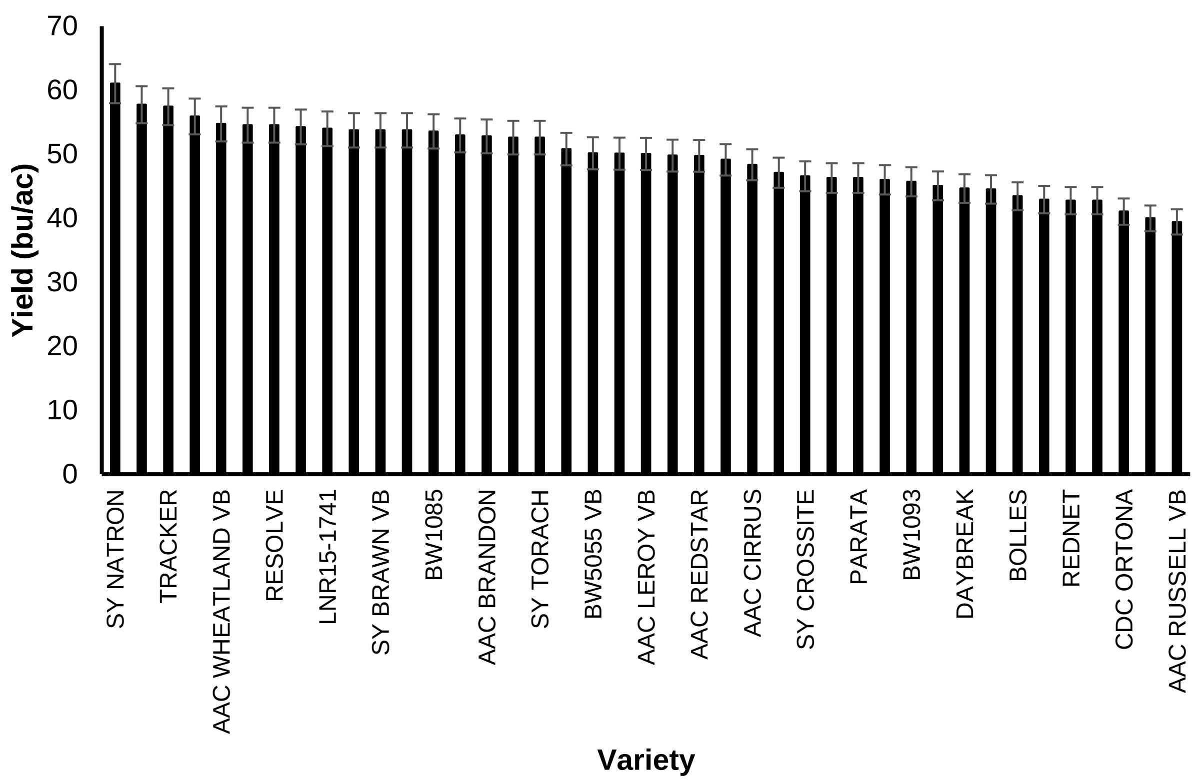

Figure 1: Average yield for spring wheat entries in Evaluation 1 (Canadian Western Red Spring)

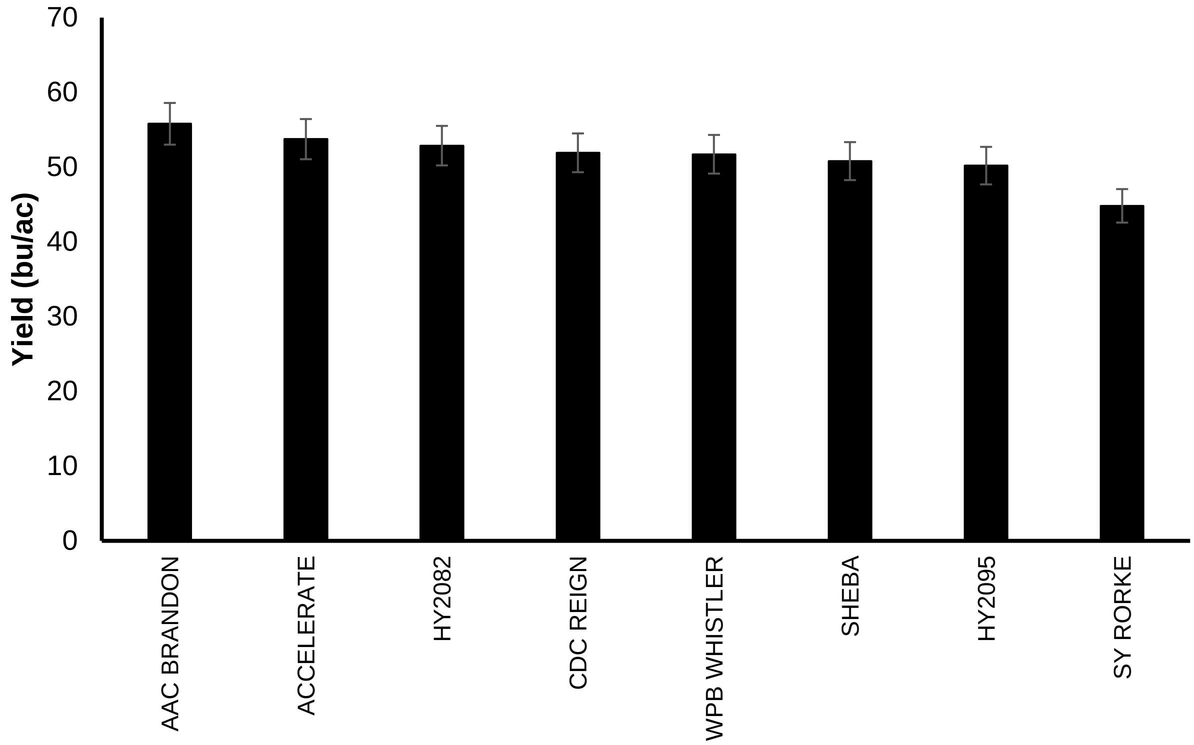

Figure 2: Average yield for spring wheat entries in Evaluation 2 (High Yielding)

