PCDF

Parkland Crop Diversification Foundation

2023 ANNUAL REPORT

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Introduction

The Parkland Crop Diversification Foundation (PCDF) is located in Roblin, in the Parkland region of Manitoba and has a close liaison with Manitoba Agriculture. PCDF works alongside three other Diversification Centres in the province: Manitoba Horticulture Productivity Enhancement Centre (MHPEC) in Carberry, Prairies East Sustainability Agricultural Initiative (PESAI) in Arborg, and Westman Agricultural Diversification Organization (WADO) in Melita.

The Parkland Crop Diversification Foundation owes its success to excellent cooperation with ARD, the PCDF board of directors and staff, producers, industry, and cooperating research institutions.

The 2022 season was full of hard work and dedication from the staff to execute all the research activities that came with an ambitious project list. A thank you goes out to James Frey and all the staff: Jessica Frey, Brooklyn Bartel, Sara Marzoff and Ella Marzoff. In addition to our regular staff, PCDF was able to host an intern named Brieuc Laloux from the *École superieure des agricultures* in Angers, France. He worked with PCDF from early June through to mid-August.

Funding is essential for the Parkland Crop Diversification Foundation'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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Crop Development Centre
Ducks Unlimited
FP Genetics
Linseed Coop
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Manitoba Crop Variety Evaluation Team
Manitoba Diversification Centres
Manitoba Crop Alliance
Parkland Coop
Pepsi-co/Quaker Oats
Saskatchewan Pulse Growers
Saskatchewan Variety Performance Group
University of Alberta
University of Manitoba
University of Saskatchewan
Verve Seed Solutions

Meteorological Data

Table 1: Roblin 2023 Season Report by Month (based on 30-year average)

Month	**Precipitation**		**Corn Heat Units**		**Growing Degree Days**	
	Actual	Normal	Actual	Normal	Actual	Normal
April	15	24	14	33	2	7
May	6	45	469	321	279	172
Jun	58	73	662	530	413	314
Jul	26	71	540	645	331	392
Aug	59	56	600	587	371	354
Sep	15	53	482	292	287	163
Oct	40	26	118	42	70	11

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

Table 2: Roblin 2023 Season Summary April 1 – October 31

	Actual	**Normal**	**% of Normal**
Number of Days	214	-	-
Growing Degree Days	1757	1415	124
Corn Heat Units	2888	2452	118
Total Precipitation	22	350	63

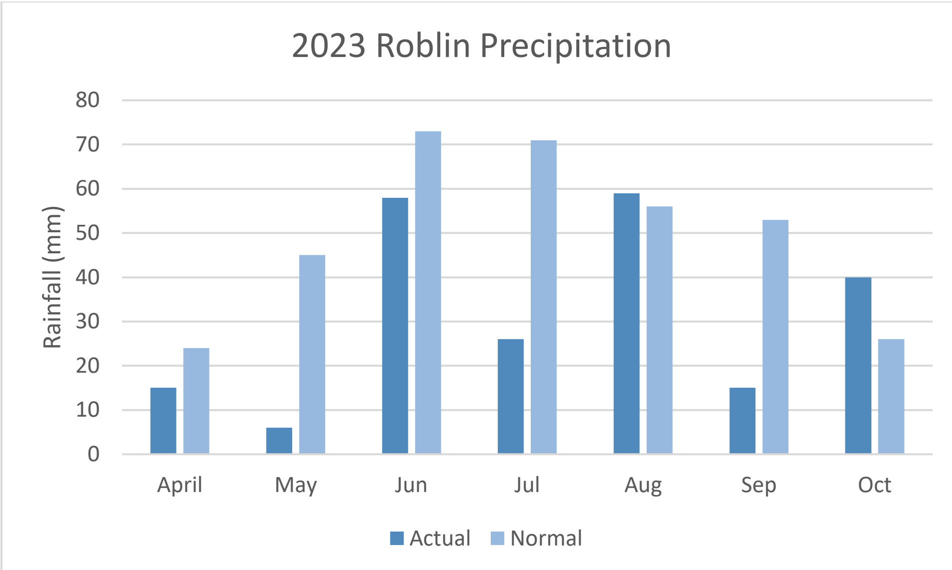


Figure 1: Roblin 2023 Precipitation by Month April – October

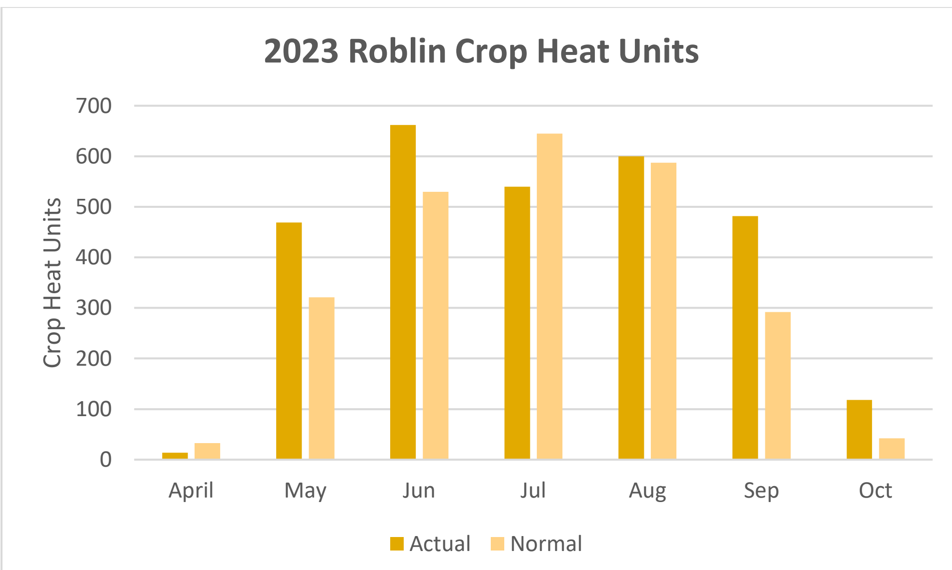


Figure 2: Roblin 2022 Crop Heat Units by Month April-October

Extension Activities

Table 3: PCDF 2023 Extension Activities

Name	Medium	Date	Location
Ag Days	Diversification Centre Booth	Jan 16-18	Brandon
Crop Connect	Diversification Centre Booth	Feb 14-15	Winnipeg
Crop Diagnostic School	Guest Speaker James Frey	Jul 12	Carman
WADO Field Day	Guest Speaker Jessica Frey	Jul 19	Melita
PCDF Field Day	Site Tour	Aug 2	Roblin
MCDC Field Day	Guest Speaker James Frey	Aug 9	Carberry
Manitoba Agronomist Conference	Poster Presentation James Frey	Dec 15	Winnipeg
Manitoba Agronomist Conference	Poster Presentation Jessica Frey	Dec 14-15	Winnipeg

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

Table 4: Summary of 2023 PCDF Trials

Crop Type	Collaborators	Purpose	# Plots
Barley	Saskatchewan Variety Performance Group	2-row barley variety trial	93
Canola	University of Manitoba	Measure NO_2 emissions from different rates and forms of nitrogen fertilizer	28
	Verve Seed Solutions	Variety trial	48
Fababean	Saskatchewan Pulse Growers	White and coloured variety evaluation	36
	University of Saskatchewan	Low tannin fababean variety evaluation	30
	University of Saskatchewan	Tannin fababean variety evaluation	21
Flax	Linseed Coop	Variety trial	36
	Manitoba Crop Alliance	Seed treatment	32
Forage	Ducks Unlimited	Hay establishment evaluation to determine best practices	54
	Ducks Unlimited	“Living Library” forage demonstration	58
Fruit	PCDF	Sour cherry and haskap	10
Hemp	Verve Seed Solutions	Seed treatment	48
	Verve Seed Solutions	Hybrid hemp variety trial	64
Hops	PCDF	Variety evaluation	24
Intercropping	University of Manitoba	Establishment of an annual grain crop with a living mulch	32

	University of Manitoba	Corn intercrop with forages for late-season grazing of livestock	20
	PCDF	Corn intercrop with forages to demonstrate late-season grazing of livestock	N/A
	PCDF	Pea-chicory-winter wheat intercrop	18
	PCDF	Barley stubble with clover cover (Year 2)	20
	PCDF	Canola stubble with clover cover (Year 2)	20
	PCDF	Oat stubble with clover cover (Year 2)	20
	PCDF	Wheat stubble with clover cover (Year 2)	20
Oats	Murphy et al.	Variety trial	144
	Murphy et al.	Variety trial	72
	Saskatchewan Variety Performance Group	Variety trial	33
	Quaker Oats	Variety trial	80
	University of Saskatchewan	Variety trial	108
	University of Saskatchewan	Variety trial	24
Peas	FP Genetics	Variety trial (1)	69
	FP Genetics	Variety trial (2)	72
	Assiniboine Community College & Manitoba Pulse and Soybean Growers	Comparative fungicide efficacy testing for managing mycosphaerella blight and white mould in peas	24
	Manitoba Pulse and Soybean Growers	Pea seed treatment	16
	Saskatchewan Pulse Growers	Variety trial	72
	University of Manitoba	Evaluation of impact of stubble, tillage, and phosphorus on pea production (Year 2)	48
Quinoa	Phillex	Variety trial	18
Soybean	Saskatchewan Pulse Growers	Long-season variety trial	60
	Saskatchewan Pulse Growers	Short-season variety trial	66
Spring wheat	Parkland Coop	Variety trial	63
	Saskatchewan Variety Performance Group	Variety trial (A)	117
	Saskatchewan Variety Performance Group	Variety trial (B)	42
Teff	PCDF	Intercrop for grain and forage	16
	PCDF	Variety Trial for grain and forage	24
	PCDF	Nursery	6
	PCDF	Seeding date for grain and forage	40
	PCDF	Seeding rate for grain and forage	40
	PCDF	Herbicide	24
Winter wheat	Ducks Unlimited	Evaluate management practices for high yielding winter wheat	42
Total plots			**2052**

Manitoba Crop Variety Evaluation Trials

In addition to the trials presented in Table 5, PCDF participated in the Manitoba Crop Variety Evaluation Trials (MCVET) to evaluate winter wheat, fall rye, oat, barley, fababean, pea, forage, and flax. A summary of the trials is provided in Table 4. Annual results are included in the *Seed Manitoba Guide*, which can be found online. The results for PCDF are listed under "Roblin".

Table 5: 2023 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	Millet	May 11	123-10-0	Axial @ 500 ml/ac + Basagran @910 ml/ac on June 19 Lagon @ 225 ml/ac on June 28	Sep 2	48
Oats	Millet	May 9	65-10-0	Banvel II @117 ml/ac on June 19	Sep 8	30
Flax and Linseed	Millet	May 12	102-10-0	Clethodim @ 150 ml/ac + Basagran @ 710 ml/ac on June 15	Oct 24	36
Fababean	Millet	May 9	0-20-0	Basagran Forte @ 910 ml/ac + Assure II @ 300 ml/ac on June 23	Sep 29	51
Fall Rye	Millet	Sep 13	102-15-0	None	Aug 25	21
Forage	Millet	May 19	40-20-0	None	Aug 12 and Sep 18	42
Peas	Millet	May 8	0-20-0	On June 15: Clethodim @ 150 ml/ac + Basagran @710 ml/ac + Viper ADV @ 400 ml/ac + UAN 28% @ 810 ml/ac On June 23: Basagran Forte @ 910 ml/ac + Assure II @ 300 ml/ac	Aug 14	54
Winter Wheat		Sep	102-15-0	None	Aug 25	21
Total plots						**303**

As with any agricultural operation, unforeseeable circumstances result in changes to plans. Table 6 summarizes the trials that were discontinued at PCDF.

Table 6: 2023 Discontinued Trials

Crop Type	Collaborators	Purpose	Number of Plots
Corn Grazing Intercrop	University of Manitoba	Prairie-wide corn intercropping trial	35
Corn Grazing Demonstration	PCDF	Demonstrate corn intercrops for late-season grazing of livestock	N/A
Hemp	Canadian Hemp Trade Alliance	Variety Trial	40
Pea-Winter Wheat Intercrop	PCDF	Evaluate intercropping potential for peas and winter wheat	18
Wheat-Phacelia Intercrop	PCDF	Field Trial	20
Total plots			**113**

- The corn intercrop trial with the University of Manitoba was seeded at PCDF on May 16. The trial was terminated due to poor emergence and damage by cutworms. 2023 was the final year of the project. PCDF has plans to explore the concepts of that trial through a corn intercrop grazing demonstration in 2024.
- Funding for the National Hemp Variety Trials with the Canadian Hemp Trade Alliance was reconfigured in 2023, resulting in the trials being cancelled for the growing season. Funding is expected to be in place for 2024.
- The pea-winter wheat intercropping trial was discontinued close to harvest due to high weed pressure. However, visual observations, combined with the successful harvest of the crop for the pea-winter wheat demonstration suggests that the intercrop can be successful.
- The wheat-phacelia intercropping trial, sponsored by PCDF, was cancelled before planting due to limitations of time.

Table 7: 2023 Private Collaborator Trials

Crop Type	**Collaborators**
Canola	Verve Seed Solutions
Peas	FP Genetics
Hemp	Verve Seed Solutions
Oats	Pepsi-Co/Quaker Oats
Oats	Murphy et al, Inc

Table 8: 2023 Disease and Insect Monitoring Activities

Crop Type	**Collaborator**	**Purpose**
Spring wheat	PCDF and Midge Busters	Assess wheat midge population in three producer fields
Spring wheat, Winter wheat and Barley	University of Manitoba	Assess Fusarium Head Blight occurrence and severity

Table 6: 2023 Demonstrations

Saltlander	PCDF
Intermediate Wheatgrass	PCDF
Teff hay	Lyle Chase, Roblin
Teff grain	PCDF
Living Library forage demo	Manitoba Beef and Forage Initiatives, Brookdale Farm and 1st Street Pasture

Agronomic Trials

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

Adapted from a report written by Brodie Erb

Project Duration: 2020 – 2023

Objectives: To study the effect of preceding crop, residue management and starter-P placement on field pea yield and other important agronomic factors.

Collaborators: Soybean and Pulse Agronomy Lab (U of M), Parkland Crop Diversification Foundation

Background:
Field pea (*Pisium sativum*) cultivation in Manitoba, dating back to 1908, reached its peak in 1998 at over 260,000 acres. Recent years have witnessed a resurgence, driven by initiatives like Protein Industries Canada and the growing global pea protein market. Despite this, management practices lack standardization, and an increased interest warrants a research focus on agronomic practices. Comparing tilled versus direct-seed wheat or canola stubble, with variations in P application, the research aims to establish best practices. Hypotheses include the potential benefits of wheat preceding peas, the possible advantage of direct seeding, and the impact of starter P applications. Addressing gaps in local knowledge, this research seeks to optimize field pea production in Manitoba, contributing to sustainable and efficient agricultural practices.

Preliminary Findings:

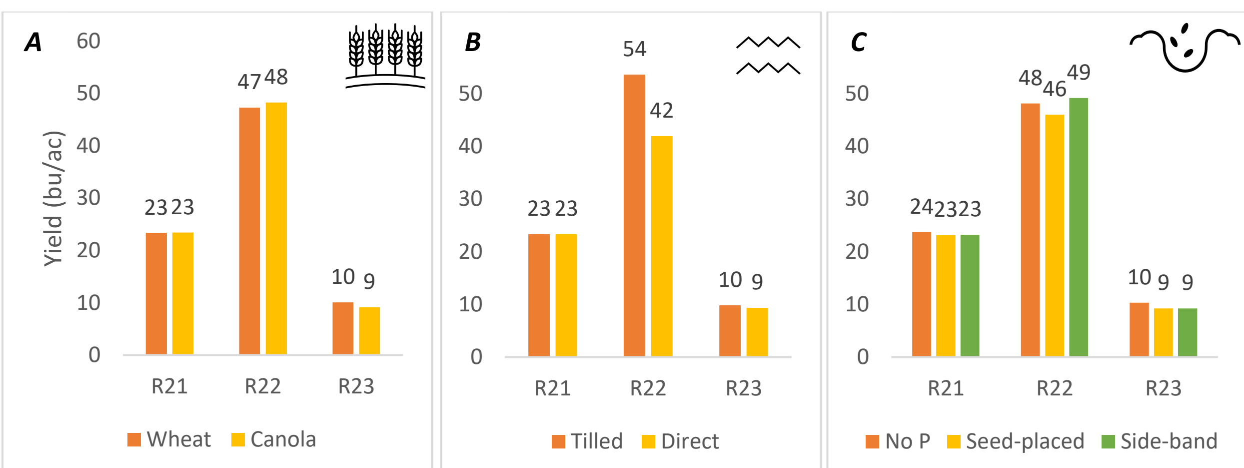


Figure 1. *Yield (bu/ac) comparisons of field pea at Roblin for each factor: (A) preceding residue, (B) residue management, and (C) starter-P placement. Only one significant effect was observed amongst factor levels and no significant interactions were observed. Residue management at Roblin 2022 was significant where peas grown in tilled plots yielded on average 12 bu/ac higher than direct-seeded peas. Further analysis needs to be done looking at environmental effects of this year.*

Materials & Methods:
This experiment was performed at the Ian N. Morrison Research Farm (INMRF) in Carman, MB (49.50106, -98.02822) and the Parkland Crop Diversification Foundation (PCDF) in Roblin, MB (51.18268, -101.36249) in 2020-21, 2021-22 and 2022-23 (6 site years in total). Each experiment examined the (1) preceding crop (2 levels - wheat, canola), (2) residue management/tillage strategy (2 levels – direct seeded, tilled), and (3) starter-P (MAP) placement (3 levels – none, seed-placed, side-banded) in field pea production. The experimental design was a 3-way factorial arrangement (Table 1) of a randomized complete block design (RCBD) with 12 treatments (2x2x3) replicated four times.

Table 1. *Treatment factors and levels.*

Trt	Preceding Crop	Residue MGMT	Starter-P Placement
1	Wheat	Tilled	None
2	Wheat	Tilled	Seed-placed
3	Wheat	Tilled	Side-banded
4	Wheat	Direct	None
5	Wheat	Direct	Seed-placed
6	Wheat	Direct	Side-banded
7	Canola	Tilled	None
8	Canola	Tilled	Seed-placed
9	Canola	Tilled	Side-banded
10	Canola	Direct	None
11	Canola	Direct	Seed-placed
12	Canola	Direct	Side-banded

Table 2. *Site characteristics.*

Soil textural class	Clay loam
Mean daily temperature*	15.3-16.5°C (14.1°C)**
Mean precipitation*	150-345mm (273 mm)**
Soil phosphorus (ppm)	37-39
Soil pH	7.6

*May – August
**Long term average

Each site-year included two growing seasons. The first year was seeded to either wheat (344 seeds/m^2) or canola (108 seeds/m^2) with both crops receiving 40 lb/ac P_2O_5 (crop removal rate) and managed as a commercial crop in a manner that would be typical for the area. Tilled plots were cultivated using a rototiller either in fall or spring prior to pea planting. In year two, AAC Carver field peas (100 seeds/m2) were planted between April 20 and May 10 using a Monoseed GP Planter (7.5” spacing) in Carman and a Fabro disc drill (9.4” spacing) in Roblin. Starter-P application was 15 lbs P_2O_5/ac as monoammonium phosphate and was either seed-placed or banded 2” away from the seed row. Throughout the growing season and post-harvest the following measurements were collected:

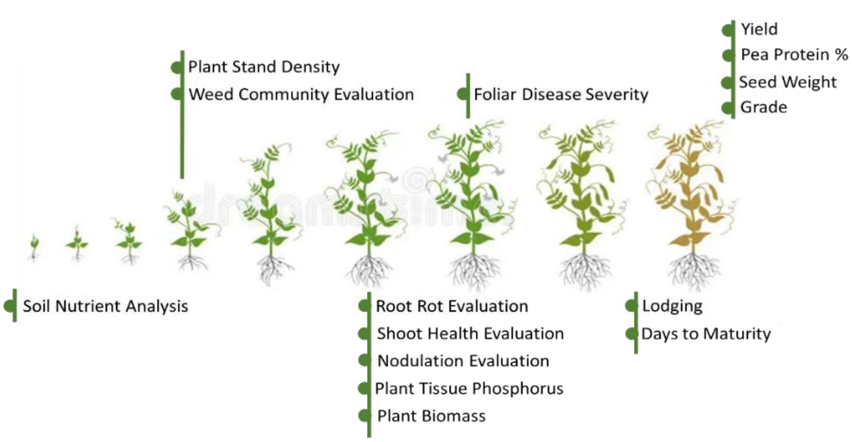


Figure 2. *Experimental ratings and measurements of field peas throughout the growing season.*

Preliminary data was analyzed in R using a two-way ANOVA followed by Tukey HSD post-hoc tests. Shapiro-Wilk normality test and Bartlett's test were used to confirm normality and homogeneity respectively. Preceding crop, residue management and placement were fixed effects and blocking analyzed as a random effect.

Experimental Design: Rectangular Lattice
Treatments: 12
Varieties: Wheat – AAC Brandon; Canola – L233P

Table 3. *Seeding and Harvest Information*

	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
Site 2 (Year 2)	May 16, 2022	Aug 31, 2022
Site 3 (Year 1)	May 27, 2022	Oct 5, 2022
Site 3 (Year 2)	May 15, 2023	Aug 28, 2023

Agronomic information
Previous year's crop: Barley silage (2020); Oat Silage (2021), Canola (2022)
Soil Type: Erickson Clay Loam
Landscape: Rolling with trees to the east
Seedbed preparation: Tilled or direct-seeded, depending on the treatment

Table 4. *Data collection*

Data collected	Date collected					
	Site 1 (Year 1)	Site 1 (Year 2)	Site 2 (Year 1)	Site2 (Year 2)	Site 3 (Year 1)	Site 3 (Year 2)
Plant density	Jun 16	Jun 16	Jun 16	Jun 13	Jun 23	May 29
Disease risk at wheat flag leaf	Jun 24	-	Jun 6-15	-	Jun 30	June 28
Pea Root Rot Rating	-	Jun 16	-	Jun 16	-	Jun 20
Pea Shoot Symptoms Rating	-	Jul 6	-	Jun 16	-	Jun 20
Mycosphaerella Blight Rating	-	Jun 16	-	Jul 20	-	Jun 28
Disease risk at canola anthesis (20-50% bloom)	Jul 8-15	-	Jul 2	-	Jul 15-18	-
Days to Maturity Rating	-	Beginning of August	-	Beginning of August	-	Beginning of August
Height	Aug 15	-	early Aug	-	Early Aug	-
Lodging	Aug 15	Aug 18	Sep 20	Aug 29	-	Aug 28

Funding partners
Manitoba Pulse and Soybean Growers (MPSG), Sustainable Canadian Agricultural Partnership

Barley

SVPG 2-Row Barley Variety Trial and Western Canadian Malt Barley Field Trial

Project duration: May 2023 – August 2023
Objectives: Evaluate 2-row barley varieties for the Saskatchewan Variety Performance Group
Collaborators: Steve Piche and Sara Tetland, Saskatchewan Agriculture
Canadian Malt Barley Technical Centre

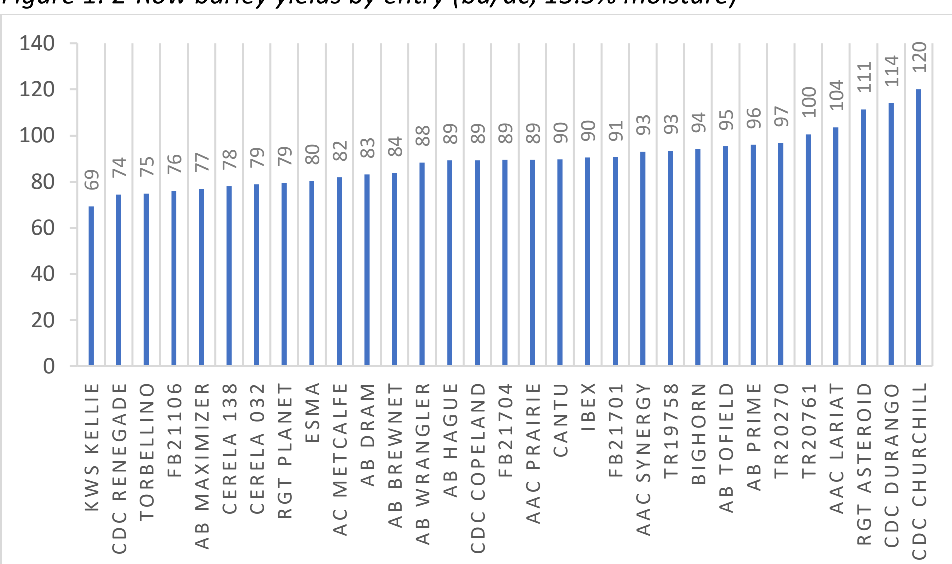
Background
The Saskatchewan Variety Performance Group (SVPG) conducts variety trials for 2-row barley to evaluate important varieties. Find the Saskatchewan Seed Guide here. The SVPG collaborates with the Canadian Malt Barley Technical Centre (CMBCT) to evaluate lines of malt barley. The CMBCT has released annual reports to summarize the results for malt barley entries, including quality overviews and lists of recommended varieties.

Results
Malt barley varieties were sent to the Canadian Malting Barley Technical Centre for analysis. Malt varieties included:

- CDC Churchill
- AAC Synergy
- AB Dram
- AAC Prairie
- CDC Copeland
- AB BrewNet
- AC Metcalfe

The barley was harvested at around 18% moisture, which was the target moisture recommended by CMBTC for the malt entries. All entries were put on air to dry before subsampling and storage. The yield results (bu/ac) for the Roblin site are shown in Figure 1.

Figure 1: 2-Row barley yields by entry (bu/ac, 13.5% moisture)



Materials and methods

Experimental Design:	Random Complete Block Design
Entries:	31 varieties
Seeding:	May 11
Harvest:	Aug 28

Agronomic information

Previous year's crop:	Millet
Soil Type:	Erickson Clay Loam
Landscape:	Rolling with trees to the east
Seedbed preparation:	Direct seeded

Table 2: Fertility Information

	Available	Added (actual)	Type
N	66 lb/ac	123 lb/ac	46-0-0
P	48 ppm	10 lb/ac	11-52-0-0
K	194 ppm	-	-

P banded with seed; N side-banded

Table 3: Spraying Information

Crop stage	Date	Product	Rate	
Pre-emerge	May 12	Glyphosate	640	ml/ac
		Authority	118	ml/ac
In-crop	Jun 19	Axial	500	ml/ac
		Basagran	910	ml/ac

Forages

Ducks Unlimited Hay Establishment Evaluation

Project Duration: June 2023 – October 2024

Objectives: To evaluate the establishment of a hay crop with different rates of phosphorous and an oat nurse crop.

Collaborators: Ducks Unlimited Canada

Background

When establishing a perennial forage crop, a common practice is to plant it with a cereal "nurse crop", such as oats or barley. The nurse crop is typically cut for greenfeed mid-summer, after which the perennial forage grows with full access to sunlight, water, and soil nutrients. Alternatively, the nurse crop may be harvested for grain, often used to feed livestock. The benefit of these practices to producers is to provide a harvestable crop in the year of establishment, even when the nurse crop is seeded at a reduced rate, as compared to normal seeding rates for greenfeed or feed grain.

Nevertheless, observations by staff at Ducks Unlimited Canada suggest that the use of a nurse crop can have a negative impact on the perennial forage crop, leading to reduced hay yields in Year 2. Although this effect may be less pronounced for oats than for barley (which can be highly competitive against other crops), observations suggest that establishing a perennial forage without a nurse crop will result in a better stand, leading to higher forage yields in Year 2 and beyond.

The current study was initiated to examine the effect of a nurse crop on perennial forage establishment, as well as to examine the effect of using starter phosphorous. Where present, the oat grain was combined in mid-October. Performance data will be collected in Year 2, especially forage yield.

Materials and Methods

The hay seed was provided by Ducks Unlimited Canada and is an alfalfa-brome-timothy mix. The oat nurse crop was Haymaker, a tall variety with wide leaves and large seed size. This variety was used with the expectation that the "quarter rate" oat nurse crop would be cut for greenfeed. However, due to delays in cutting the treatment, a decision was made to harvest all the oats for grain at maturity.

Table 1: 2023 materials and methods.

Overview	
Design	RCBD
Entries	18 (see Table 2)
Reps	4
Harvest area	19.2 m2
Target Fertility	N: No added (available in soil = 57 lb/ac) P: See Table 2
Seeding rate	See Table 2
Seeding date	June 15
Seeding depth	1/2-inch into adequate moisture
Preparation	Glyphosate (0.64 L/ac, May 26); tillage (June 7 and June 15)
Grain harvest date	Oct 19

Table 2: Treatments

Treatment	Rate
Nurse crop (Haymaker oat)	2 bu (full rate)
	0.5 bu (quarter rate)
	None
Hay mix (alfalfa-brome-timothy)	8 lb/ac
	12 lb/ac
	15 lb/ac
Phosphate (seed-placed)	No added
	25 lb/ac
Number of hay cuts (Year 2)	One
	Two

Observations

Timely rains in late June resulted in good growing conditions for all treatments. In general, hay mix-only treatments established well and competed adequately with any weeds that were present. Treatments with oats resulted in vigorous growth for oats, with varying levels of growth for the hay crops. The treatment with a full rate of oats and 8 lb/ac of hay mix showed the least growth for hay crops.

Figure 1: (left) Hay mix at 15 lb/ac without oats; (right) hay mix at 8 lb/ac with a full rate of oats.

Figure 2: (left) 12 lb/ac hay mix with full rate of oats; and (right) 8 lb/ac hay mix with quarter rate of oats

Discussion

The preliminary observations from the 2023 growing season suggest that the plots that were established without an oat nurse crop achieved better growth, which likely means that those plots will produce more vigorous growth in 2024. The data that will be gathered in 2024, especially plot yield, will be used to develop best management practices that can be shared with producers.

Agronomic information

Previous year's crop:	Millet
Soil Type:	Erickson Clay Loam
Landscape:	Rolling with trees to the east

Fertility Information

	Available		Added (actual)
N	66	lb/ac	None
P	48	ppm	According to treatment
K	194	ppm	None

Ducks Unlimited Living Library Demonstration

Project Duration: June 2023 – October 2025

Objectives: To demonstrate perennial forages.

Collaborators: Ducks Unlimited Canada, Manitoba Beef and Forage Initiatives

Background

Perennial forage species abound, providing farmers with a wealth of options to produce high quality feed for livestock. The Living Library was established to demonstrate several dozen unique species of grasses and legumes, as well as native species and commercially available blends. Also included in the demonstration are nine entries intended to demonstrate the effect of different agronomic practices on hay establishment. In total, the demonstration comprises 56 entries.

Materials and Methods

The plots were seeded with a small-plot seeder and mowed during the growing season to control weeds.

Table 1: 2023 materials and methods.

Design	Demonstration
Entries	56 (see Table 2)
Plot area	24.0 m2
Target Fertility	N: No added (available in soil = 38 lb/ac) P: 20 lb/ac (placed with seed)
Seeding rate	See Table 2
Seeding date	June 15
Seeding depth	1/2-inch into adequate moisture
Preparation	Glyphosate (0.64 L/ac, May 26); tillage (June 7 and June 15)

Table 2: Entries by type with seeding rates

Name	Rate (lb/ac)
Grasses	
AC Killarney Orchardgrass	7
Boreal Creeping Red Fescue	5
Carlton Smooth Brome	12
Creeping Foxtail	17
Creeping Red Fescue	5
Crested Wheatgrass	12
Eschelon Orchard grass	12
Fleet Brome	12
Hybrid Brome	12
Hybrid Brome	20
Intermediate Wheatgrass	5
Kentucky Blue	6
Mahulena Festulolium	20
Meadow Fescue	12
Pubescent Wheatgrass	18

Russian Wildrye	8
Saltlander	5
Saltlander + Green Wheatgrass	5
Tall Fescue Rough	18
Tall Fescue Satin	8
Tall Wheatgrass	12
Tall Wheatgrass	20
Tetrax Meadow Fescue	8
Timothy	10
Tored Meadow Fescue	12
Valerio Perennial Ryegrass	8
Legumes	
Ace Alfalfa tap root variety	12
Alsike Clover	5
Birdsfoot Trefoil	8
Exceed Alfalfa - Branch Root	12
Foothold Alfalfa creeping root variety	12
Red Clover	8
Revolution Alfalfa - low lignin/tap root	12
Sainfoin	20
Torrent Alfalfa	12
White Clover	5
Native species	
Blue Grama	10
Canada Milkvetch	10
Purple Prairie Clover	10
Side-oats Grama	10
Slender Wheatgrass	10
Commercial Blends	
#1 Super Hay Blend	12
#11 Super Grassland Pasture Blend	12
#20 Super Pasture Hay Dual Purpose Blend	12
Exceed Alfalfa & AC Knowlges HB	13
Premium Hay Max	10
Agronomic Blends	
DUC MAP* (+58 lb/ac P)	15
DUC RLCP** (no oats, no added P)	12
DUC RLCP (no oats, +58 lb/ac P)	12
DUC RLCP (+0.5 bu/ac oat, no added P)	12
DUC RLCP (+0.5 bu/ac oats, +58 lb/ac P)	12
DUC RLCP (+2.0 bu/ac oat, no added P)	12
DUC RLCP (+2.0 bu/ac oat, +58 lb/ac P)	12
DUC RLCP (no added P)	15
DUC RLCP (+58 lb/ac P)	15

** Marginal Areas Program*

*** Revolving Lands Conservation Program*

Discussion

The plots appeared to establish well, despite the relatively hot and dry conditions at seeding. As this is the establishment year, there are no results to be shared at this time. The Living Library is situated in a prominent location near the entrance to the field site, where the plots will provide extension opportunities in the coming years. Outputs of the demonstration will likely include field workshops and videos highlighting the characteristics of different forages and blends. The Living Library will be used in tandem with the Hay Establishment trial, also grown in collaboration with Ducks Unlimited Canada (DUC), to share information with producers on best management practices for forage species.

PCDF collaborated with Manitoba Beef and Forage Initiatives (MBFI) to seed two Living Library demonstrations at the Brookdale Farm and the 1st Street Pasture. MBFI will use these sites to share information with producers and may collaborate with PCDF and DUC to produce informational videos.

Agronomic information

Previous year's crop:	Organic spring wheat
Soil Type:	Erickson Clay Loam
Landscape:	Rolling with trees to the east
Seedbed preparation:	Tillage, heavy harrow

Teff Intercrop Evaluation for Grain and Forage

Project Duration: May – October 2023

Objectives: To evaluate the potential to intercrop teff with barley, millet, oats, and wheat for grain and forage production

Collaborators: PCDF

Background

Teff *(Eragrostis tef)* is a warm-season annual grass that originates in northeast Africa, where it is grown for grain and forage production. The grain is very small, about the size of a poppy seed, with approximately 1.2 million seeds per pound (2.6 million seeds per kilogram). The flour is used to produce a traditional flatbread called *injera*, which is naturally gluten-free. As a forage, the crop is notable for its high protein content and palatability, as well as its potential for high yields. For a detailed examination of teff forage nitrogen and irrigation requirements, see this Pacific Northwest Extension Publication.

This report presents the yield results for grain and forage when grown with barley, millet, oats, and wheat. The trial builds on small-plot trials that were conducted in Roblin in 2021-2022, and in Arborg in 2022. In brief, total forage yields for those trials did not differ significantly by seeding rate. Grain yields (at Roblin only) did not differ by seeding rate, but yielded significantly less if the teff was cut for hay in mid-season than if the grain was allowed to reach full maturity without being cut. In 2021, barley greenfeed at Roblin yielded less than the combined yield for two cuts of teff. In 2022, barley greenfeed yields were higher than combined teff yields at both Roblin and Arborg.

Figure 1: (a) Forage intercrop plots, July 28; (b) grain intercrop plots, Aug 17.

Figure 2: Teff intercrops for grain (from left) with barley, oats, and wheat (Sept 18).

Figure 3: Teff intercrop grain samples before cleaning (from left) with barley, oats, and wheat.

Figure 4: Teff intercrops for forage (from left) with barley and oats (Aug 15) and millet (Aug 30).

Figure 5: Teff-oat regrowth (left, Oct 17), teff-only (centre, Nov 1), and teff-oat (right, Nov 1).

Table 1: 2023 materials and methods.

Overview	
Design	RCBD
Reps	4
Treatments	
Grain	Teff only Teff-barley (Austenson) Teff-oats (Summit) Teff-wheat (Landmark)
Forage	Teff only Teff-barley (Maverick) Teff-oats (Haymaker) Teff-millet (Japanese)
Harvest area	8.0 m2
Target N	110 lb/ac
Seeding rate (lb/ac)	
Teff	5
Barley	108
Millet	25
Oats	102 (Summit), 80 (Haymaker)
Wheat	108
Seeding date	
Roblin	May 26
Number of cuts (forage plots only)	
Teff-millet	1
All other treatments	2
Harvest dates	
Grain, straw	Sept 18
Forage	Aug 15 (teff-only, teff-barley, teff-oats) Aug 30 (teff-millet) Oct 17 (2nd cut, except teff-millet)

Results

<u>Grain Yield</u>

Yields for grain plots are shown in Figure 6. For all figures, yields marked with the same letter do not differ significantly.

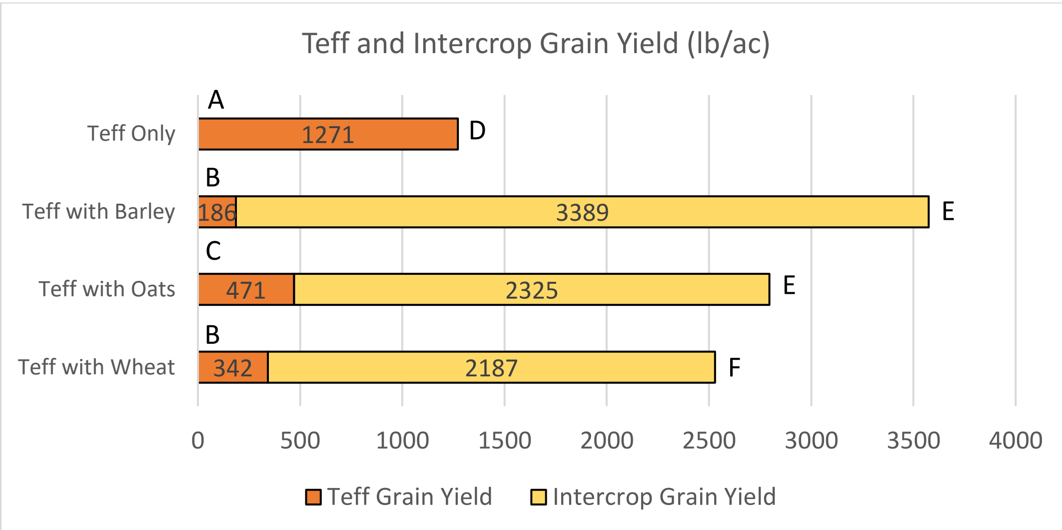


Figure 6: Grain yield (lb/ac) for teff intercrops.