Table 1: Comparison of yield means and statistical difference for spring wheat entries in Evaluation 1 (CWRS) (varieties connected by the same letter are statistically significant)

Variety	**Statistical significance for yield**											**Yield (bu/ac)**
LNR15-1741	A											61.03
AAC HODGE VB	A	B										57.74
AAC TOMKINS	A	B	C									55.89
AAC WHEATLAND VB	A	B	C	D								54.73
DAYBREAK	A	B	C	D								54.53
ELLERSLIE	A	B	C	D	E							53.73
BW1085	A	B	C	D	E							53.57
BW5062	A	B	C	D	E							52.93
AAC BRANDON	A	B	C	D	E	F						52.78
RESOLVE	A	B	C	D	E	F	G					50.88
AAC WARMAN VB	A	B	C	D	E	F	G					50.80
SY GABBRO		B	C	D	E	F	G					50.17
BW5055 VB		B	C	D	E	F	G	H				50.15
AAC STARBUCK VB		B	C	D	E	F	G	H				50.08
AAC LEROY VB		B	C	D	E	F	G	H				50.05
AAC BROADACRES VB		B	C	D	E	F	G	H				49.78
AAC REDSTAR		B	C	D	E	F	G	H				49.74
PT598		B	C	D	E	F	G	H	I			49.42
BW5045		B	C	D	E	F	G	H	I			49.13
PARATA		B	C	D	E	F	G	H	I			49.10
SY CAST		B	C	D	E	F	G	H	I	J		48.53

AAC CIRRUS		B	C	D	E	F	G	H	I	J		48.36
PT5003			C	D	E	F	G	H	I	J		47.32
AAC MAGNET			C	D	E	F	G	H	I	J	K	47.10
CDC SKRUSH			C	D	E	F	G	H	I	J	K	46.29
SY NATRON			C	D	E	F	G	H	I	J	K	46.05
AAC HOCKLEY			C	D	E	F	G	H	I	J	K	46.00
BW1093			C	D	E	F	G	H	I	J	K	45.69
BW5031 VB				D	E	F	G	H	I	J	K	45.05
AAC ALIDA VB				D	E	F	G	H	I	J	K	44.50
SY BRAWN VB				D	E	F	G	H	I	J	K	44.39
BOLLES					E	F	G	H	I	J	K	43.43
JAKE						F	G	H	I	J	K	42.74
SY TORACH							G	H	I	J	K	42.44
CDC ORTONA							G	H	I	J	K	41.03
REDNET							G	H	I	J	K	40.89
AAC WHITEHEAD VB								H	I	J	K	39.98
TRACKER								H	I	J	K	39.75
AAC RUSSELL VB									I	J	K	39.42
SY CHERT VB										J	K	39.02
SY CROSSITE											K	36.88
LSD	8.50											
% CV	13.87											

Table 2: Comparison of yield means and statistical difference for spring wheat entries in Evaluation 2 (High Yielding) (varieties connected by the same letter are statistically significant)

Variety	**Statistical Significance for Yield**	**Mean**
AAC BRANDON	A	55.80
ACCELERATE	A	53.74
HY2082	A	52.87
CDC REIGN	A	51.92
WPB WHISTLER	A	51.72
SHEBA	A	50.80
HY2095	A	50.20
SY RORKE	A	44.82
LSD	14.51	
% CV	14.56	

Plant heights for spring wheat entries in Evaluation 1 (CWRS) are shown in Figure 3, and for spring wheat entries in Evaluation 2 (High Yielding)