<u>Hay Yield</u>

Yields for forage plots are shown in Figure 7. Teff-only, teff-barley and teff-oat were harvested on Aug 15 and measured for regrowth on Oct 17. Teff-millet was not ready for harvest until Aug 30 and did not yield a second cut. Feed values for regrowth (teff-only and teff-oat) are shown in Table 2.

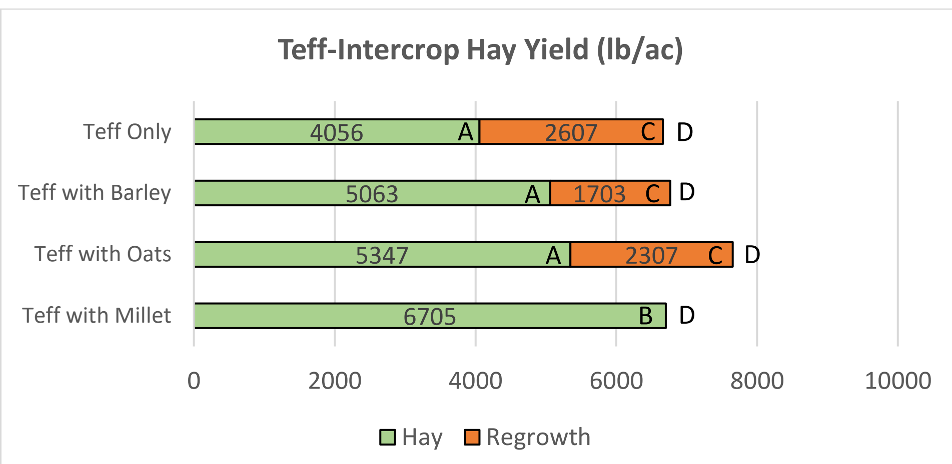


Figure 7: Hay yield (lb/ac, 15% moisture) for 1st cut and 2nd cuts by treatment.

Table 2: Feed values for regrowth

Treatment	**Protein**	**TDN**
Teff only	9.8	61.4
Teff-oat	11.0	62.6

* *Dry matter values from Central Testing Laboratory, Winnipeg*

Straw Yield

For the grain plots, straw was collected after harvest. The results are included in Figure 8. Feed values for the straw are presented in Table 3.

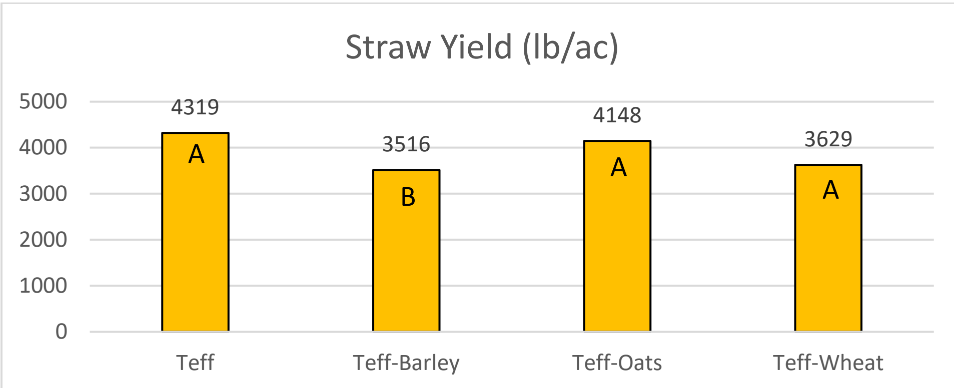


Figure 8: Straw yield (lb/ac, 15% moisture) by treatment.

Table 3: 2023 Feed values for straw

Treatment	2023*		2022*		Standard values†	
	Protein	TDN	Protein	TDN	Protein	TDN
Teff only	6.1	61.5	8.4	51.6		
Teff-barley	4.9	49.9				
Teff-oat	4.3	51.1				
Teff-wheat	5.5	52.0				
Barley only					4.9	44.0
Oat only					4.5	44.0
Wheat only					3.9	48.0

* *Dry matter values from Central Testing Laboratory, Winnipeg*

† *Saskatchewan Agriculture*

Plant Height

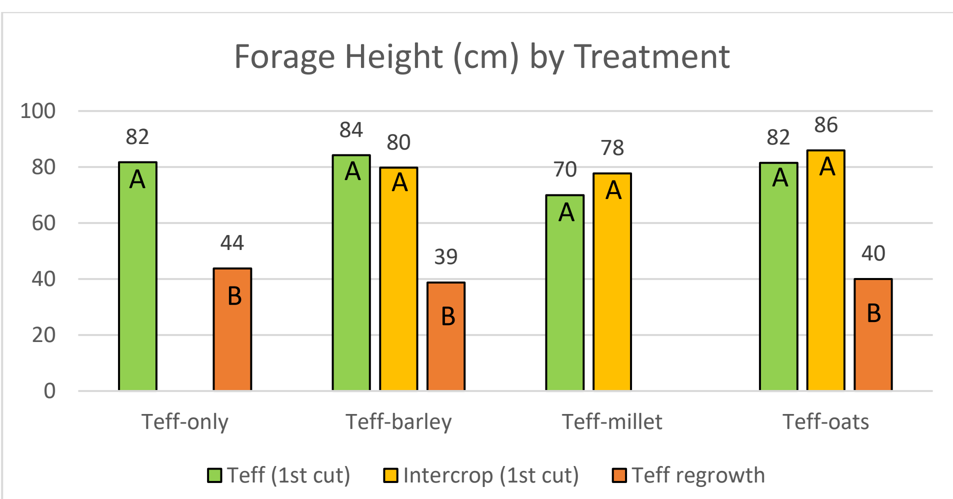


Figure 9: Forage height (cm) by treatment.

Lodging

Due to the relatively weak stem strength of teff compared to other common field crops, lodging can be a problem in teff production. The lodging ratings for grain and forage intercrops are shown in Figure 10.

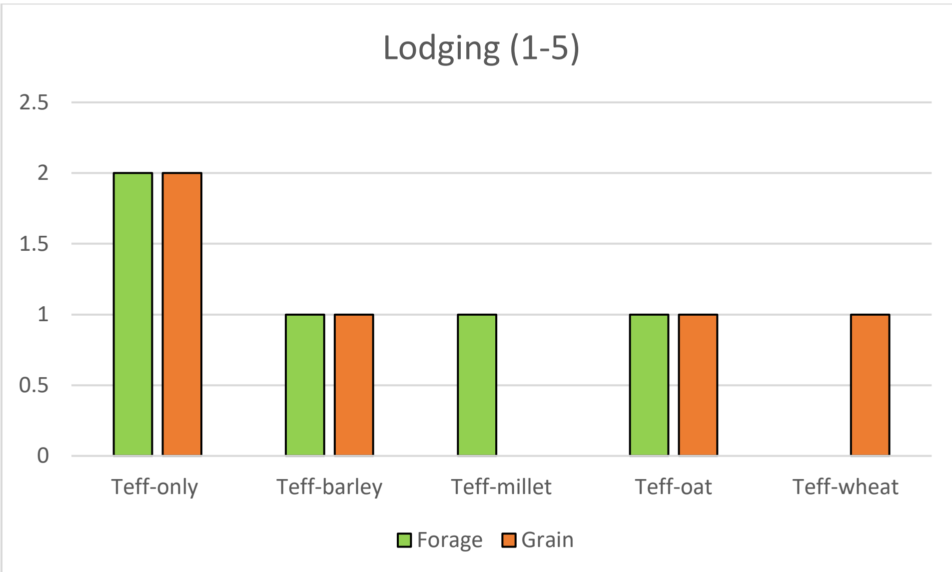


Figure 10: Lodging ratings for grain and forage intercrops (1-5; 1 = upright, 5 = flat)

Discussion

Teff seeds are 1 mm long, roughly the same size as a poppy seed. The ideal seeding depth is no more than 1/8 of an inch. Although germination usually occurs in 2-3 days, when surface soil conditions are dry, the small roots can easily dry out, resulting in poor establishment.

The relatively low grain yields for all intercrops may be attributed to a shortage of precipitation and high temperatures during the establishment period, compounded by high weed pressure from volunteer millet. Midseason precipitation and heat approached normal levels, but crop development remained delayed for the early part of this period. Table 4 provides a summary of climate conditions, expressed as percent normal, compared to the 30-year average.

Table 4. Precipitation, crop heat units and growing degree days (% normal) for key periods of plant growth.

	% Normal		
	Establishment May 15 – June 15	**Midseason June 15 – Aug 31**	**All Season April 15 – Sept 30**
Precipitation	63	94	58
Crop Heat Units	140	96	115
Growing Degree Days	151	98	120

Grain production

Teff grain production in Manitoba presents a promising opportunity. As the community of migrants from northeast Africa in North America grows, so does the demand for teff flour, which is used to produce *injera*, a staple fermented flatbread. Although milling capacity for teff exists in Manitoba, the grain is currently imported from Ethiopia. Producing teff grain in Manitoba may provide a unique opportunity to tap into pre-existing markets and infrastructure.

The results from this trial show that teff grain yield is sharply reduced by intercropping with other cereals. Teff grain yields for intercrops were significantly higher for the teff-oat treatment (471 lb/ac), with acceptably high oat yields (68 bu/ac). Whereas grain yield for barley (71 bu.ac) did not appear to be negatively affected by intercropping with teff, wheat yields were unacceptably low (36 bu/ac). Teff grain yield for both treatments was also low.

These results suggest that the crop interactions between teff and oats may be more favourable. Additionally, intercropping these crops maintains a gluten-free product, which has important economic implications.

<u>Straw</u>

In regions where teff is cultivated for grain, the straw plays an important role in livestock production. In Manitoba, cereal straw is used to provide bulk to livestock rations, especially in years when other feed sources are in short supply. Only the straw yield for teff-barley was significantly lower than for other treatments. However, protein and total digestible nutrients (TDN) were low for all treatments, especially for the teff-only treatment compared to values for other years. The comparatively lower values for that treatment may be the result of better threshing at grain harvest, reducing the quantity of seed left the feed sample (which would result in elevate protein levels in the test results).

Nevertheless, the observed feed values compare favourably with the standard values for cereal straw from Saskatchewan Agriculture (Table 2), suggesting that intercropping these cereals with teff results in straw with higher feed values.

<u>Forage production</u>

The selection of forage variety is important for intercrops. Maverick was used for the teff-barley treatment and Haymaker for the teff-oat treatment, both of which performed well. However, the Japanese millet matured slowly, and was harvested 15 days later than the other intercrops. As a result, the teff-millet treatment had no regrowth. Using a short-season millet variety may allow for an early harvest, allowing for regrowth.

Regrowth can facilitate late-season grazing with livestock, increasing the number of days that animals may remain away from the yard, and reducing the amount of feed that must be put up for winter. Additionally, feed values were high for regrowth from the teff-only and teff-oat treatments. However, nitrate levels in the material are likely high, and caution should be taken when introducing livestock to the feed.

Unfortunately, feed results for the first forage cut are not available, as they were accidentally discarded before a sample could be sent to the laboratory for analysis. Teff has been shown to have high feed values, especially protein and TDN, and it is assumed that intercropping teff with other cereals will result in better quality feed. This remains an area for future study.

<u>Plant height</u>

There were no significant differences in height between treatments or intercrops. This finding suggests that the intercrop does not affect the height of the teff crop. However, the intercrops were grown in a situation where moisture was limited; plant height might be affected if moisture was not a limiting factor.

Lodging

Crop lodging can be a major challenge for teff cultivation, whether for grain or forage. Lodging was moderate for teff-only treatments for both grain and forage, whereas there was no lodging in the intercrop treatments. This finding suggests that the intercrop acts as a support for the teff crop, preventing lodging. More research is needed to see if this finding holds true for grain intercrops when the grain yield is greater, and lodging is a greater risk.

Conclusion

The results presented here suggest that intercropping teff with other cereals can be a good strategy for grain and forage production. Teff-oat appears to be the best choice for grain production, whereas all intercrops appear to be well suited for forage production. Selection of variety appears to be an important factor for successful forage production, with earlier maturing varieties preferred, allowing for late-season regrowth.

Additional research is needed to identify the ideal fertility rates for grain production. Whereas excessive nitrogen applications are to be avoided in a teff-only scenario, the improved lodging ratings in an intercrop scenario suggest that higher rates of nitrogen may be acceptable. Increased nitrogen may improve grain yields for teff intercrops. Testing in 2024 will explore grain yield response for teff and teff with oats at fertility rates ranging from 60 to 140 lb N/ac.

Agronomic information

Previous year's crop:	Millet
Soil Type:	Erickson Clay Loam
Landscape:	Rolling with trees to the east
Seedbed preparation:	Direct seeded

Fertility Information

	Available	Added (actual)	Type
N	27 lb/ac	83 lb/ac	46-0-0
P	34 ppm	20 lb/ac	11-52-0-0
K	269 ppm	-	-

P banded with seed; N side-banded

Spraying Information

Crop stage	Date	Product	Rate
Pre-emerge	May 26	Glyphosate	910 ml/ac
In-crop	Jun 23	Banvel II	117 ml/ac

Teff Variety Nursery

Project Duration: May – October 2023

Objectives: To evaluate the tolerance of teff to select broadleaf herbicides.

Collaborators: PCDF

Background

Teff *(Eragrostis tef)* is a warm-season annual grass that originates in northeast Africa, where it is grown for grain and forage production. The grain is very small, about the size of a poppy seed, with approximately 1.2 million seeds per pound (2.6 million seeds per kilogram). The flour is used to produce a traditional flatbread called *injera*, which is naturally gluten-free. As a forage, the crop is notable for its high protein content and palatability, as well as its potential for high yields.

This report summarizes the activities to increase the seed supply of six varieties obtained from the Saskatoon Research and Development Centre (SRDC), which is part of the Canadian national gene bank information system operated by Agriculture and Agri-Food Canada. Due to limited supply, the SRDC was only able to supply approximately 100-200 seeds per variety. Consequently, the purpose of the project was to increase seed for in-field variety testing in 2024.

The varieties comprised four red and two white. Although all the varieties differ in physical characteristics and days to maturity, a more general difference can be seen in the colour of the seeds: white varieties have lighter, cream-coloured seeds, whereas the seed of red varieties ranges from brown to reddish orange. Identifying a white variety that is suitable for Manitoba growing conditions is important, as white grain is prized for its lighter taste and texture in *injera*, relative to red varieties.

Table 1: 2023 materials and methods.

Variety	CN*	Colour
Unidentified	114392	Light red
Beten	114686	White
Gea-Lamie	114687	Dark red
Tullu Nasy	114688	White
Red Dabi	114689	Dark red
Unidentified	114690	Light red

* Identifier assigned by the SRDC

Activities

The seeds were germinated in a greenhouse in early April and transplanted to the field on June 6. Due to the extremely hot and dry conditions at that time, the plants were watered for about two weeks as the roots established. Weeds were controlled by hand.

At physical maturity, the plants were cut by hand and spread on the concrete floor of the shop. When dry, all the plants for each variety were threshed by passing them through the combine, and the seed was placed on air to dry for storage.

Due to the prolific production of straw from Beten and 114392, the straw from those varieties was tested for feed value.

Figure 1: (left) the seeds of one red variety provided by the Saskatoon Research and Development Centre (with a five-cent piece for size reference); and (right) the plants before transplanting into the field.

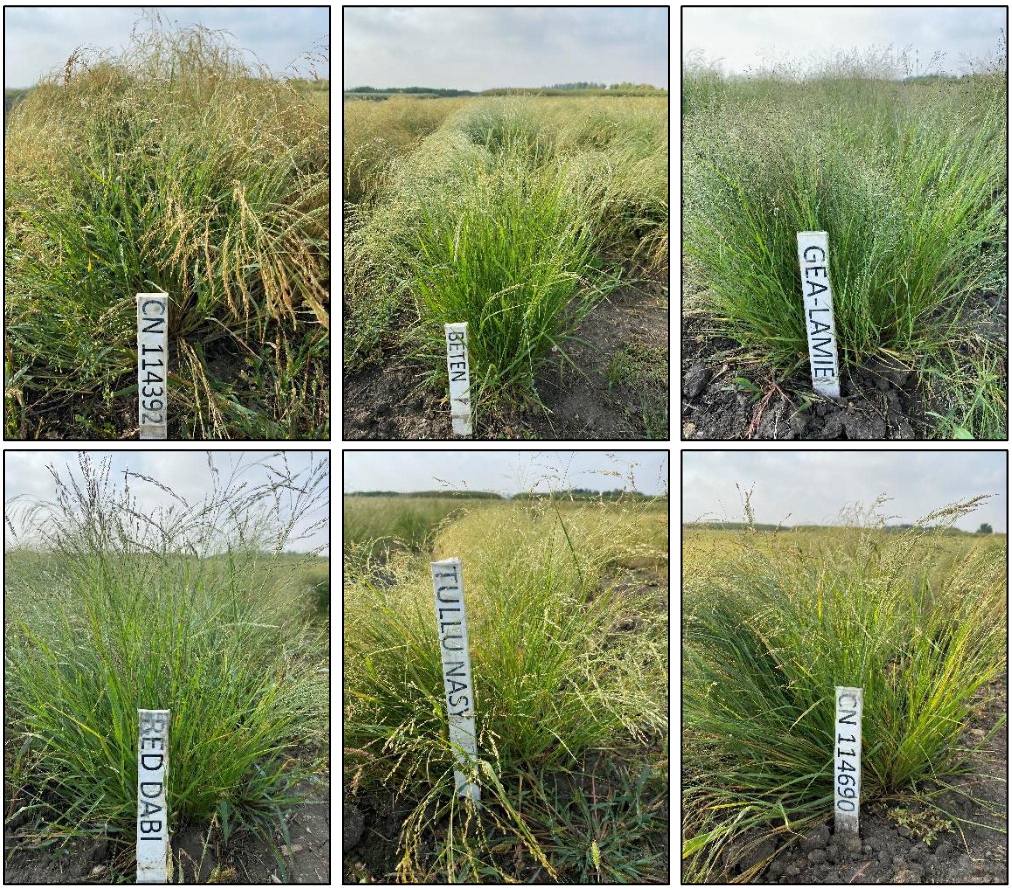


Figure 2: Varieties at physical maturity

Observations

The varieties showed strong differences in height, shape, stem thickness, maturity period and yield potential (see Figure 3). Among the red varieties, 114392 was the tallest entry, yielding the most grain and straw on a per plant basis. The plant shape was bushy, with thick, curving stems that showed good strength. The seed is very light in colour compared to the other red varieties. The variety 114690 also performed well. Red Dabi and Gea-Lamie were both relatively short and yielded small amounts of seed and straw on a per plant basis.

Of the two white varieties, Beten was the tallest and yielded the most straw. The shape for that variety was erect, with thick stems. Tullu Nasy was shorter and finer, with lower yields for straw, but higher yields for grain, on a per plant basis.

Figure 3: Varieties by height, with a meter stick for reference. (A) 114392; (B) Beten; (C) 114690; (D) Tullu Nasy; (E) Red Dabi; and (F) Gea-Lamie.

Figure 4: (left) harvested plants drying on the shop floor; (right) threshed seed by variety: (A) Red Dabi; (B) Beten; (C) 114392; (D) Gea-Lamie; (E) Tullu Nasy; and (F) 114690.

Figure 5: Seedheads for 114392, nicknamed "Nebiri" (Amharic for "Tiger").

<u>Feed test results</u>

Based on the straw yield (on a per plant basis), feed tests were done for 114392 (red) and Beten (white). The results for protein and total digestible nutrients (TDN) are shown in Table 2.

*Table 2: Feed test results for straw**

Variety	Protein (%)	TDN (%)
114392	7.89	60.03
Beten	8.55	57.10

* *Dry matter feed values from Central Testing Laboratory, Winnipeg*

Discussion

The goal of the project was to increase the supply of seed for the six varieties received from the Saskatoon Research and Development Centre. The seeds were germinated in a greenhouse well before they could have been safely planted in a field. After transplanting, the plants were watered and kept weed-free by hand. Given the artificial conditions for growth, the actual days-to-maturity for the varieties remains unknown. Nevertheless, the study provides indications as to the suitability of the varieties to Manitoba's growing conditions. General observations are summarized in Table 3.

Table 3: General observations and varietal suitability to Manitoba's growing conditions

Variety	Observation	Suited to MB
114392	Strongest entry overall, with good grain and straw yield. The light-red grain may provide a taste comparable to white grain.	Likely
Beten	Good straw yield, but relatively low grain yield.	Maybe
Gea-Lamie	Small plant with low grain yield.	Likely not
Tullu Nasy	Good grain yield, but low straw yield.	Maybe
Red Dabi	Very similar to Gea-Lamie.	Likely not
114690	Moderate grain and straw yield.	Maybe

The varieties will be included in a variety trial in 2024, in which all entries will be planted directly into the field using PCDF's standard plot seeder. That trial will compare the performance of each variety against other varieties that have been tested in previous years, for a total of ten varieties. The variety trial will test for grain and straw yield, as well as days-to-maturity and physical characteristics. This will confirm whether the varieties grown in the current nursery trial are suited to the growing conditions in Manitoba. Additionally, seed increase plots will be established for each variety to enable future testing, as required.

PCDF thanks the Saskatoon Research and Development Centre for contributing the varieties for the project. In appreciation, PCDF has sent 200 grams of each variety to the SRCD to update their seed supply.

Teff Herbicide Evaluation

Project Duration: May – October 2023

Objectives: To evaluate the tolerance of teff to select broadleaf herbicides.

Collaborators: PCDF

Background

Teff *(Eragrostis tef)* is a warm-season annual grass that originates in northeast Africa, where it is grown for grain and forage production. The grain is very small, about the size of a poppy seed, with approximately 1.2 million seeds per pound (2.6 million seeds per kilogram). The flour is used to produce a traditional flatbread called *injera*, which is naturally gluten-free. As a forage, the crop is notable for its high protein content and palatability, as well as its potential for high yields.

This report provides preliminary results for the tolerance of teff to select broadleaf herbicides.

Materials and Methods

The teff was seeded with a 15-foot drill with 9.5-inch row spacing. Plots were flagged after emergence, with a two-meter alley separating replications. Herbicides were applied at early tillering with a CO_2 sprayer. Plots were harvested with a combine and the grain was cleaned prior to calculating yield.

Table 1: 2023 materials and methods.

Overview	
Design	RCBD
Entries	6 (see Table 2)
Reps	4
Harvest area	16.0 m2
Target N	110 lb/ac
Seeding rate	5 lb/ac
Seeding date	June 5
Seeding depth	1/8-inch
Spray date	July 11
Harvest date	Sept 25

Table 2: Treatments tested with teff by rate

Herbicide	Rate
None	N/A
Bromoxynil	400 mL/ac
Dicamba	117 mL/ac
Dicamba	334 mL/ac
Stellar	400 mL/ac
Tridem	21 g/ac (A) plus 405 mL/ac (B) plus 60 mL/ac (Bindem)

Results

The teff was seeded into very dry soil during an extended spell of hot, dry weather. Consequently, although the crop emerged well (due to a good rainfall event), plant growth remained minimal throughout the first few weeks. Weeds were controlled prior to seeding by herbicide (glyphosate at 0.64 L/ac) and a subsequent tillage pass to control weeds such as black medic, thistle, and plantain.

Observations

None of the herbicides in the study had any observable effect on crop condition. This finding suggests that all the herbicides in the study can be safely applied to teff. However, more testing is needed to confirm this finding. Further, note that none of the herbicides in this study are registered for use on teff.

Figure 1: (left) at tillering, June 23; and (right) at spraying, July 11

Grain yield is shown in Figure 4. Although the grain yield was very low, there were no statistical differences for yield between any of the treatments. Crop performance was strongly negatively impacted by low soil moisture and low fertility levels. Nevertheless, the project's aims were achieved with regards to assessing the impact of herbicide application on teff.

Plots in Figure 4 are colour coded to show relative yield, with green representing low yielding plots and red representing high yielding plots. High yields are concentrated in the first and second replications, especially to the left side of the plot map. This suggests that that slightly higher fertility levels were present in these plots. The differences in yield did not appear to be due to weed pressure, which was even across the plots. Note that the plot yields are critically low and would represent a crop failure.

*Figure 4: Grain yield by treatment (lb/ac).**

3	285	338	290	358	364	259
	Dicamba 117 mL	Stellar	Tridem	Bromoxynil	Dicamba 334 mL	Control
2	461	520	533	525	405	360
	Bromoxynil	Control	Dicamba 334 mL	Stellar	Dicamba 117 mL	Tridem
1	573	568	565	487	506	417
Replication	Control	Tridem	Bromoxynil	Dicamba 117 mL	Dicamba 334 mL	Stellar
Plot	**1**	**2**	**3**	**4**	**5**	**6**

* Plots are colour coded to show relative yield (green = low; red = high)

Discussion

The herbicides examined in this study appear to be safe for use with teff at early tillering at the rates provided in Table 2. However, more research is needed to verify these observations and to meaningfully assess the impact of the herbicides on yield under more favourable conditions. PCDF has plans to continue this work in 2024.

Seeding Rate Evaluation for Teff Grain and Forage

Project Duration: May – October 2023

Objectives: To evaluate seeding rates of teff for grain and forage production

Collaborators: PCDF; Manitoba Crop Diversification Centre (MCDC), Westman Agricultural Diversification Organization (WADO)

Background

Teff *(Eragrostis tef)* is a warm-season annual grass that originates in northeast Africa, where it is grown for grain and forage production. The grain is very small, about the size of a poppy seed, with approximately 1.2 million seeds per pound (2.6 million seeds per kilogram). The flour is used to produce a traditional flatbread called *injera*, which is naturally gluten-free.

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 report presents the results for teff grain and forage trials grown at Carberry (MCDC), Melita (WADO) and Roblin (PCDF). The trial was also established at Arborg (Prairies East Agricultural Sustainability Initiative) but was terminated due to poor emergence.

The current report builds upon tests in 2021 in Roblin and in 2022 at Arborg and Roblin. In brief, total forage yields for those trials did not differ significantly by seeding rate. Grain yields (at Roblin only) did not differ by seeding rate, but yielded significantly less if the teff was cut for hay in mid-season than if the grain was allowed to reach full maturity without being cut. In 2021, barley greenfeed at Roblin yielded less than the combined yield for two cuts of teff. In 2022, barley greenfeed yields were higher than combined teff yields at both Roblin and Arborg.

Figure 1: (a) 1st cut teff hay (b) 2nd cut teff hay.

Figure 2: (a) mature teff plants prior to grain harvest (Oct 6, 2022); (b) close-up of teff seeds (with 10-cent piece for size reference.

Table 1: 2023 materials and methods.

Overview	
Design	RCBD
Entries	10 (5 forage, 5 grain)
Reps	4
Harvest area	8.0 m2
Target N	110 lb/ac
Seeding rate (lb/ac)	
Barley	108
Teff	4, 5, 6, 7
Seeding date	
Carberry	May 23
Melita	May 31
Roblin	May 26
Number of cuts (forage plots only)	
Barley	1
Teff	2
Harvest dates	
Carberry	Aug 1 (teff 1^{st} cut, barley) Sept 13 (teff 2^{nd} cut; grain)
Melita	Jul 31 (teff 1^{st} cut) Aug 1 (barley) Sept 28 (teff 2^{nd} cut; no grain harvest)
Roblin	Jul 14 (teff 1^{st} cut) Aug 3 (barley) Sept 22 (teff 2^{nd} cut; grain)

Results

Hay Yield

Total hay yields (two cuts) and barley greenfeed yields (one cut) are shown for Carberry (Figure 3), Melita (Figure 4) and Roblin (Figure 5). Yields marked with the same letter do not differ significantly.

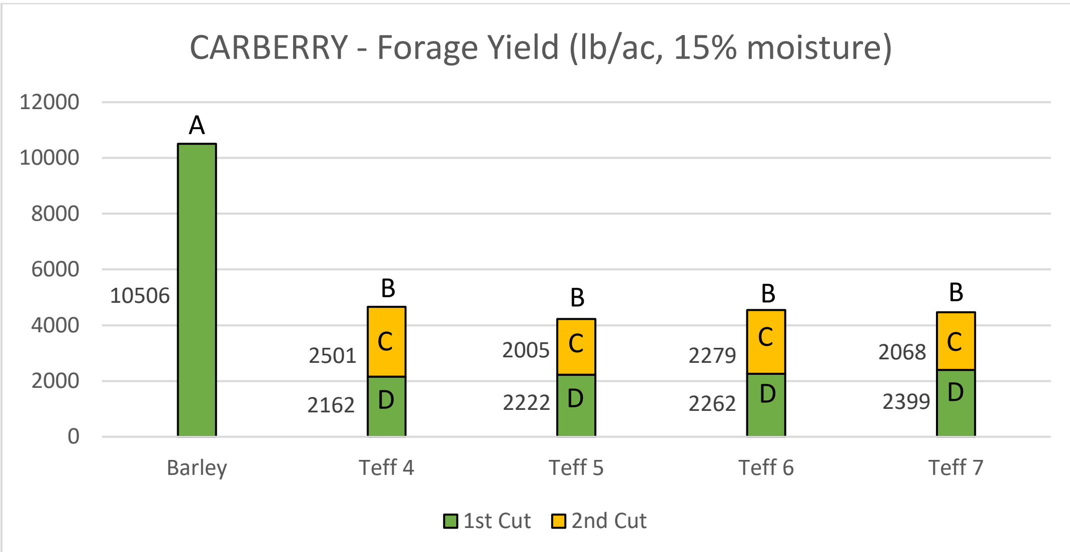


Figure 3: Carberry teff forage yields (lb/ac, 15% moisture) for 1st cut and 2nd cut by seeding rate (lb/ac), plus yield for barley greenfeed comparison.

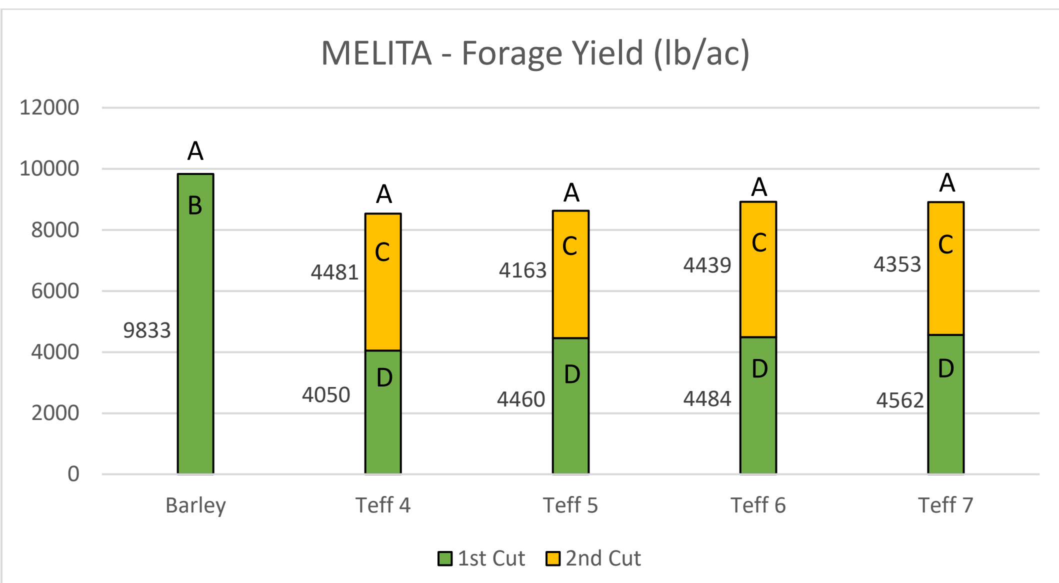


Figure 4: Melita forage yields (lb/ac, 15% moisture) for 1st cut and 2nd cut by seeding rate (lb/ac), plus yield for barley greenfeed comparison.

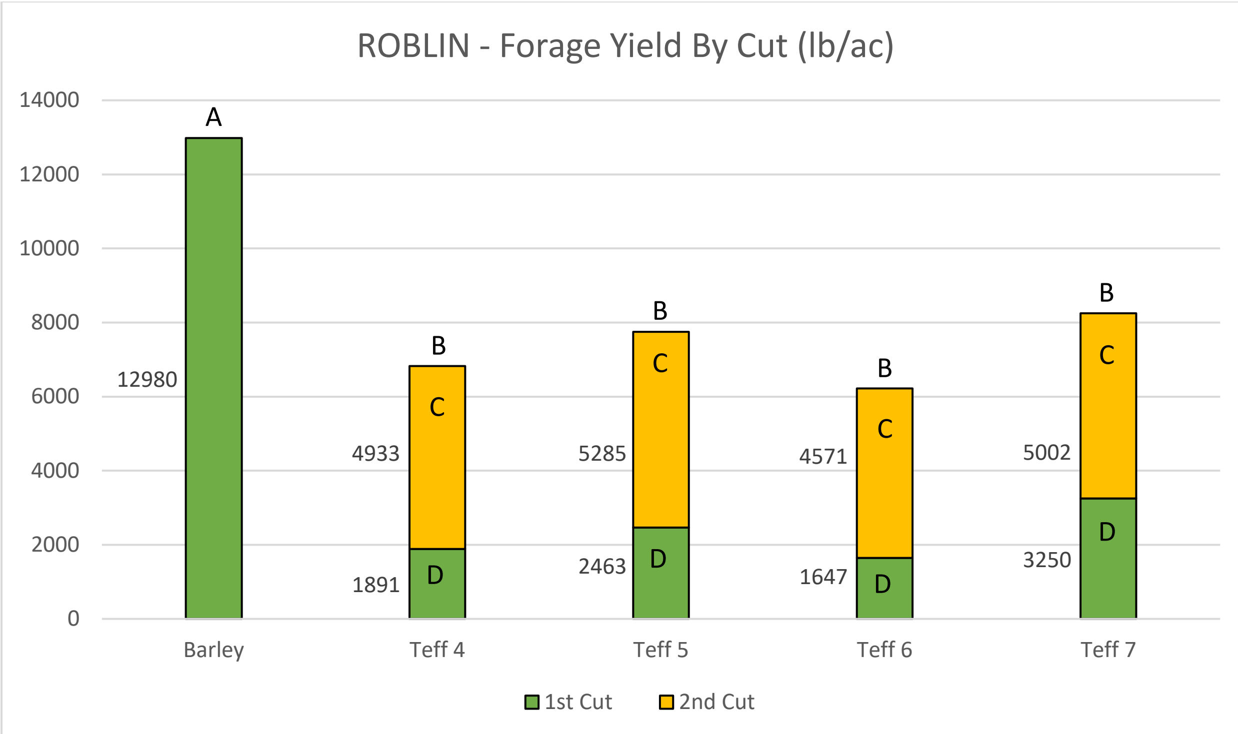


Figure 5: Roblin forage yields (lb/ac, 15% moisture) for 1st cut and 2nd cut by seeding rate (lb/ac), plus yield for barley greenfeed comparison.

Barley greenfeed yields were higher than teff yields for all sites. Melita showed the most robust teff yields and the lowest barley yields, such that the total teff yield for all treatments did not differ statistically from the yield for barley. However, total teff yields were significantly lower than for barley at Carberry and Roblin. A more detailed comparison of the effect of yields on cost of production for hay is provided later in this report.

The timing of the first cut for teff is important. At Roblin, the first cut for teff occurred before the plants had headed out (July 14). This resulted in smaller plants that were very smooth and not easily cut by the plot swather. Consequently, plot yields were highly variable, and the dried harvest material was difficult to collect due to its small size. On a field scale, attempting to cut at this stage would likely result in very low yields. Waiting until the plants have headed out is critical to achieving a good cut with a swather and will result in a better ability pick up the dried material with a baler.

Straw Yield

In regions where teff is cultivated for grain, the straw plays an important role in livestock production. For the grain plots, straw was collected after harvest with the plot combine. The results are included in Figure 6. Yields marked with the same letter do not differ significantly.

Note that the teff grain was not harvested in Melita. The higher straw yields at that site compared to the other sites may be due to the weight of unharvested grain on the plants. This dynamic is inferred from observations in Roblin, where much higher forage yields were observed in 2021 (when no grain was harvested) than in 2022 (when plots were combined before measuring straw yield). The difference in straw yield between Melita and the other sites is roughly comparable to the grain yield for the other sites (Figure 7).

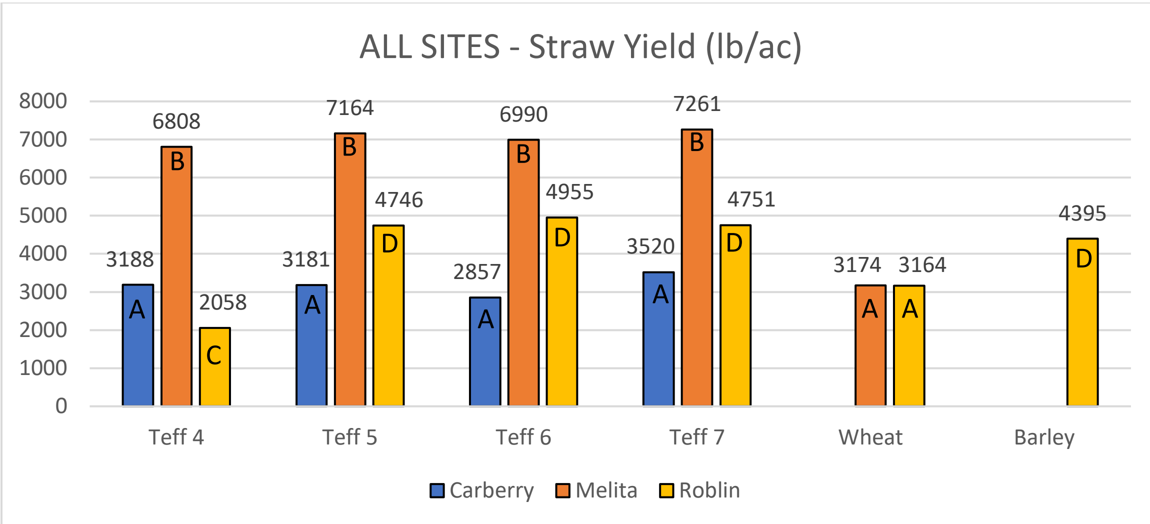


Figure 6: Straw yield for all sites (lb/ac, 15% moisture) for teff (by seeding rate, lb/ac), plus wheat and barley for comparison.

<u>Feed quality</u>

The results for feed quality at Roblin are shown in Table 2. Note that the values are for samples collected in 2022. The general feed requirements for cattle are provided for comparison. Mineral content for feed by treatment is shown in Table 3.