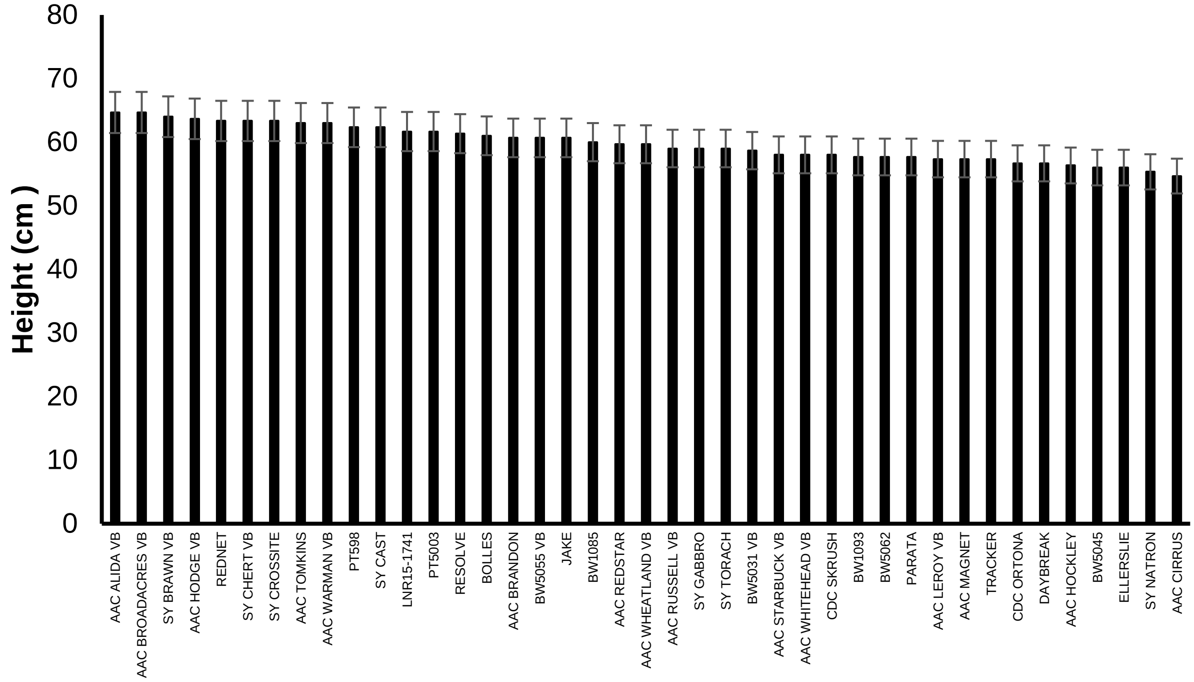

Figure 3: Plant heights for spring wheat entries in Evaluation 1 (CWRS)

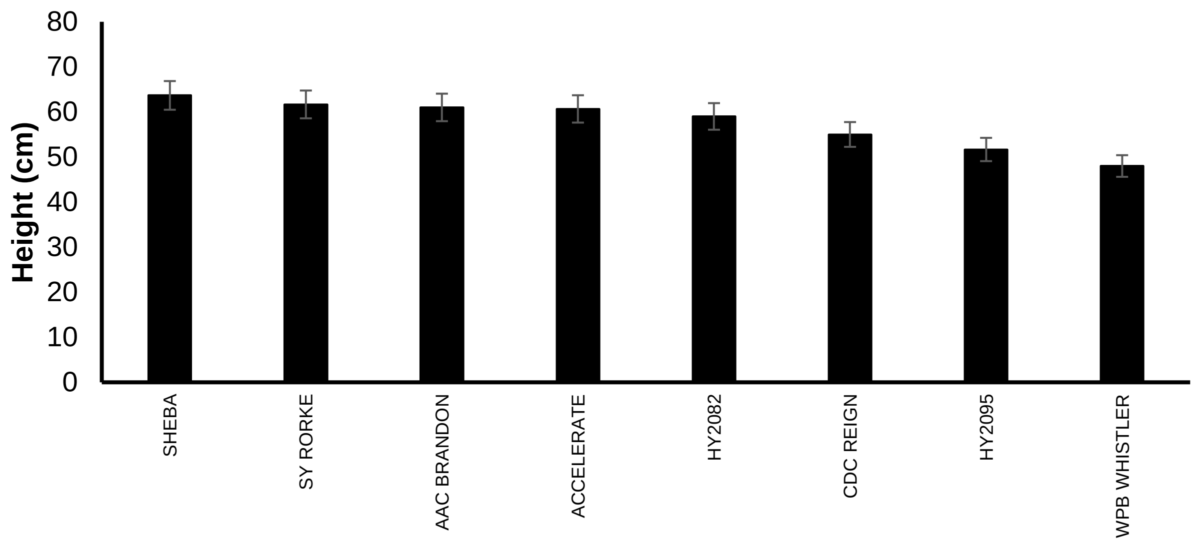

Figure 4: Plant heights for spring wheat entries in Evaluation 2 (High Yielding)

Table 3: Comparison of height means and statistical difference for spring wheat entries in Evaluation 1 (CWRS) (varieties connected by the same letter are statistically significant)

Variety	Statistical significance for yield							Height (cm)
SY CROSSITE	A							70.00
PARATA	A	B						65.00
AAC ALIDA VB	A	B	C					64.67
AAC BROADACRES VB	A	B	C					64.67
ELLERSLIE	A	B	C	D				64.00
AAC HODGE VB	A	B	C	D				63.67
SY GABBRO	A	B	C	D				63.67
REDNET	A	B	C	D				63.67
JAKE	A	B	C	D	E			63.00
AAC TOMKINS	A	B	C	D	E			63.00
AAC WARMAN VB	A	B	C	D	E			63.00
SY BRAWN VB	A	B	C	D	E	F		62.33
SY CHERT VB	A	B	C	D	E	F		61.67
DAYBREAK	A	B	C	D	E	F		61.33
SY NATRON	A	B	C	D	E	F		61.33
BOLLES		B	C	D	E	F	G	61.00
AAC BRANDON		B	C	D	E	F	G	60.67
BW5055 VB		B	C	D	E	F	G	60.67
BW1085		B	C	D	E	F	G	60.00
RESOLVE		B	C	D	E	F	G	59.67
AAC WHEATLAND VB		B	C	D	E	F	G	59.67
AAC REDSTAR		B	C	D	E	F	G	59.67
AAC RUSSELL VB		B	C	D	E	F	G	59.00
BW5031 VB		B	C	D	E	F	G	58.67
SY CAST		B	C	D	E	F	G	58.67
CDC SKRUSH		B	C	D	E	F	G	58.00
AAC WHITEHEAD VB		B	C	D	E	F	G	58.00
AAC STARBUCK VB		B	C	D	E	F	G	58.00
BW5062		B	C	D	E	F	G	57.67
BW1093		B	C	D	E	F	G	57.67
AAC LEROY VB		B	C	D	E	F	G	57.33
AAC MAGNET		B	C	D	E	F	G	57.33
CDC ORTONA		B	C	D	E	F	G	56.67
PT5003		B	C	D	E	F	G	56.67
AAC HOCKLEY		B	C	D	E	F	G	56.33
BW5045			C	D	E	F	G	56.00
SY TORACH				D	E	F	G	55.67
AAC CIRRUS					E	F	G	54.67
PT598					E	F	G	54.67
TRACKER						F	G	54.00
LNR15-1741							G	52.33
LSD	**8.83**							
% CV	**9.58**							