*Table 2: Feed values for teff and barley compared to animal feed requirements**

Entry	% Crude Protein	% TDN
Teff 1st cut	20.9	69.2
Teff 2nd cut	11.4	59.9
Teff straw	8.4	51.6
Barley greenfeed	10.0	58.4
Teff screenings (chaff and light seed)	18.5	66.7
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

* *Dry matter feed values from Central Testing Laboratory, Winnipeg, 2022*

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

*Table 3: 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
Teff straw	0.34	0.14	0.18	0.04	1.57	-	-	-	-	-
Barley greenfeed	0.33	0.21	0.14	0.26	1.49	1.17	3.60	17.27	23.80	90.55
Teff screenings (chaff and light seed)	0.58	0.44	0.28	0.03	1.00	2.35	7.54	56.51	91.41	956.60

* *Dry matter values from Central Testing Laboratory, Winnipeg, 2022*

Grain Yield

Teff grain was harvested at Carberry and Roblin. Additionally, wheat and barley grain were harvested at Roblin to provide comparative yields for more typical crops. Melita had exceptionally high numbers of grasshoppers, which fed on the seedheads of the maturing teff plants. As a result, grain was not harvested at that location. The grain yields for Carberry and Roblin are shown in Figure 7.

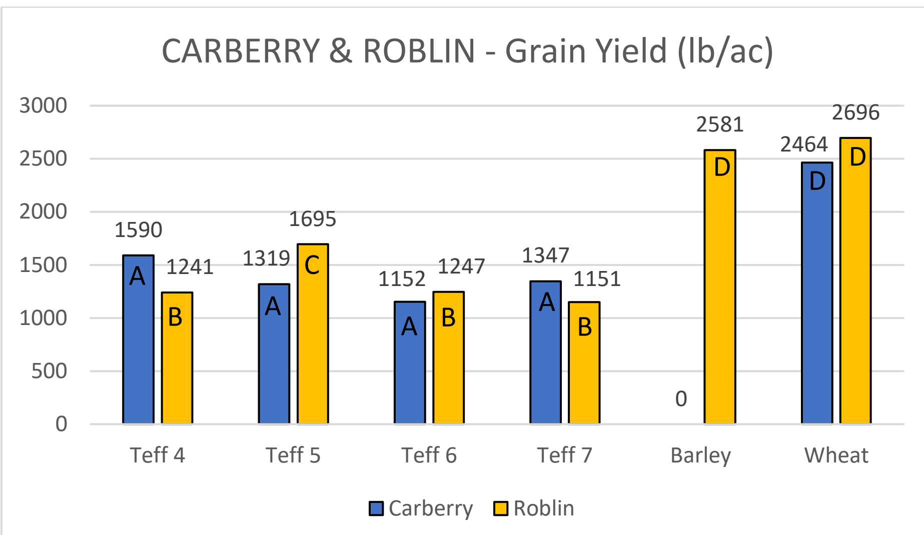


Figure 7: Grain yield (lb/ac) by location for teff (by seeding rate, lb/ac), plus wheat and barley for comparison.

Discussion

Teff seeds are 1 mm long, roughly the same size as a poppy seed. The ideal seeding depth is no more than 1/8 of an inch. Although germination usually occurs in 2-3 days, when surface soil conditions are dry, the small roots can easily dry out, resulting in poor establishment. The spring season was dry across all sites, and especially Arborg, which received only 12% of the normal precipitation from May 15 to June 15. Poor establishment resulted in the termination of the trial at that location.

A summary of climate factors at the growing sites is provided in Table 4. The 2023 values are expressed as percent normal, compared with the 30-year average for the location. Note that the amount of precipitation for each site was low (55-58% of the 30-year average), while heat units and growing degree days were higher than normal for all sites.

Table 4. Precipitation, crop heat units and growing degree days for trial locations (% normal) for April 15 to September 30.

	% Normal		
	MCDC	PCDF	WADO
Precipitation	58	58	55
Crop Heat Units	112	115	108
Growing Degree Days	120	120	113

Hay cost of production

An estimate of the cost of production is provided in Table 5. The cost includes the seed and the cost of cutting the hay. Other factors, such as land rental and baling costs, are not included.

Table 5: 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)
Barley (single cut)	0.29	108	20.00	51.50
Teff (Two cuts)	5.39	4	20.00	61.56
		5		66.95
		6		72.34
		7		77.73

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

The relative cost of production (Figure 8) compares the cost by treatment (from Table 5) to produce one unit of teff hay, protein, and total digestible nutrients (TDN), relative to the cost for barley greenfeed. The values are averaged for all sites. A more detailed breakdown of relative costs for all sites is presented in Figure 9.

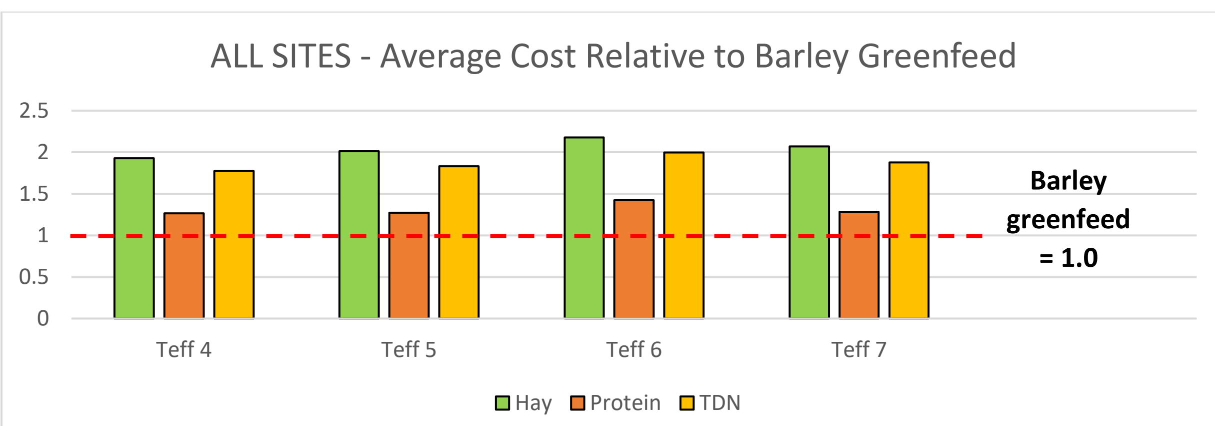


Figure 8: Average cost of production for all sites, relative to barley greenfeed.

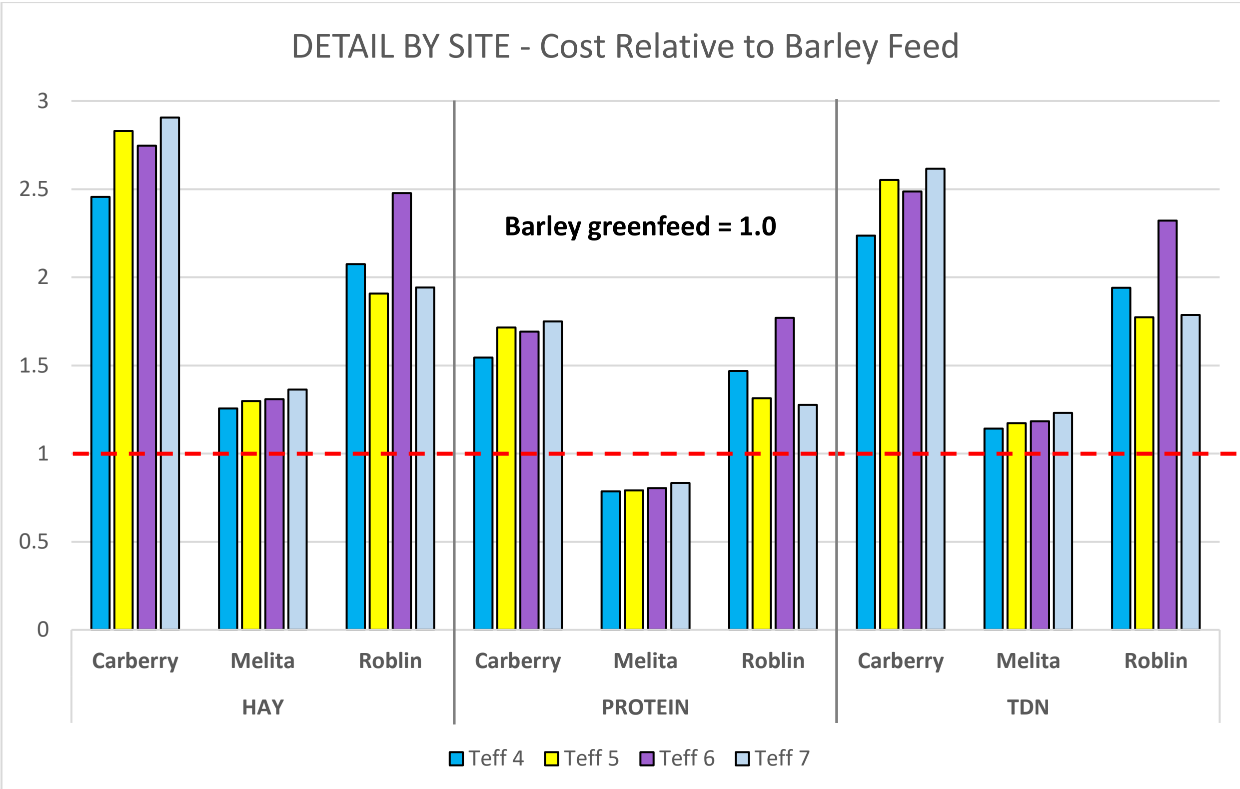


Figure 9: Detailed cost of production by site, relative to barley greenfeed.

The relative cost of production presented here is directly influenced by the yield of barley greenfeed. In 2021, when dry conditions resulted in low barley yields at Roblin, the relative cost of production for teff was favourable (about half the cost of barley greenfeed for all categories). However, under the more favorable conditions for barley at Roblin in 2022, the relative cost for producing teff increased considerably.

In 2023, barley production was high at Carberry and Roblin, with relatively low yields for teff. As a result, the relative cost of production is high for teff at those sites. At Melita, where barley yields were lower and teff yields were higher, the relative cost of production is more favourable. Notably, the cost of protein at Melita was lower for teff than for barley greenfeed. This highlights the strategic role that teff may play for some producers as a source of high-quality forage. Further, although barley greenfeed provided more protein overall than some treatments, because of the lower concentration of protein, animals would have to consume more barley greenfeed than teff hay to obtain the same amount of protein.

<u>Grain production</u>

Teff grain production in Manitoba presents a promising opportunity. As the community of migrants from Northeast Africa grows in North America, so does the demand for teff flour, which is used to produce *injera*, a staple fermented flatbread. Although milling capacity for teff exists in Manitoba, the grain is currently imported from Ethiopia. Producing teff grain in Manitoba may provide a unique opportunity to tap into pre-existing markets and infrastructure.

The screenings from teff provide a promising additional source of animal nutrition. Due to the very small size of the seed, appropriate combine harvester settings may result in the collection of moderate amounts of chaff. This is primarily comprised of material from the seed head, as well as lightweight seed. With more than 18% protein and good energy values (Table 2), this material may be advantageous to feed to livestock. The very high values for mineral content especially zinc, manganese and iron, likely result from the presence of teff seed, which is higher in minerals than the forage material alone (Table 3). Due to the small seed size, feeding the chaff in pelletized form may be best, as processing would help to break the seed coat and improve digestibility.

The results from this trial and previous trials suggest that a seeding rate of 5 lb/ac is ideal. Lower rates tend to produce lower grain yields, and higher rates increase seeding costs without significantly increasing grain yields.

More work is needed to identify ideal fertility rates for grain production. Excessive nitrogen applications are to be avoided due to the plant's tendency to lodge, which can result harvest difficulties, yield losses, and spoilage. Testing in 2024 will explore grain yield response at fertility rates ranging from 60 to 140 lb N/ac, with 100 lb N/ac assumed to be optimal target.

Herbicide tolerance is another area for more study. Additional testing for herbicide is slated for 2024 in Roblin.

Teff Variety Evaluation for Grain and Forage

Project Duration: May – October 2023

Objectives: To evaluate varieties for grain and forage production

Collaborators: Dawit Teferi; PCDF; Manitoba Crop Diversification Centre (MCDC), Westman Agricultural Diversification Organization (WADO)

Background

Teff *(Eragrostis tef)* is a warm-season annual grass that originates in northeast Africa, where it is grown for grain and forage production. The grain is very small, about the size of a poppy seed, with approximately 1.2 million seeds per pound (2.6 million seeds per kilogram). The flour is used to produce a traditional flatbread called *injera*, which is naturally gluten-free. As a forage, the crop is notable for its high protein content and palatability, as well as its potential for high yields.

This report presents the results for teff grain and forage trials, grown in partnership with Dawit Teferi, a businessperson who provided one red and one white variety for testing. The trials were grown at Carberry (MCDC), Melita (WADO) and Roblin (PCDF). The trial was also established at Arborg (Prairies East Agricultural Sustainability Initiative) but was terminated due to poor emergence.

The current report builds upon tests in 2021 in Roblin and in 2022 at Arborg and Roblin. In brief, total forage yields for those trials did not differ significantly by seeding rate. Grain yields (at Roblin only) did not differ by seeding rate, but yielded significantly less if the teff was cut for hay in mid-season than if the grain was allowed to reach full maturity without being cut. In 2021, barley greenfeed at Roblin yielded less than the combined yield for two cuts of teff. In 2022, barley greenfeed yields were higher than combined teff yields at both Roblin and Arborg.

Figure 1: (a) "Teferi Red" variety, Aug 17, Roblin (b) "Teferi White" variety (showing characteristic red plants), Aug 29, Roblin.

Figure 2 (clockwise from top-left):
a. "Control Red" at grain harvest (Sept 22)
b. "Teferi Red"
c. "Teferi White"
d. Close-up of teff seeds (with 10-cent piece for size reference).

Table 1: 2023 materials and methods.

Overview	
Design	RCBD
Entries	3 (grain) at Carberry and Melita
	6 (3 grain, 3 forage) at Roblin
	"Control Red"
	"Teferi Red"
	"Teferi White"
Reps	4
Harvest area	8.0 m2
Seeding rate	5 lb/ac
Target N	110 lb/ac

Seeding date	
Carberry	May 23
Melita	May 31
Roblin	May 26
Number of cuts (Roblin forage only)	
Teff	2
Harvest dates	
Carberry	Sept 13 (grain and straw)
Melita	Sept 28 (straw; no grain harvest)
Roblin	Jul 14 (1st forage cut)
	Sept 22 (2nd forage cut; grain, straw)

Results

Grain Yield

Teff grain was harvested at Carberry and Roblin. Melita had exceptionally high numbers of grasshoppers, which fed on the seedheads of the maturing teff plants. As a result, grain was not harvested at that location. The grain yields for Carberry and Roblin are shown in Figure 3. Yields marked with the same letter do not differ significantly.

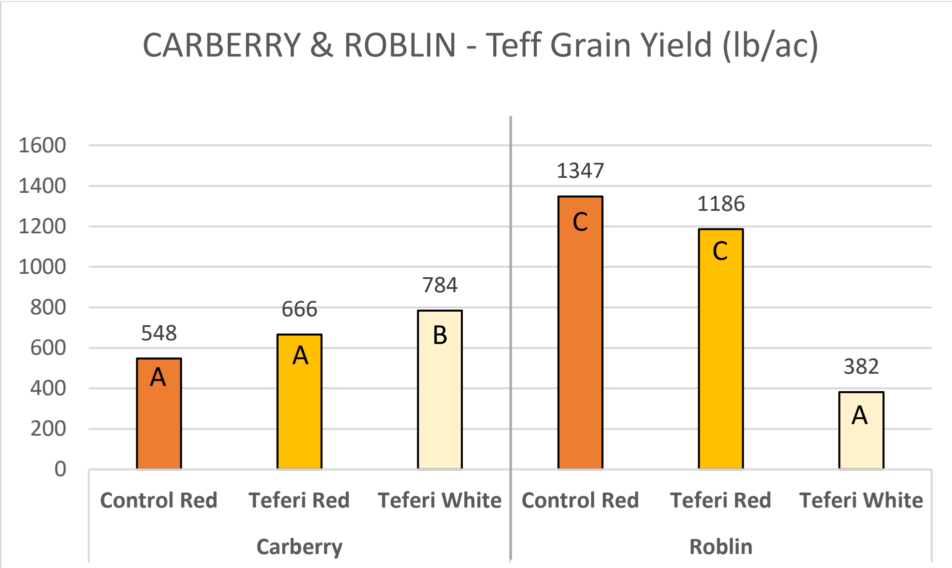


Figure 3: Grain yield (lb/ac) by location for teff varieties.

Hay Yield

The varieties were tested for hay yield at Roblin only. Yields for both cuts are shown in Figure 4.

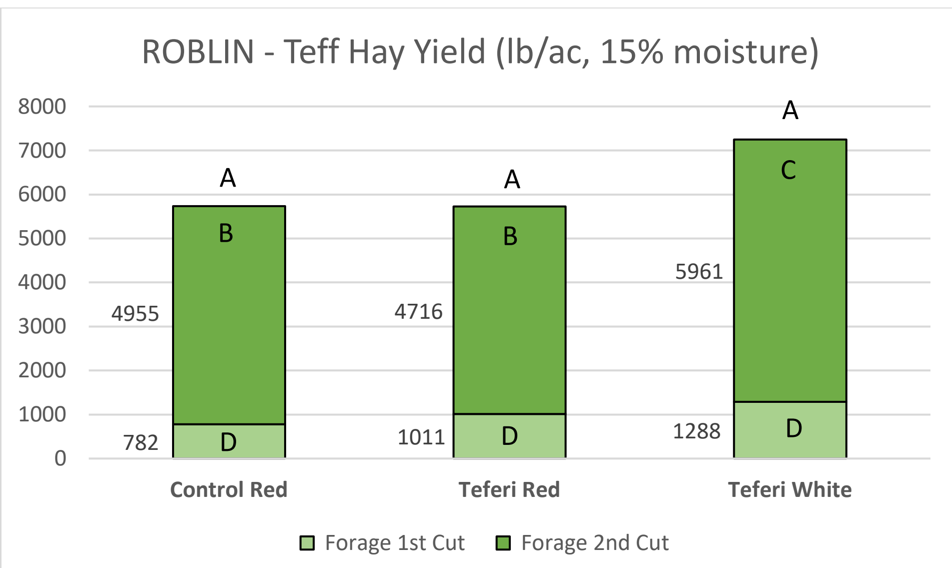


Figure 4: Hay yields (lb/ac, 15% moisture) at Roblin for 1st cut and 2nd cut by variety.

Straw Yield

In regions where teff is cultivated for grain, the straw plays an important role in livestock production. For the grain plots, straw was collected after harvest with the plot combine. The results are included in Figure 6.

Note that the teff grain was not harvested in Melita. The higher straw yields at that site compared to the other sites may be due to the weight of unharvested grain on the plants. This dynamic is inferred from observations in Roblin, where much higher forage yields were observed in 2021 (when no grain was harvested) than in 2022 (when plots were combined before measuring straw yield). The difference in straw yield between Melita and the other sites is roughly comparable to the grain yield for the other sites (Figure 3).

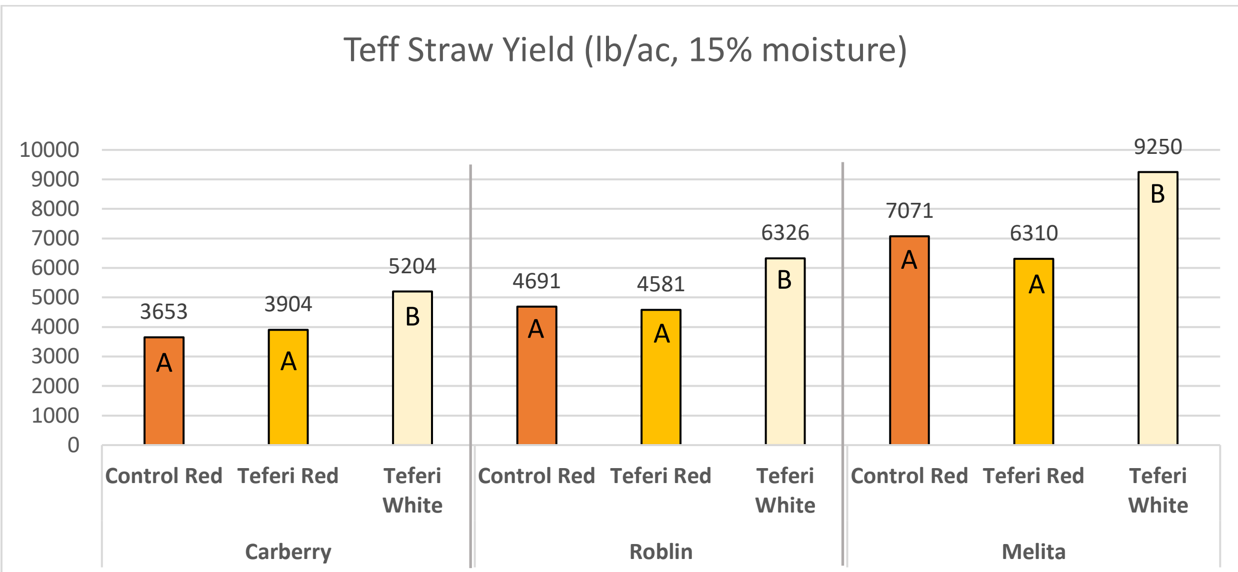


Figure 6: Straw yield for all sites (lb/ac, 15% moisture) for teff varieties.

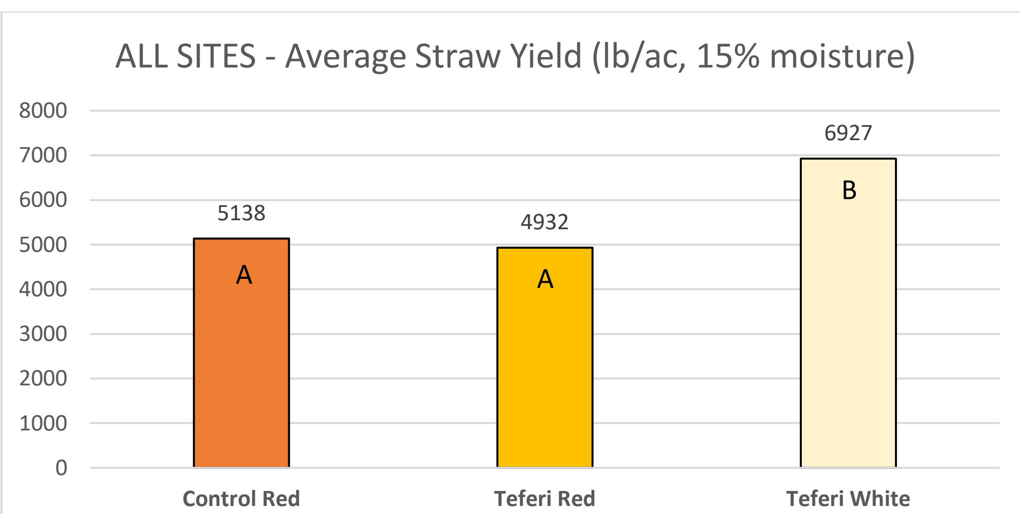


Figure 7: Average straw yield for all sites (lb/ac, 15% moisture) for teff varieties.

Plant Height

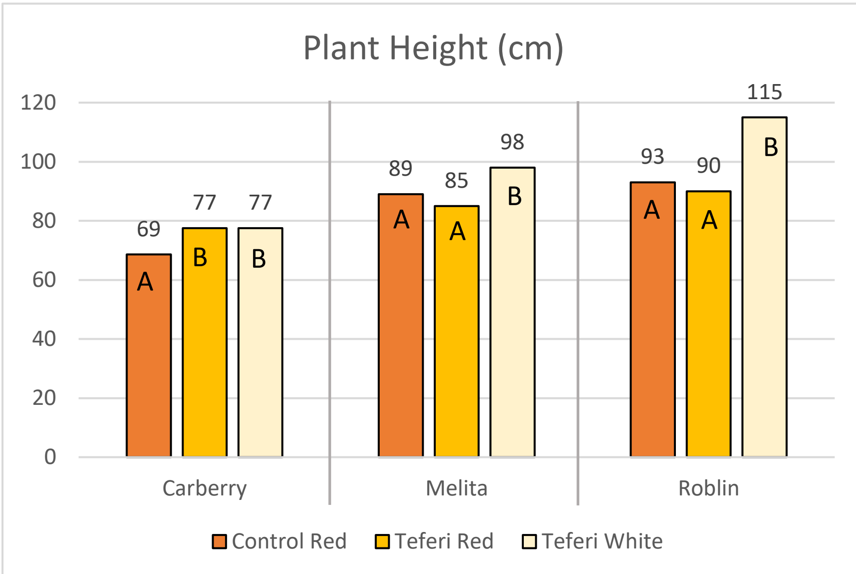


Figure 8 (above): Plant height (cm) by variety for all locations.

Figure 9 (side): Comparison of Teferi White (left) and Teferi Red (right). Note the branching form and thinner stems of Teferi Red.

Lodging

Due to the relatively weak stem strength of teff compared to other common field crops, lodging can be a problem in teff production. The lodging ratings by variety are shown for all sites in Figure 10.

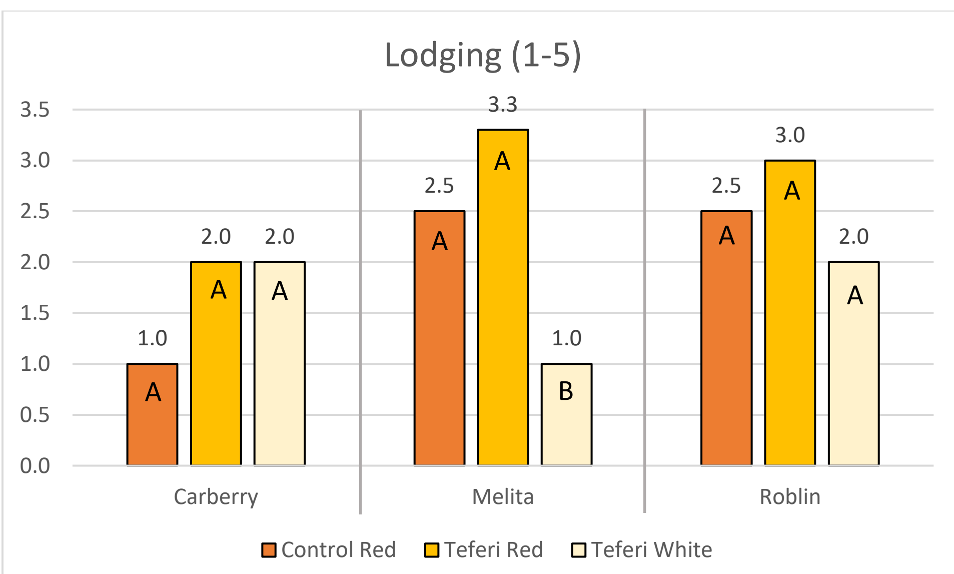


Figure 10: Lodging ratings for teff varieties at all sites (1-5; 1 = upright, 5 = flat)

Discussion

Varietal differences

The Teferi Red variety performed well for grain, straw, and hay production when compared to the Control Red variety. Hay yields (Roblin only) did not differ from the control.

The Teferi White variety yielded significantly more grain at Carberry than the other entries, but significantly less grain in Roblin. The difference in grain yields is likely connected to the difference in plant height, where Teferi White remained vegetative and actively growing for longer at Roblin. This plant response might be attributed to more favourable heat conditions in Carberry, triggering earlier seed formation.

Although the Teferi White variety yielded statistically more hay for both 1st and 2nd cut (Roblin only), there was no statistical difference in yield for both cuts combined (p-value = 0.066). Based on the observation that seed was only beginning to develop in early October, the variety appears to be a long-season variety that is not well-suited to Manitoba growing conditions.

Crop height was greater for Teferi White than for the control at all sites, but Teferi Red was taller than the control at Carberry only. Lodging differed only at Melita, where Teferi White showed better standability. This is likely due to the low seed production for that variety at that location.

General observations

Teff seeds are 1 mm long, roughly the same size as a poppy seed. The ideal seeding depth is no more than 1/8 of an inch. Although germination usually occurs in 2-3 days, when surface soil conditions are dry, the small roots can easily dry out, resulting in poor establishment. The spring season was dry across all sites, and especially Arborg, which received only 12% of the normal precipitation from May 15 to June 15. Poor establishment resulted in the cancellation of the trial at that location.

The relatively low grain yields at both sites may be attributed to a shortage of early season moisture (Table 2). The 2023 values are expressed as percent normal as compared to the 30-year average for the location. Note that the amount of precipitation for each site was low (55-58% of the 30-year average), while heat units and growing degree days were higher than normal for all sites.

Table 2. Precipitation, crop heat units and growing degree days for trial locations (% normal) for April 15 to September 30.

	% Normal		
	MCDC	**PCDF**	**WADO**
Precipitation	58	58	55
Crop Heat Units	112	115	108
Growing Degree Days	120	120	113

The timing of the first cut for teff is important. At Roblin, the first cut for teff occurred before the plants had headed out (July 14). This resulted in smaller plants that were very smooth and not easily cut by the plot swather. Consequently, plot yields were highly variable, and the dried harvest material was difficult to collect due to its small size. On a field scale, cutting at this stage would likely result in very low yields. Waiting until the plants have headed out is critical to achieving a good cut with a swather and will result in a better capacity to pick up the dried material with a baler.

Grain production

Teff grain production in Manitoba presents a promising opportunity. As the community of migrants from northeast Africa in North America grows, so does the demand for teff flour, which is used to produce *injera*, a staple fermented flatbread. Although milling capacity for teff exists in Manitoba, the grain is currently imported from Ethiopia. Producing teff grain in Manitoba may provide a unique opportunity to tap into pre-existing markets and infrastructure.

The results from teff seeding rate trials at the Diversification Centres suggest that a seeding rate of 5 lb/ac is ideal. Lower rates tend to produce lower grain yields, and higher rates increase seeding costs without significantly increasing grain yields.

Nevertheless, more work is needed to identify ideal fertility rates for grain production. Excessive nitrogen applications are to be avoided due to the plant's tendency to lodge, which can result harvest difficulties, yield losses, and spoilage. However, the relatively low yields for the control variety, relative to the yield for other test years, suggests that the crop was limited for nitrogen. Testing in 2024 will explore grain yield response at fertility rates ranging from 60 to 140 lb N/ac, with 100 lb N/ac assumed to be optimal target.

Herbicide tolerance is another area for more study. Additional testing for herbicide is slated for 2024 in Roblin.

Livestock Grazing Demonstration on Winter Cereals

Project Duration: Sept 2022 – August 2023
Objectives: To evaluate the suitability of fall rye and winter wheat for early-season grazing by sheep to alleviate pasture stress.
Collaborators: PCDF, FP Genetics

Background
One of the keys to maintaining healthy pasture is deciding when to move animals onto pasture in spring. Hugo Gross, a forage researcher with Agriculture and Agri-Food in Brandon, is credited with a well-established rule of thumb: for every day that a pasture is grazed too early in the spring, three days of grazing are lost in the fall. Stated slightly differently, if animals are moved onto pasture one week too soon in spring, three weeks of grazing may be lost in the fall. For many producers, this loss would require animals to be returned to the yard or given supplemental feed in the pasture. The costs associated with either option may result in significant financial losses. Crucially, the increased grazing pressure can result in degraded pasture, loss of plant species, and higher weed pressure.

Studies in Canada and the United States show that winter cereals can be a good source of early-season grazing for livestock and can allow producers to delay moving animals onto seasonal pasture by up to three weeks. Building on a pilot project at PCDF in 2022, the project explored the potential of fall rye and winter wheat as a source of early-season grazing for livestock.

Materials and Methods
Two varieties of fall rye (donated by FP Genetics) and one winter wheat variety were planted in the 3rd week of September, 2022 (Table 1). Emergence was even, with sufficient growth in the fall to allow for good overwinter survival. The sheep were introduced at late tillering and were permitted to graze until virtually all leafy material had been removed from the plants. The sheep were then relocated to summer pasture. Where possible, the plants were harvested for grain in late August.

Table 1: 2023 materials and methods

Design	Demonstration
Entries	Cossani fall rye (hybrid grain-type) Danko fall rye (open-pollinated, suitable for forage) Emerson winter wheat (open-pollinated grain-type
Total area	4.5 acres (1.5 acres per entry)
Animals	60 ewe sheep 55 lambs 1 alpaca = 16 animal units (AU) total
Grazing period	May 25-June 8
AU/day	3.5 AU/day for 15 days
Target Fertility	N: No added (available in soil = 57 lb/ac) P: 15 lb/ac (seed-placed)
Seeding rate	24 plants/ft^2
Seeding date	Sept 18
Seeding depth	1/2-inch into good moisture
Herbicide	Glyphosate (0.64 L/ac, pre-emergence)
Grain harvest date	August 21, 2023

Observations

The season began with dry, unusually warm weather. Adequate soil moisture allowed for quick growth of tillers, providing a good amount of forage for the animals. Initially, the sheep showed a preference for the winter wheat, which was slightly less advanced and may have been more palatable. During the grazing period, the sheep grazed the winter wheat so completely that the plants died. The sheep ate most of the fall rye leaves, but not the heads, which emerged during the grazing period.

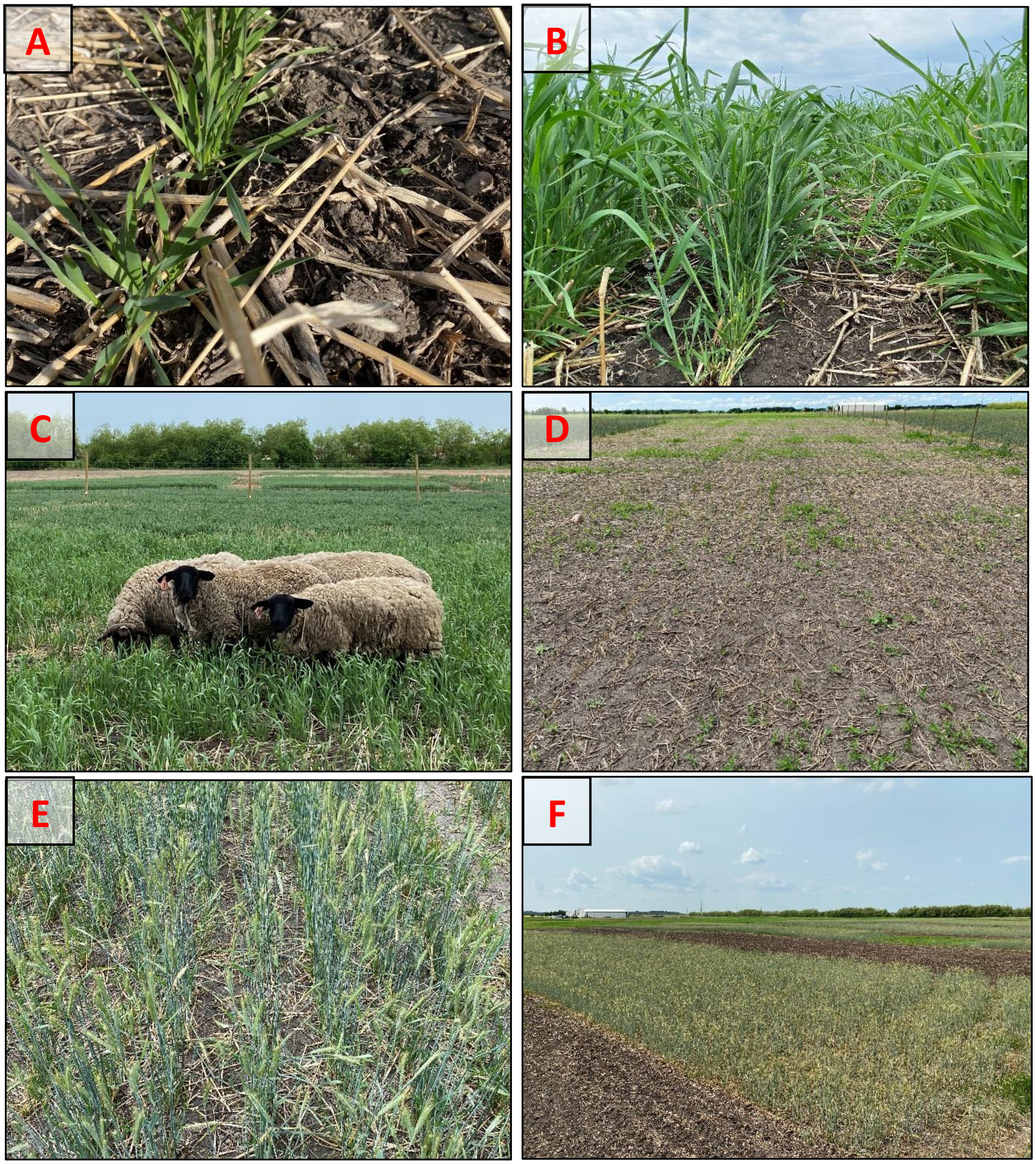


Figure 1: A) Fall rye establishment, Oct 14, 2023; B) Close-up of plant staging of fall rye when sheep were introduced; C) Sheep introduced to fall rye and winter wheat, May 29, 2024; D) Winter wheat after grazing, with virtually no surviving plants; E) Fall rye after grazing, with few leaves, but heads left intact; and (F) Fall rye plants with winter wheat areas tilled and planted to barley greenfeed (June 15, 2023).

After grazing, the winter wheat areas, which had been killed by intense grazing, were sprayed with glyphosate and seeded to barley (June 15). The barley established well and was cut for greenfeed (harvested Sept 8).

Regrowth for the fall rye varied across the trial area, with better plant stands (i.e., more plants/ft2) remaining predominantly free of weeds and lower plant stands becoming heavily infested with weeds (including millet, pigweed and volunteer canola). In the latter areas, grain yield for fall rye was severely compromised. The fact that the fall rye was already heading out when the sheep were removed presents a challenge to controlling for weeds. Of the herbicides registered for use with fall rye, only tralkoxydim may be applied without staging restrictions; the others should not be applied after early flag stage. Seeding rates may be an important tool to control weeds, with higher rates providing better ground cover. Similarly, narrower row spacing may provide better ground cover than wider spacing.

Figure 2: (left) fall rye with good ground cover and few weeds (August 4, 2023); and (right) fall rye with poor ground cover and many weeds.

Discussion

The practice of growing winter cereals for grazing with livestock in early spring is well established in parts of Canada and the United States. The Government of Saskatchewan reports that fall rye can provide good grazing in spring. Likewise, studies from the United States, such as this one from Nebraska show good results from grazing winter wheat. In Manitoba's cooler climate and shorter growing season, fall rye may have more potential than winter wheat, which tends to produce less plant material than fall rye. Nevertheless, some winter wheat varieties, such as this variety from Montana, are reported to produce more plant material than traditional grain varieties.