Table 4: Comparison of height means and statistical difference for spring wheat entries in Evaluation 2 (High Yielding) (varieties connected by the same letter are statistically significant)

Variety	Statistical Significance for Height				Height (cm)
SHEBA	A				63.67
SY RORKE	A	B			61.67
AAC BRANDON	A	B			61.00
ACCELERATE	A	B			60.67
HY2082	A	B	C		59.00
CDC REIGN		B	C	D	55.00
HY2095			C	D	51.67
WPB WHISTLER				D	48.00
LSD	**14.51**				
% CV	**14.56**				

Materials and methods

Experimental Design: Random Complete Block Design
Entries: Wheat 1, 41 entries; Wheat 2, 8 entries
Seeding: May 6
Harvest: Wheat 1 Sep 8; Wheat 2 Aug 31

Agronomic information
Previous year's crop: Oat Silage
Soil Type: Erickson Clay Loam
Landscape: Rolling with trees to the east
Seedbed preparation: Vertical tilled
Data collected Date collected
Maturity: Aug 10
Height: Aug 10
Lodging: Aug 31
Yield: Sep 8
Moisture: Sep 8

Table 5: 2021 Fertility Information

	Available		Added	Type
N	93	lb/ac	96 lb/ac	46-0-0
P	46	ppm	15 lb/ac	11-56-0-0
K	709	ppm	-	-

Table 6: Pesticide Application

Crop stage	Date	Product	Rate
Pre-emerge	May 10	Heat LQ	35 ml/ac
		Amigo	750 ml/ac
In-crop	Jun 14	Curtail M	810 ml/ac
		Puma	271 ml/ac

Ducks Unlimited Canada: Winter wheat fertility program to maximize yield potential of new winter wheat varieties

Project duration: 2019-2021

Objectives: To compare historical/standard "Producer Practice (100% spring)" fertility program to a balanced "High Yield Practice (Balanced)" as determined by Western Ag Soil analysis and recommendations.

Collaborators: Elmer Kaskiw, Ducks Unlimited Canada, Western Ag Lab and Professional Agronomy

Background

Following decades of extensive work in winter wheat production in North America, many researchers and producers have begun to implement best management practices to obtain higher grain yield and improve profitability in the crop. Management practices presently being implemented to improve winter wheat production include; increasing seeding rate, application of starter fertilizer by banding during seeding, variety selection, pest control (Anderson, 2008) and split application, during planting in fall and at tillering or stem elongation in spring (Schulz et al., 2015). Fertility management, in particular nitrogen and phosphorus, remains an integral part of the overall management package aimed at achieving higher yields in winter wheat (Halvorson et al. 1987). Recommended fertilizer management, particularly nitrogen management, differs widely in winter wheat production, but the crop's nitrogen demand is correlated to yield potential and availability of moisture in dryland production systems (Beres et al., 2018). Compared to spring wheat, winter wheat presents more challenges in development as a result of its higher nitrogen demand during the long vegetative phase, hence the reason why it requires 25 to 50% more N than spring wheat in the Prairies (Fowler et al., 1989). The ideal fertility management package would help counteract the escalating cost of winter wheat production per unit area, which is the main goal that producers aim to achieve. There is still a knowledge gap on the rates and timing of nitrogen fertilizer application, particularly in Western Canada, that result in improved yield without compromising grain quality and economic returns. Morris et al. (2018) suggested the implementation of adaptive use of nitrogen to help augment and improve nitrogen application rate decision making by farmers. Therefore, there is a great need to continue with research on the best management practices that can be availed to producers to improve economic returns in winter wheat production. Nitrogen is most often the focus of crop fertility in field studies. However, having a balanced approach and considering other essential nutrients, such as, phosphorus, potassium and sulphur and micronutrients available in the soil, offers great yield potential when nitrogen needs of the crop are met. Perhaps more efficient returns on investment potential can be achieved as fertility management is optimized.