The project at PCDF demonstrates that growing winter cereals for the purpose of grazing them with livestock in early spring has the potential to improve pasture health, primarily by delaying the introduction of livestock onto pasture in early spring. Dr. Llewellyn Manske, a grassland researcher with North Dakota State University, states that grass plants must grow 3 to 3.5 new leaves to recover nutrients that were lost during the winter (Wheatland Country Connector, December 2021, page 17). Grazing before this milestone can seriously set the plant back for the remainder of the season. In this context, winter cereals can be an important source of feed during the two or three weeks in early spring when pasture plants are regrowing their first leaves. Supporting this point, the owner of the sheep that grazed the winter cereals at PCDF reported that the home pasture had better growth, despite very dry conditions, when the sheep were introduced on June 9.

Grazing winter cereals can also have benefits for annual cropland, including manure additions from livestock, as well as some light disturbance resulting from hoof action. Manure is well understood to have positive impacts on soil and plant health due to nutrients, changes to soil structure and chemistry, and biological activity. Moving animals from winter quarters in the yard also reduces the amount of manure that must be cleaned up and spread in the field.

Nevertheless, some challenges to grazing winter cereals include weed management and the need to move animals twice in spring. Whereas winter cereals usually produce enough early growth to outcompete weeds, grazing with livestock has the effect of keeping the canopy open. Consequently, when the livestock are removed, weeds can grow with minimal competition, causing yield losses and creating additional weed problems for future years. Due to crop staging, few in-crop herbicide options are available for winter cereals after the livestock have been removed. Although it is possible to take the crop to grain yield, producers may also consider terminating the winter cereal crop and planting an annual hay crop such as barley for greenfeed, or a mixture for late season grazing. If a producer is interested in establishing a perennial forage crop, it may be advantageous to plant a perennial forage (with or without a cereal nurse crop) after grazing a winter cereal (Figure 3).

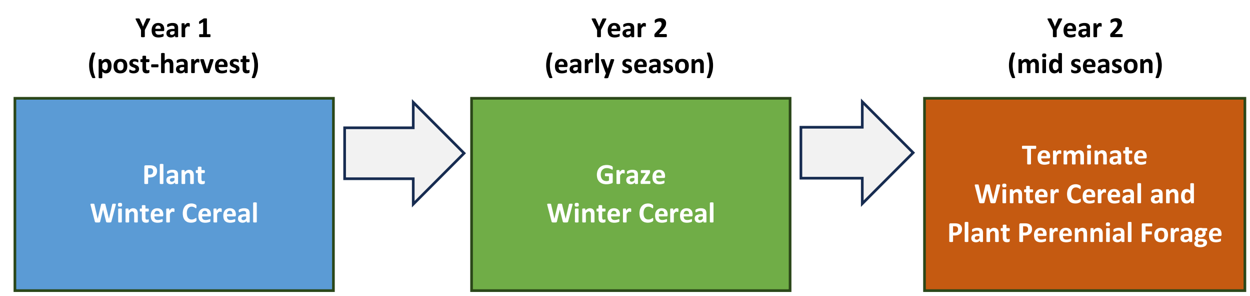


Figure 3: Idealized system including winter cereal for grazing of livestock, followed by establishment of perennial forage.

PCDF has tentative plans to conduct a similar grazing demonstration with fall rye and cattle in 2024. The fall rye has been planted, and the decision to go forward with the project will depend on the availability of labour to manage the cattle.

Flax and Linseed

CDC Linseed and Flax Coop Variety Evaluation

Project duration: May 2023 – September 2023
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
Linseed and flax are both names of the species *Linum usitatissisum*. In North America, the term *flax* is typically used to refer to varieties that produce seeds that may be eaten, whereas *linseed* is used to refer to varieties that will be pressed for oil. However, in practice, names may be used interchangeably. Flax varieties have seeds that are dark to reddish brown, whereas linseed varieties have paler, yellow seeds.

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

Results
The mean yields for named and unnamed varieties are shown in Figure 1. The mean heights by variety are shown in Figure 2.

Figure 1: Flax yield by variety (bu/ac, 10% moisture)

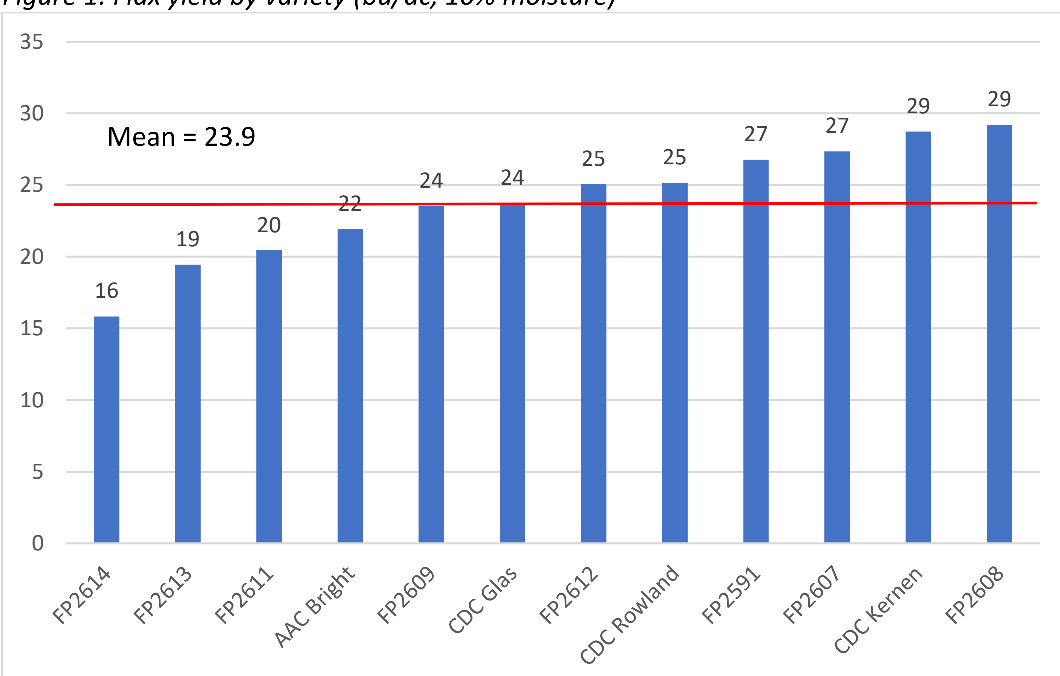
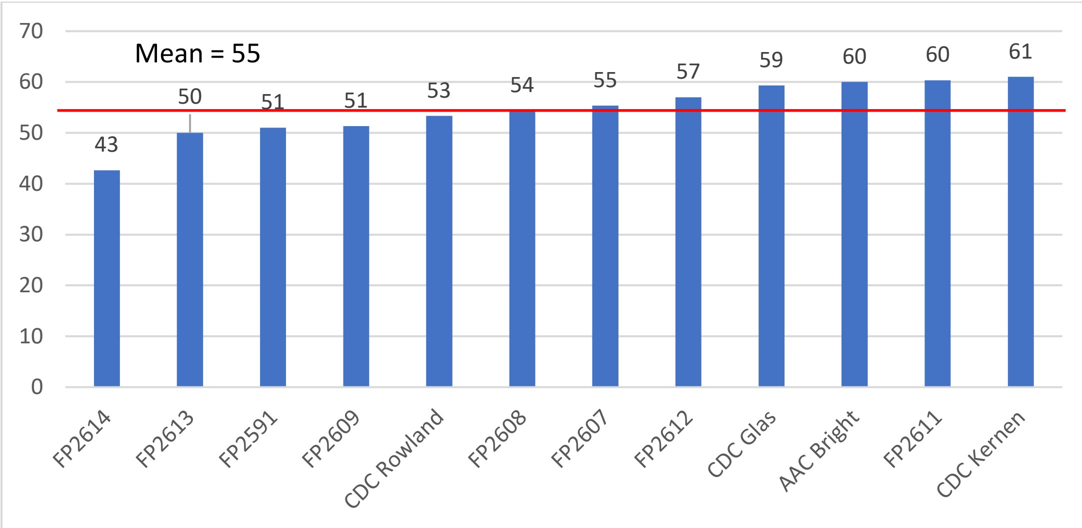


Figure 2: Flax height by variety at maturity (cm)



Summary statistics for the test are shown in Table 1.

Table 1: Mean (bu/ac) and % CV

Mean (bu/ac)	23.93
CV (%)	18.1

Materials and methods

Experimental Design:	Random Complete Block Design
Entries:	12
Seeding:	May 12
Harvest:	Sept 12

Data collected	Date collected
Height:	Aug 24
Determinate Habit:	First week of September
Dry down Habit:	First week of September
Maturity:	First week of September
Lodging:	Sept 12

Previous year's crop:	Millet
Soil Type:	Erickson Clay Loam
Landscape:	Rolling with trees to the east
Seedbed preparation:	Direct seeded

Table 3: Fertility Information

	Available		Added (actual)	Type
N	38	lb/ac	100 lb/ac	46-0-0
P	35	ppm	10 lb/ac	11-52-0-0
K	357	ppm	-	

P banded with seed; N side-banded

Flax Seed Treatment Evaluation

Adapted from a report prepared by Daryl Rex, MCA

Project duration: May 2023 – September 2025

Objectives: 1) To evaluate the efficacy of Manitoba registered flax seed treatments against soil borne diseases in two flax types (brown & yellow);
2) To evaluate the relationship between the seed treatment on germination, emergence, and ultimately yield in both types of flax.

Collaborators: Manitoba Crop Alliance

Background

Little recent testing has been done to evaluate commercially available seed treatments for flax in Manitoba. The project will evaluate commercially available seed treatments using labelled rates in both brown and yellow seeded flax varieties. The trial was planted at all 4 of the Manitoba Diversification Centres. This trial will be continued until 2026.

Materials and Methods

The seed of both flax varieties were seed treated in a jar. The flax seed treatment trial was established at all 4 Diversification Centres in 2023. A two-factorial plot design was used based upon the variety and seed treatment used (Table 1). Agronomic details for all sites is provided in Table 2.

Table 1: Treatments

Variety	Seed Treatment
AAC Bright	untreated
	Insure Pulse (low)
	Insure Pulse (high)
	Vitaflo
CDC Rowland	untreated
	Insure Pulse (low)
	Insure Pulse (high)
	Vitaflo

Table 2: Agronomic details for all growing sites

	Arborg	Carberry	Melita	Roblin
Planting Date	15-May	16-May	04-May	14-May
Planter Opener	double disc	disc opener	hoe type	Double disc
Planting Depth	3/4"	1 1/4"	1"	1/2"
Desiccation Date	--	25-Aug	17-Aug	--
Harvest Date	26-Sep	31-Aug	29-Aug	13-Sep

Results

The initial findings are shown in Table 3. At Roblin, significant differences were observed for plant establishment between the two varieties. CDC Rowland had better establishment than the yellow seeded variety, AAC Bright. Similar results were observed at Arborg and Melita, but no significant differences between plant establishment were observed at Carberry.

Table 3: Plant establishment by variety (A) and seed treatment (B)

	Arborg	**Carberry**	**Melita**	**Roblin**
Factor A (variety)				
AAC Bright	82.8^{A}	93.8	37.5^{A}	73.1^{A}
CDC Rowland	96.3^{B}	93.8	55.6^{B}	91.6^{B}
Prob.	0.0000	0.9997	0.0004	0.0000
CV (%)	5.40	5.70	26.21	8.93
Sign.	**Yes**	No	**Yes**	**Yes**
LSD	**3.6**	--	**9.0**	**5.4**
Factor B (seed treatment)				
Untreated	90.0^{B}	88.8^{A}	38.8	73.1^{A}
Insure Pulse – Low	93.1^{B}	89.4^{A}	46.3	85.0^{B}
Insure Pulse – High	93.8^{B}	96.9^{B}	53.1	85.0^{B}
Vitaflo	81.3^{A}	100.0^{B}	48.1	86.3^{B}
Prob.	0.0001	0.0006	0.1591	0.0054
CV (%)	5.40	5.70	26.21	8.93
Sign.	**Yes**	**Yes**	No	**Yes**
LSD	**5.0**	**5.6**	--	**7.6**

Table 4 shows a significant difference in yield, with AAC Rowland yielding higher than AAC Bright at all locations.

Table 4: Yield summary by variety for all locations.

Variety	**Arborg**	**Carberry**	**Melita**	**Roblin**
AAC Bright	17.7^{A}	29.9^{A}	45.9^{A}	16.5^{A}
CDC Rowland	21.1^{B}	32.0^{B}	52.7^{B}	22.8^{B}
Prob.	0.0001	0.0084	0.0000	0.0000
CV (%)	10.43	9.37	6.18	14.49
Sign.	**Yes**	**Yes**	**Yes**	**Yes**
LSD	**1.5**	**2.2**	**2.2**	**2.1**

Agronomy (Roblin)

Emergence:	10 days after seeding
Flowering Date:	First week of July
Fusarium Wilt	Mid season
Seedling Blight	Mid season

Root Rot	Mid season
Aster Yellows/Pasmo	Mid season
Height:	Aug 17
Maturity:	Last week of August
Yield:	Sept 13
Moisture:	Sept 13

Previous year's crop:	Millet
Soil Type:	Erickson Clay Loam
Landscape:	Rolling with trees to the east
Seedbed preparation:	Direct seeded

Table 2: Fertility Information

	Available		Added (actual)	Type
N	27	lb/ac	100 lb/ac	46-0-0
P	34	ppm	10 lb/ac	11-52-0-0
K	269	ppm	-	

P banded with seed; N side-banded

Table 3: Pesticide Application

Crop stage	Date	Product	Rate
Pre-emerge	May 15	Glyphosate	640 ml/ac
		Authority	118 ml/ac
In season	June 15	Clethodim	118 ml/ac
		Basagran	710 ml/ac

Plots were also handed weeded throughout the season, as needed.

Intercrop

Preliminary Results: Establishing an Annual Crop-Living Mulch System at Four Manitoba Locations

Project duration: May 2023 – September 2024

Objectives: To examine the performance of living mulches planted with a spring wheat crop, as well as the impact on wheat grain yield, at four Manitoba locations.

Collaborators: Jessica Frey, Parkland Crop Diversification Foundation
Joanne Thiessen Martens Department of Soil Science, University of Manitoba
Manitoba Crop Alliance
Prairies East Sustainable Agriculture Initiative
Manitoba Crop Diversification Centre
Westman Agricultural Diversification Organisation

Background

The use of perennial cover crops outside of the normal growing season provides well-documented benefits to the soil. In Manitoba, where the growing season typically consists of 90-110 frost-free days, establishing a cover crop that persists into the next growing season is a niche form of cover cropping that is termed "living mulch". Perennial legumes are of particular interest in this system for their ability to take up atmospheric nitrogen into their root tissues. When a legume living mulch is planted with an annual field crop, the latter can benefit from the transfer of nitrogen though direct contact with the roots of the legume crop (Xiao et al., 2004). After harvest, the legume remains in the soil, providing similar benefits to the following crop.

Growing multiple crops in the same system results in three possible outcomes: complementarity, facilitation, or competition.

- Complementary systems are typically observed in nature, where plants of different species make use of the same soil space and other resources at different times, varying depths, and even different chemical forms, creating a diverse, resilient, and multipurpose system (Martens et al., 2015). The potential for species to complement each other comes about because of differences in root structure, and timing and balance of nutrient demand (Dowling et al., 2021a).
- Facilitative systems are interplant relationships that take time to develop, such as the decomposition of roots and organic matter from one plant that then contributes to the plant and soil health of the other. In the case of legumes, this leads to an increase in soil N (Wivstad, 1999).
- A competitive system is described by (Dowling et al., 2021a) as one in which "two individuals in a stand interact in such a way that at least one exerts a negative effect on the other", such as through competition for water, soil nutrients and light. In an agricultural setting, this interaction will typically result in decreased yields and financial loss.

The goal of a living mulch system is to take advantage of the complementary and facilitative features of the interacting crop species, while minimizing competition. To achieve this, the living mulch can be seeded in Year 1 at the same time and the same depth as the annual field crop, which allows the more vigorous annual field crop to establish ahead of the slower growing living mulch crop. After harvest of the annual field crop, the living mulch grows without competition.

In Year 2, the living mulch is strategically set back through mowing or a non-lethal application of herbicide. This is done to decrease the competitiveness of the living mulch before the seeding of the annual field crop. Importantly, research indicates that damage caused to the top growth of a legume can result in a release of nitrogen in a stable, plant-available form from the legume's roots (Bergkvist, 2003). This release could provide a timely boost of nutrients to the annual field crop.

Materials and Methods

This report presents preliminary results for a spring wheat-living mulch system established in May 2023 at four Manitoba sites (Arborg, Carberry, Melita, and Roblin). Four legume species and one grass species were seeded in the same row and at the same depth as wheat.

Table 1: Treatments

Wheat- only Control 1	Wheat-only Control 3	Wheat – Alfalfa	Wheat – White Clover
Wheat-only Control 2	Wheat – Sweet Clover	Wheat – Red Clover	Wheat – Perennial Ryegrass

Wheat-only control plots will be assigned differing fertility targets in Year 2

Table 2: Site Profiles

	Arborg	Carberry	Melita	Roblin
Soil Sample Date	08-May	28-Apr	28-Apr	27-Apr
Stubble	Canola	Canola	Canola	Millet
Soil Preparation	Direct seed	Direct seed	Direct seed	Direct seed
Seeding Date	23-May	12-May	10-May	12-May
Moisture at Seeding	dry	good	Very good	poor
Added N	All sites background N topped up to 140 lb/ac			
Added P	All sites applied P to match 70 bu/ac target yield			
Pre-emergence spray	May 31 Pardner @ 0.4 L	May 8 Glyphosate @ 0.8L + Heat @ 60ml	May 10 Roundup @ 0.67L + Aim @ 20ml	Glyphosate @ 0.64 L
Mid season spray	Jul 14 Pardner @ 0.4L	Jun 19 Basagran Forte @ 0.8 L + UAN @ 1.6L	Jun 1 Koril @ 0.5L (3 leaf)	Jun 21 Axial @ 0.5L + Basagran Forte @ 0.7L
Anthesis	12-Jul	06-Jul	27-Jun (heading)	28-Jun
Soft Dough	first week August	20-Jul	17-Jul	03-Aug
Reseed	NA	30-Aug	05-Sep	NA

Table 3: Seasonal Weather Data January 1 to December 21 2023

	Arborg		Carberry		Melita		Roblin	
	Actual	**% Normal**	**Actual**	**% Normal**	**Actual**	**% Normal**	**Actual**	**% Normal**
Precipitation	296	67	255	59	438	89	248	58
Crop Heat Units	3116	115	3097	115	3155	109	2888	118
Growing Degree Days	1898	119	1922	123	1970	116	1757	124

The seeding rate for all the mulch crops targeted the high end of recommendations. The wheat seeding rate targeted the low end of recommendations and was uniform across all treatments. The seeding rates are provided in Table 4.

Table 4: Seeding rate by crop type

Crop type (variety)	Seeding rate
Wheat (Landmark)	250 plants/m2
Alfalfa (Stellar II)	12 lb/ac
Red Clover (Single Cut)	10 lb/ac
Sweet Clover (Yellow Blossom)	10 lb/ac
White clover (Bombus)	6 lb/ac
Perennial Ryegrass (Soraya)	12 lb/ac

Results and Discussion

Establishment

Wheat establishment at three out of the four sites was found to be unaffected by the presence of the living mulch as compared to the wheat-only control plots, even though precipitation received between May 1 and June 15 was well below the 30-year average at all four locations (Arborg 21%, Carberry 41%, Melita 63%, Roblin 67%). In only one case (Roblin) was the emergence for wheat seeded with alfalfa found to be significantly lower. However, subsequent measurements throughout the summer did not show those wheat plots to be disadvantaged. Establishment for wheat is shown in Table 5.