Materials and Methods

This study was established at four locations, Melita, Arborg, Carberry and Roblin, Manitoba in the fall of 2020 (Table II). In Melita, wheat was seeded into canola stubble at a depth of 0.5" on September 14, 2020 using a 6-row dual knife seed hawk air seeder. The soil was characterized as Ryerson5Loam/ Regent5Loam. No pre-emergent herbicide was necessary in 2020 at the Melita site. Post emergence weed control was done in spring to control flowering volunteer canola by application of Mextrol 450 at

0.5 L ac-1. No fungicide application was needed at the Melita site in 2021, but Prosaro or Folicur fungicides were applied at the Arborg, Carberry and Roblin sites. The treatment structure consisted of a factorial arrangement of two fertilizer management practices and four to six winter wheat varieties in a randomized complete block design. The winter wheat varieties utilized at all sites were; Gateway, Goldrush, Elevate and Wildfire. At the Carberry site, AAC Network and W583 varieties were also incorporated into the trial. Fertilizer treatments included:

- **Producer practice:** 100 lbs of nitrogen (urea plus agrotain) per acre applied in spring and 30 lbs phosphorus banded at seeding in fall and,
- **Balanced fertility practice:** Nitrogen was applied as per Western Ag recommendations based on soil test results, and application was split with 50% N banded at seeding and the other 50% N (urea plus Agrotain) broadcasted in spring. In addition, site specific P, K, S, and micronutrient recommendations were applied.

A summary of fall soil tests conducted at Melita, Roblin, Carberry and Arborg, and fertilizer treatments for the 2020/2021 trial are presented in Table I. Data were analyzed using Minitab 18.1 software, and means were separated using Fisher's mean separation method at 95% confidence.

Table I. Fall soil test results by site and producer practice (100% N in spring) and balanced practice (50% N in spring) treatments for winter wheat in the 2020/2021 season

Fall Soil Test Results (lbs ac^{-1})				
Nutrient	**Location**			
	Melita	**Roblin**	**Carberry**	**Arborg***
N	11	53	31	93
P	10	71	27	44
K	306	410	48	660
S	36	22	15	582
Zn	1.4	1.1	0.04	0
* Farmers Edge sampling				
Producer Practice Application (all N applied in Spring)				
N	100	100	100	100
P	30	30	30	30
K	0	0	0	0
Balanced Practice application recommendations (Western Ag Processional Agronomy Laboratory) 50% N applied in fall				
N	130	105	130	161
P	38	20	30	40
K	50	0	100	50
S	0	0	5	0
Zn	0	0	0	0

Table II. Site description and agronomics for each trial site in the 2020/2021 season

Location	Melita	Carberry	Roblin	Arborg
Cooperator	WADO	CMCDC	PCDF	PESAI
Legal	NW23-3-27W1	South ½ of 8-11-14 W1	NE 20-25-28 W1	NW 16-22-2 E1
Rotation (2 yr.)	Spring wheat – LL Canola	Soybean (2019), Canola (2020)	Barley silage (2019), Oat silage (2020)	Canola – Cereals
Soil Series	Ryerson Loam	Ramada Clay Loam	Erickson clay loam	Fyala heavy clay
Soil Test Done? (Y/N)	Yes	Yes	Yes	Yes
Field Prep	No till	No till	Vertical tilled	No till
Stubble	LL Canola	Canola	Oat	Canola
Burn off (Date/Rate per acre/Products)	None	09-Sep-20: Roundup 0.67 L + Heat 29 g + Water 40 L sprayed before seeding	None	None
Soil Moisture at Seeding	Very poor	Fair	Dry	Optimal
Seed Date	14-Sep-20	16-Sep-20	18-Sep-20	21-Sep-20
Seed depth (Inches)	0.5	1.0	0.75	1.0
Seeder (drill/planter?)	Knife drill	Knife drill	Disc drill	Disc drill
Errors at seeding	None	None	None	None
Topdressing	09-Apr-21	23-Apr-21	16-Apr-21	29-Apr-21
Herbicides (Date, Rate/ ac, Name)	08-Jul: 0.5 L Mextrol 450 on flowering canola	09-Sep: 0.7 L Glyphosate, 30 g Heat 15-Jun: 0.12 Fitness, 0.4 L Buctril M, 0.5 L Axial	14-Jun: 0.81 L Curtail M, 0.71 mL Puma	None
Fungicides	none	08-Jul: 0.325 L Prosaro	15-Jun: 0.202 L Folicur	22-Jun: 0.2 L Folicur
Insecticides	17-Jul: Coragen, aerial, hoppers	None	None	28-Jun: 0.325 L Prosaro
Harvest Date	16-Aug-21	12-Aug-21	25-August-21	3-Aug-21
Total Precipitation (mm) (Seeding > Harvest)	222			

Results

Winter wheat variety was not found to have a significant effect on wheat yield at any of the individual trial sites (Table a). However, over all four site years, a significant (P = 0.003) grain yield trend was observed. Across all four site years, Wildfire winter wheat produced the greatest average yield, though this yield was not significantly different from that of Elevate winter wheat. AAC Network and W583 varieties were not included in multi-site analysis as these varieties were only included in the Carberry trial. Winter wheat variety significantly influenced grain protein content at the Melita, Roblin and Arborg sites in the 2020/2021 growing season. At the Melita site, protein content of Gateway grain (15.8%) was significantly (P < 0.001) higher than that of Elevate, Goldrush and Wildfire varieties. In Roblin, Gateway winter wheat also resulted in the greatest protein content (16.7%), though this was not significantly different from that of Goldrush winter wheat (16.4%). At the Arborg site, no significant difference in protein content was observed among Wildfire (14.4%), Gateway (14.3%) or Goldrush (13.9%) varieties. Elevate winter wheat resulted in the lowest average grain protein content at the Melita, Roblin, and Arborg sites, indicating a potential protein content disadvantage of this variety in Manitoba compared to the other varieties used in this trail. Protein content data was not collected for Carberry grain in 2021. Protein content of Elevate winter wheat was also demonstrated to be significantly (P < 0.001) lower than all other varieties when Melita, Roblin, and Arborg site data was combined (14.0%), while protein content of Gateway winter wheat (15.6%) was demonstrated to be greater than all other varieties grown at these sites. Test weight significantly varied across varieties at the Melita, Roblin, and Arborg sites, as well as across varieties over all four site years. At these sites, the greatest average test weight was observed from Gateway winter wheat.

Fertilizer management practice did not have a significant influence on grain yield at the Melita, Roblin, or Carberry sites. In Arborg, winter wheat grown with a balanced fertility practice (50% N in fall) had a significantly (P = 0.034) greater average yield than winter wheat grown with the current producer fertility practice (100% N in spring). No significant effect of fertility practice on winter wheat grain protein content was observed at the Melita or Arborg sites, but winter wheat grown using current producer fertility practice at the Roblin site had greater average protein content (16.1%) than winter wheat grown using the balanced fertility practice at this site (15.7%). However, when data from all sites was combined and analyzed, no significant influence of fertility management practice on winter wheat grain yield or protein content was observed. Fertility management practice had a significant influence on grain test weight at the Melita site, the Carberry site, and over all site years, with test weight of grain grown under the producer fertility practice significantly greater than that of grain grown under a balanced fertility practice.

Significant variety and fertility practice interactions (variety x fertility) were observed when yield data from all site years was combined, but no significant interactions were observed at individual sites. Over all four site years, Wildfire winter wheat grown under producer fertility practices had the greatest average yield (4176 kg ha-1), though this yield was not significantly different from that of Goldrush winter wheat under balanced fertility practices (3895 kg ha-1). No significant yield differences were observed between fertility practices for Elevate or Gateway winter wheat varieties over four site years. A balanced fertility practice resulted in a greater average yield than the current producer fertility practice for Goldrush winter wheat, though the opposite was true for Wildfire winter wheat. This result may indicate that yields of some winter wheat varieties respond better to a balanced fertility practice than others. At the Melita site, Gateway winter wheat grown under balanced fertility practice resulted in the greatest average test weight (73.5 kg hL-1), though this test weight was not significantly different from that of Elevate, Gateway, or Goldrush winter wheat grown under producer fertility practices. Protein content of winter wheat was not significantly different among variety and fertility management practice combinations (variety x fertility) at individual sites or when Melita, Roblin, and Arborg protein data was combined.

Overall, results from the 2020/2021 growing season indicate that yields of some winter wheat varieties respond better to a balanced fertility program than others. Additionally, yield results from the Arborg site demonstrate a potential yield benefit of a balanced fertility program, as wheat grown under a balanced fertility program at this site yielded significantly higher than wheat grown under a current producer fertility program. Winter wheat protein content was demonstrated to likely be more influenced by winter wheat variety than fertility management practices in the 2020/2021 growing season, as fertility management practice only had significant impact on winter wheat protein content at the Roblin site, while variety significantly influenced protein content at all sites. Test weight of harvest grain was significantly greater in wheat grown under current producer fertility practices than in wheat grown under a balanced fertility practice at two sites indicating a potential test weight benefit of applying all nitrogen in spring. Continued field study is necessary to further evaluate the performance of new winter wheat varieties under both fertility management strategies, and to effectively develop fertilizer management recommendations that winter wheat producers can implement in their production systems.

Table a. Analysis of variance for average winter wheat yield (kg ha^{-1}), protein content (%), and test weight at Melita, Roblin, Arborg, and Carberry, Manitoba sites for the 2020/2021 growing season.

			Location													
			Melita			Roblin			Arborg			Carberry		All Sites		
Treatment			Yield (kg ha^{-1})	Protein (%)	Test Wt. (kg hL^{-1})	Yield (kg ha^{-1})	Protein (%)	Test Wt. (kg hL^{-1})	Yield (kg ha^{-1})	Protein (%)	Test Wt. (kg hL^{-1})	Yield (kg ha^{-1})	Test Wt. (kg hL^{-1})	Yield (kg ha^{-1})	Protein* (%)	Test Wt. (kg hL^{-1})
Variety	Elevate	1	2134	14.1d	72.1ab	3862	14.8c	60.4c	3216	13.0b	79.0b	5582	69.1	3699ab	14.0c	70.1b
	Gateway	2	1935	15.8a	73.0a	3377	16.7a	63.3a	2922	14.3a	81.5a	5582	70.2	3454c	15.6a	72.0a
	Goldrush	3	2299	15.4b	71.0c	3428	16.4a	62.2b	3103	13.9a	78.2b	5750	69.6	3645bc	15.2b	70.2b
	Wildfire	4	2456	14.9c	71.3bc	3661	15.7b	59.2d	2983	14.4a	76.9c	6597	70.0	3925a	15.0b	69.3c
	AAC Network	5	-	-	-	-	-	-	-	-	-	6545	69.6	-	-	-
	W583	6	-	-	-	-	-	-	-	-	-	5925	70.3	-	-	-
Fertility	Balanced	1	**2077**	**15.1**	71.4b	**3478**	15.7b	61.4	3167a	14.1	78.8	5829	69.3b	3628	15.0	70.2b
	100% Spring	2	**2335**	**15.0**	72.3a	**3686**	16.1a	61.1	2945b	13.7	79.0	6164	70.3a	3733	14.9	70.7a
Var x Fert		1,1	1855	14.3	71.2cd	3706	14.5	60.3	3365	13.4	79.2	5334	68.6	3565bcd	14.1	69.8
		1,2	2413	13.9	72.9ab	4018	15.0	60.4	3068	12.6	78.8	5831	69.6	3832bc	13.9	70.4
		2,1	1778	15.9	73.5a	3106	16.9	62.9	3025	14.6	81.5	5609	70.0	3379d	15.8	72.0
		2,2	2091	15.7	72.6abc	3648	16.5	63.6	2820	14.1	81.5	5555	70.4	3529cd	15.5	72.0
		3,1	2370	15.3	69.8d	3575	15.9	63.1	3340	14.0	77.8	6296	69.3	3895ab	15.1	70.0
		3,2	2227	15.4	72.2abc	3281	16.9	61.3	2866	13.7	78.7	5205	69.8	3395d	15.3	70.5
		4,1	2302	14.9	71.1cd	3526	15.4	59.4	2939	14.4	76.7	5923	69.0	3673bcd	14.9	69.0
		4,2	2610	14.9	71.5cd	3797	15.9	58.9	3027	14.4	77.2	7271	70.9	4176a	15.1	69.7
		5,1	-	-	-	-	-	-	-	-	-	5914	68.8	-	-	-
		5,2	-	-	-	-	-	-	-	-	-	7176	70.4	-	-	-
		6,1	-	-	-	-	-	-	-	-	-	5901	70.0	-	-	-
		6,2	-	-	-	-	-	-	-	-	-	5948	70.633	-	-	-
P values	Variety		0.082	**<0.001**	**0.006**	0.221	**<0.001**	**<0.001**	0.176	**0.011**	**<0.001**	0.066	0.113	**0.003**	**<0.001**	**<0.001**
	Fertilizer		0.075	0.158	0.021	0.252	**0.036**	0.265	**0.034**	0.197	0.493	0.18	**0.001**	0.223	0.824	**0.008**
	Var x Fert		0.353	0.297	**0.035**	0.405	0.115	0.072	0.248	0.721	0.533	0.072	0.482	**0.001**	0.181	0.605
	CV(%)		15	1	1	12	3	1	8	5	1	12	1	11	3	1

Values followed by the same letter are not significantly different by Fisher's mean separation method at 95% confidence.
*Does not include Carberry site

References

Anderson, R. L. 2008. Growth and Yield of Winter Wheat as Affected by the Preceding Crop and Crop Management. Agronomy Journal 100 (4) 977-980.

Beres, B. L., Graf, R. J., Irvine, R. B., O'Donovan, J. T., Harker, K.N., Johnson, E. N., Brandt, S., Hao, X., Thomas, B. W., Turkington, T. K., and Stevenson, F. C. 2018. Enhanced Nitrogen Management Strategies for Winter Wheat Production in the Canadian Prairies. Canadian Journal of Plant Science 98:3. https://doi.org/10.1139/cjps-2017-0319

Fowler, D. B., Brydon, J., and Baker, R. J. 1989. Nitrogen fertilization of no-till winter wheat and rye. I. Yield and agronomic responses. *Agron. J.* 81: 66–72.

Halvorson, A.D., Alley, M. M., and Murphy, L. S. 1987. Nutrient Requirements and Fertilizer Use: In Wheat and Wheat Improvement – Agronomy Monograph (13) 2nd Edition. Madison, WI 53711, USA.

Morris, T.F., Murrell, T. S., Beegle, D. B., Camberato, J., Ferguson, R., Ketterings, Q. 2018. Strengths and limitations of nitrogen recommendations, tests, and models for corn. Agron. J. 110:1–37. doi:10.2134/agronj2017.02.0112

Schulz, R., Makary, T., Hubert, S., Hartung, K., Gruber, S., Donath, S., Dohler, J., Weiss, K., Ehrhart, E., Claupein, W., Piepho, H. P., Pekrun, C., and Müller, T. 2015. Is it necessary to split nitrogen fertilization for winter wheat? On-farm research on Luvisols in South-West Germany. *J. Agric. Sci.* 153(4): 575–587.

Horticulture Trials

Fruit Demonstration

Established: May 2009
Objectives: To demonstrate varieties of fruits being developed by the University of Saskatchewan
Collaborator: PCDF

Background
Dwarf sour cherries are not a native crop to the Canadian Prairies. They are the product of a number of crosses were initially begun by Dr. Les Kerr of the University of Saskatchewan by crossing a cold hardy cherry from Siberia, *Prunus fruiticosa,* with a sour cherry originating in Europe (brought over by settlers) by the name of *Prunus cerasus.* Since then the development has continued by incorporations of other cherries and by the use of dwarfing root stalks. The advantage of the dwarfing root stalk is that it forces earlier fruiting from the plant and it also creates a more workable tree when harvesting, for both manual and mechanical pickers. Dwarf sour cherries constitute a very typical "cherry pie filling" cherry.

Figure 1: a) dwarf sour cherries (photo credit); b) haskap berries (photo credit).

The haskap berry was introduced to Canada around 1967 and now grows across the country, thanks to new varieties developed by the University of Saskatchewan Fruit Program. The berries are similar in tast and texture blueberry, with a tartness closer to raspberry. The tartness makes them excellent for baking. Haskap plants attract fewer pests than many other prairie fruit crops and require little maintenance. Further, the crop thrives in cold climates, making it a natural fit for the Canadian prairies. Haskap is one of the first berries to ripen, and pickers can enjoy the berry beginning in the mid-June.

Birds are a problem for both fruits and appropriate measures must be taken to prevent the loss of berries.

Results
A bird net was erected over the sour cherry and haskap plants in late 2019, resulting in much higher yield results for haskaps in 2020. Sour cherries tend to yield more biennially (that is, yield are higher every other year), so 2020 was a lower year than 2019. A comparative chart below shows successive yields since 2016.

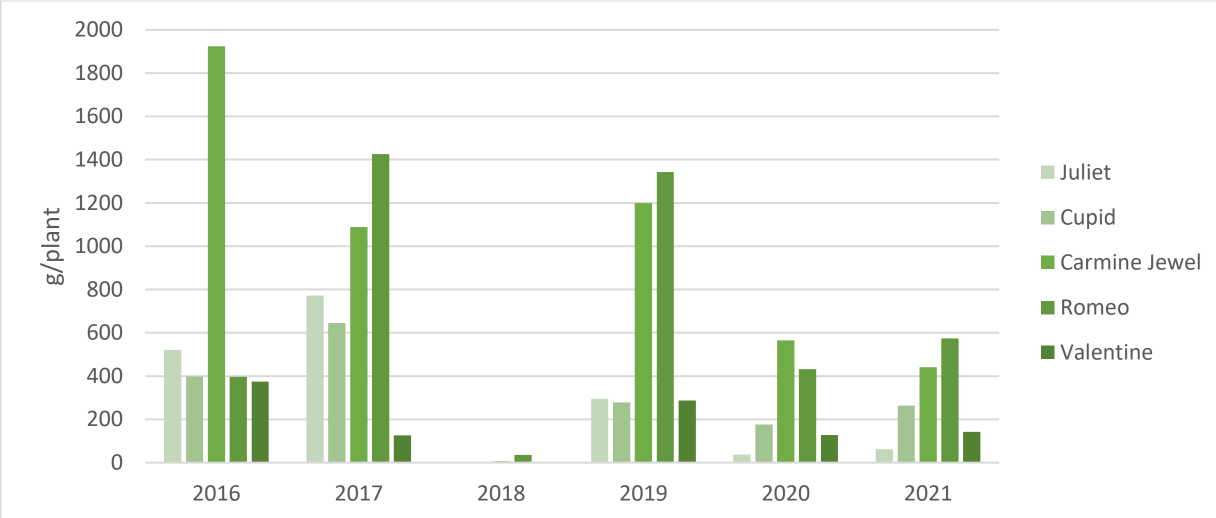

Figure 1: Roblin Sour Cherry Performance 2016-2021 (lb/plant)

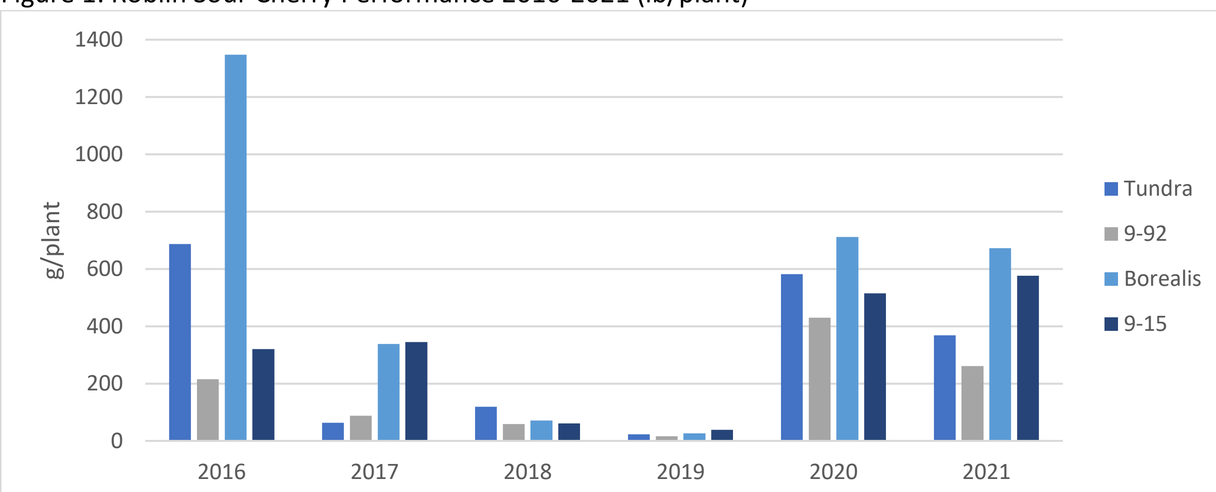

Figure 2: Roblin Haskap Performance 2016-2021 (lb/plant)

Materials and methods

Entries:	4 Haskap varieties; 5 Dwarf Sour Cherry varieties
Agronomic info	
Soil Type:	Erickson Loam Clay
Landscape:	Rolling with trees to the east
Planted:	Jun 2009
Fertilized:	Spring 2021
Pruned:	Spring 2019

Table 1: Dwarf Sour Cherry and Haskap Varieties

Haskap	Cherry
Borealis	Valentine
Tundra	Romeo
9-92	Juliet
9-15	Carmine Jewel
	Cupid

PCDF

Parkland Crop Diversification Foundation

Manitoba's diversification centres are funded in part by the Canadian Agricultural Partnership.

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