Table 5: Wheat Establishment in pl/m2 (target plant stand 250 pl/m2)

Treatment	Arborg	Carberry	Melita	Roblin
Seeding Date	May 23	May 12	May 10	May 12
Date of plant count	May 30	May 30	May 23	May 29
Wheat-only Control	351	255	234	122
Sweet Clover	368	225	224	80
Alfalfa	401	276	248	56
Red Clover	374	266	254	81
White Clover	410	264	251	76
Perennial Ryegrass	377	280	253	72
SEM	27	2	21	12
p-value	0.7	0.4	0.9	0.03

Mulches in Melita established equally well, with no significant outliers performing better or worse. Alfalfa established significantly better at both Arborg and Carberry with sweet clover not far behind alfalfa in Carberry. Alfalfa also established very well in Roblin, although it was initially surpassed by white clover. Establishment for mulches is shown in Table 6.

Table 6: Mulch Establishment (pl/m2)

Treatment	Arborg	Carberry	Melita	Roblin
	Jun 8	Jun 7	May 31	Jun 9
Sweet Clover	18	110	148	89
Alfalfa	90	148	158	193
Red Clover	12	49	101	128
White Clover	25	22	145	206
Perennial Ryegrass	37	97	130	167
SEM	11	13	20	15
p-value	0.02	0.0002	0.3	0.0007

Summer Wheat Biomass

No significant differences were noted between treatments at any of the sites for biomass produced by the wheat plants at soft dough stage when compared to the wheat-only control. The ability of wheat to produce enough biomass to subsequently harness and store the sun's energy through photosynthesis was unaffected by the competitive presence of the mulch.

Table 7: Wheat Biomass at Soft Dough (kg/ha)

Treatment	Arborg	Carberry	Melita	Roblin
Date	Aug 9	Jul 24	Jul 24	Aug 3
Wheat-only Control	9786	6733	7213	7774
Sweet Clover	8682	7713	6412	7128
Alfalfa	9006	7120	7281	6715
Red Clover	8358	6733	7728	7291
White Clover	10,155	7532	7296	7357
Perennial Ryegrass	8543	6990	7059	6981
SEM	695	571	588	409
p-value	0.4	0.8	0.7	0.9

Mulches did not perform equally well for production of biomass. By late July, biomass samples of the mulch crops began to show some clear advantages or disadvantages for the individual mulches by site. The mulches with superior establishment at Arborg and Carberry continued to perform the best with perennial ryegrass coming forward as a late contender in Arborg. In Roblin, good early establishment did not guarantee the most biomass production. Red clover and alfalfa produced the most biomass, but a sharp decline was seen between the emergence of white clover and its subsequent biomass production, while sweet clover (which did not establish well) demonstrated a marked increase of growth by late July.

Table 8: Summer Mulch Biomass (kg/ha)

Treatment	Arborg	Carberry	Melita	Roblin
Date	Aug 9	Jul 24		Aug 3
Sweet Clover	14	820	-	94
Alfalfa	121	895	-	153
Red Clover	-	-	-	125
White Clover	-	-	-	10
Perennial Ryegrass	159	-	-	11
SEM	34	337	-	18
p-value	0.02	0.9	-	0.0002

Anomalies

The following anomalies occurred at the participating sites:

- At Melita, all mulch crops were killed due to a spraying error of Bromoxynil at Melita. These plots were reseeded after the wheat harvest, with the aim of continuing the trial in Year 2.
- At Carberry, red clover, white clover, and perennial ryegrass was reseeded at the end of summer, due to negligible emergence for those crops.

- At Arborg, red clover and white clover produced very low amounts of biomass, but based on the plant counts, the crops were not reseeded. The plants are expected to produce sufficient biomass in Year 2.

It is interesting to note that, except for perennial ryegrass in Arborg, the mulches with the lowest biomass production were the ones that have fibrous root systems. It is possible that these mulches were less able to compete with wheat for the limited moisture, as they were exploring the same rooting zone.

Wheat Yield and Protein

Whereas yields and protein content differed between sites, no significant difference was observed between treatments on each site when compared to the wheat-only control. Although higher yields and protein content were observed at Arborg as compared to the other sites, the results remain comparable with the wheat-only control, with no significant difference between treatments. Wheat-only treatments are likewise comparable to the other wheat-mulch treatments at Roblin and Carberry (Table 9).

Table 9: Wheat Yield (bu/ac) and Protein content (%)

Treatment	**Arborg**		**Carberry**		**Melita**		**Roblin**	
Harvest Date	Sep 13		Aug 29		Aug 17		Aug 30	
	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein
Wheat-only Control	92	15	37	12	60	12.4	60	12.9
Sweet Clover	91	15	38	12	53	12.0	61	13.2
Alfalfa	88	14.2	39	12	59	12.8	53	13.6
Red Clover	91	15.1	33	13	66	11.8	57	12.9
White Clover	94	15.1	40	12	53	13.4	58	13.0
Perennial Ryegrass	83	14.9	40	12	60	12.0	60	13.3
SEM	6	0.3	2	1	5	0.7	2	0.3
p-value	0.8	0.4	0.2	0.6	0.5	0.6	0.4	0.5

Post-harvest Mulch Performance

After the annual field crop is harvested, the mulch has unrestricted access to sunlight and soil moisture. Biomass samples taken in the late fall indicate the mulch's ability to grow before a killing frost, fixing nitrogen in the case of the legumes, and enhancing features such as soil structure and aeration, water penetration, and mycorrhizal activity. Table 10 shows the post-harvest performance of the mulch crops.

*Table 10: Post-harvest mulch performance (kg/ha)**

Treatment	**Arborg**	**Carberry**	**Melita**	**Roblin**
Date	Oct 18	Oct 20	Oct 20	Oct 17
Sweet Clover	84	R	R	290
Alfalfa	452	273	R	557
Red Clover	-	301	R	339
White Clover	-	R	R	118
Perennial Ryegrass	1365	R	R	297
SEM	203	83	-	40
p-value	0.03	0.8	-	0.0001

** R = Reseeded after wheat harvest*

Trends already observed at earlier points in the season continued with the fall biomass cut. Alfalfa was the only mulch crop with a significantly higher level of biomass production at Roblin. Alfalfa also performed well (though not "best") at Carberry and Arborg. Perennial ryegrass produced the most biomass at Arborg and red clover produced slightly more biomass than alfalfa at Carberry. For the mulches that were reseeded at Carberry and Melita, perennial ryegrass re-established significantly better than the other reseeded mulches.

Discussion

The dry field conditions in early 2023 made challenges to the establishment of the treatments more readily observable than if soil moisture had been abundant. Each of the mulch crops has a different type of rooting system: whereas wheat has a fibrous system of roots, alfalfa and sweet clover are best described as having deep tap roots. It is hypothesized that these differences are a determining factor in whether the interaction that develops between the two crops is complementary (i.e., one that drives both crops to greater exploration of their soil resources), or competitive (i.e., where one crop overpowers the other for water and nutrients). When moisture is scarce, wheat roots will tend to explore more laterally for soil moisture, while alfalfa and sweet clover will tend to explore deeper into the soil. Dowling et al. (2021) refer to this more complementary interaction as "sparing" relationship, in which each crop "spares" soil moisture for the other. Conversely, when moisture is scarce, the more fibrous root systems of red clover, white clover, and perennial ryegrass can result in direct competition with the root systems of wheat plants, as each plant will search for moisture.

Biomass production at mid-season is an important measurement for both crops that have been seeded together. For wheat, this measurement, taken at soft dough stage, represents how much resources the plants have been able to allocate to vegetative growth throughout the season. The measurement corresponds with the photosynthetic capacity to harness and store energy for the next generation of seeds (yield) and protein storage (as a measure of seed quality). A significant decrease in biomass production for wheat seeded with a mulch crop, as compared to a wheat-only crop, would indicate that the mulch had outcompeted the wheat for water and nutrients.

For the mulch crop, biomass production signifies the plant's ability to perform its beneficial functions. Although not measured directly in this project, it is well understood that below-ground biomass (roots) increases in tandem with above-ground biomass. More root growth translates to increased soil aeration, water penetration and soil structure, the ability to form beneficial fungal hyphae networks, and increased surface area for nitrogen fixing soil bacteria to nodulate (Blackshaw et al., 2010). In the complementary relationship between legumes and nitrogen fixing bacteria, greater photosynthetic capacity for legume mulches also enhances the bacteria's nitrogen fixing potential. In an intercrop scenario, excess nitrogen can be shared with the non-leguminous annual field crop.

The measurement of greatest interest in Year 1 is wheat yield and protein content. The comparable wheat yields for intercropped and wheat-only treatments is an indicator that, at the very least, the competition from the mulch has not detracted from the quantity (yield) and quality (protein content) of wheat that was produced.

Summary

Ultimately, it is desirable for both plants in this system to do well. Whereas no decline in wheat performance is an encouraging result, there was also no increase in wheat grain yield. This indicates that, in the year of establishment, the mulch crops did not provide observable advantages to the wheat crop (such as nitrogen resulting in increased yield or protein content). Based on the relatively dry growing conditions and the overall low levels of biomass production that were observed, these results are not surprising.

Year 2 will provide another layer for understanding the interactions between the annual field crop (canola) and the living mulch. As a tap-rooted crop, it is anticipated that the interactions between canola and the mulch crops will be effectively reversed: the deep-rooted alfalfa and sweet clover crops may develop a more competitive relationship with canola, whereas the more fibrous-rooted crops may develop more complementary relationships. Nevertheless, the release of nitrogen caused by disturbing the top growth of the mulches, is expected to benefit the canola crop during critical phases of its development.

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Oat Trials

University of Saskatchewan Standard Oat Yield Trial

Project duration: May 2023 – September 2023
Objective: To evaluate oat entries for the Crop Development Centre, University of Saskatchewan
Collaborators: Aaron Beattie Crop Development Centre University of Saskatchewan

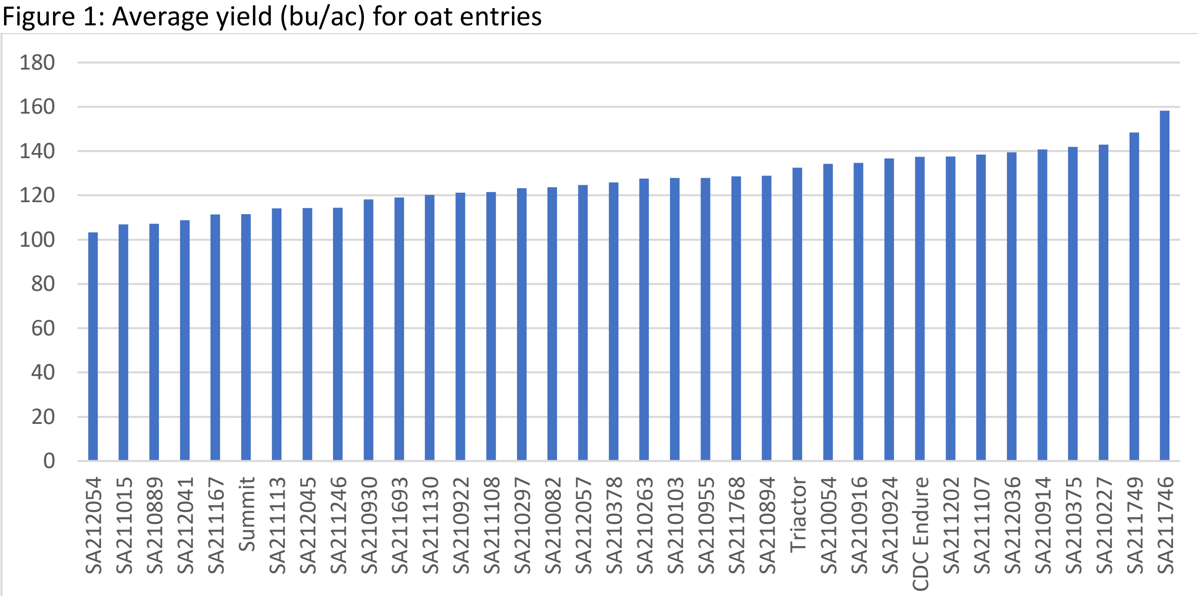
Background
Adapted from the Crop Development Centre (CDC) website: The CDC was established in 1971 to improve economic returns for farmers and the agriculture industry in western Canada by improving existing crops, creating new uses for traditional crops, and developing new crops.

Results
The average yield for oat entries is shown in Figure 1. 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 Design
Entries:	36 varieties
Seeding:	May 9
Harvest:	Sept 6

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



Yields adjusted to 14% moisture

Data collected	Date collected
Rust:	Throughout season
Height:	Aug 21
Lodging:	Sep 6
Yield:	Sep 6
Moisture:	Sep 6

Agronomic info

Previous year's crop: Millet
Soil Type: Erickson Clay Loam
Landscape: Rolling with trees to the south
Seedbed preparation: Direct seeded

Table 1: Spring 2023 Soil Test

	Available		Added (actual)	Type
N	66	lb/ac	54 lb/ac	46-0-0
P	48	ppm	10 lb/ac	11-52-0-0
K	194	ppm		

Table 2: Spraying Information

Crop stage	Date	Product	Rate
Pre-emerge	May 11	Heat	30 ml/ac
		Glyphosate	640 ml/ac
		Glyphosate	670 ml/ac
In-crop	Jun 19	Banvel II	117 ml/ac

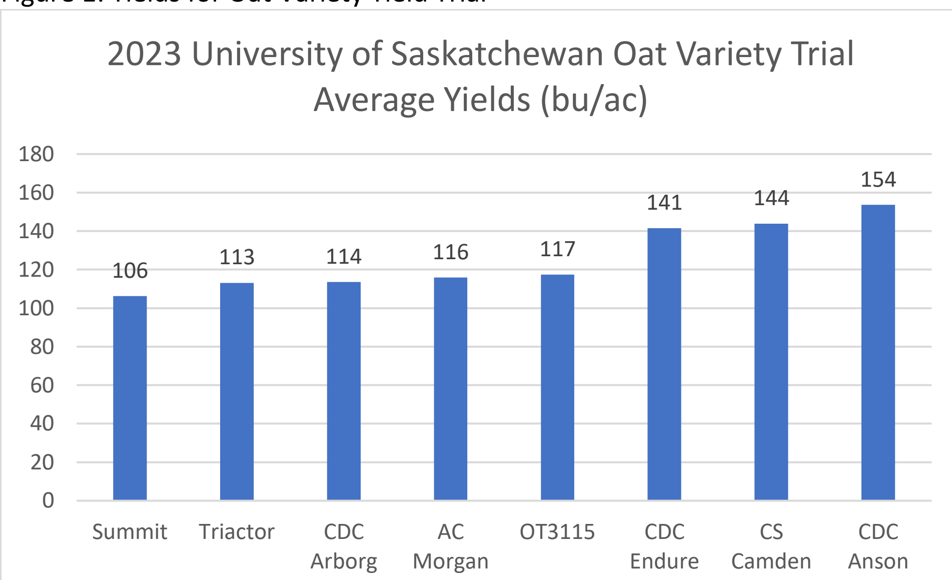
University of Saskatchewan Oat Yield Variety Trial

Project duration: May 2023 – September 2023
Objectives: To evaluate oat varieties for the University of Saskatchewan
Collaborators: Aaron Beattie, Crop Development Centre Oat and Barley Breeding Lab

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
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: Yields for Oat Variety Yield Trial



Average yield for oat entries adjusted to 14% moisture

Materials & Methods
Experimental Design: Random Complete Block Design
Entries: 8 entries, 3 replications
Seeding: May 9
Harvest: Sep 6

<u>Agronomic information</u>
Previous year's crop: Millet
Soil Type: Erickson Loam Clay
Landscape: Rolling with trees to the east
Seedbed preparation: Direct seeded

Data collected	Date collected
Yield:	Sep 6
Moisture:	Sep 6

Table 1: Spring 2023 Soil Test

	Available		Added (actual)	Type
N	66	lb/ac	54 lb/ac	46-0-0
P	48	ppm	10 lb/ac	11-52-0-0
K	194	ppm		

Table 2: Spraying Information

Crop stage	Date	Product	Rate	
Pre-emerge	May 11	Heat	30	ml/ac
		Glyphosate	640	ml/ac
		Glyphosate	670	ml/ac
In-crop	Jun 19	Banvel II	117	ml/ac

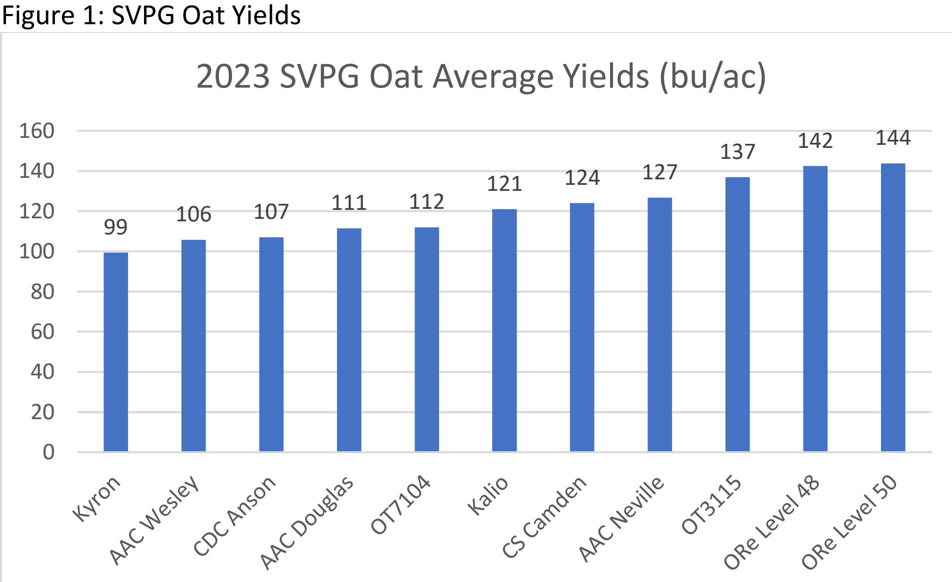
SVPG Oat Variety Evaluation

Project duration: May 2023 – September 2023
Objective: To evaluate oat entries for the Saskatchewan Variety Performance Group
Collaborators: Aaron Beattie, Crop Development Centre University of Saskatchewan

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 average yield for oat entries is shown in Figure 1. 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: SVPG Oat Yields



Yields adjusted to 14% moisture

Materials and methods
Experimental Design: Random Complete Block Design
Entries: 11 varieties
Seeding: May 9
Harvest: Sep 7

Table 1: Varieties included at Roblin 2023

AAC Douglas	AAC Wesley	CS Camden	Kyron	OreLevel50	OT7104
AAC Neville	CDC Anson	Kalio	OReLevel 48	OT3115	

Data collected	Date collected
Height:	Aug 21
Maturity:	First week of August
Lodging:	Sep 7
Yield:	Sep 7
Moisture:	Sep 7

Agronomic info

Previous year's crop:	Millet
Soil Type:	Erickson Clay Loam
Landscape:	Rolling with trees to the south
Seedbed preparation:	Direct seeded

Table 2: Spring 2023 Soil Test

	Available		Added (actual)	Type
N	66	lb/ac	54 lb/ac	46-0-0
P	48	ppm	10 lb/ac	11-52-0-0
K	194	ppm		

Table 3: Spraying Information

Crop stage	Date	Product	Rate
Pre-emerge	May 11	Heat	30 ml/ac
		Glyphosate	640 ml/ac
		Glyphosate	670 ml/ac
In-crop	Jun 19	Banvel II	117 ml/ac

Pulse Trials

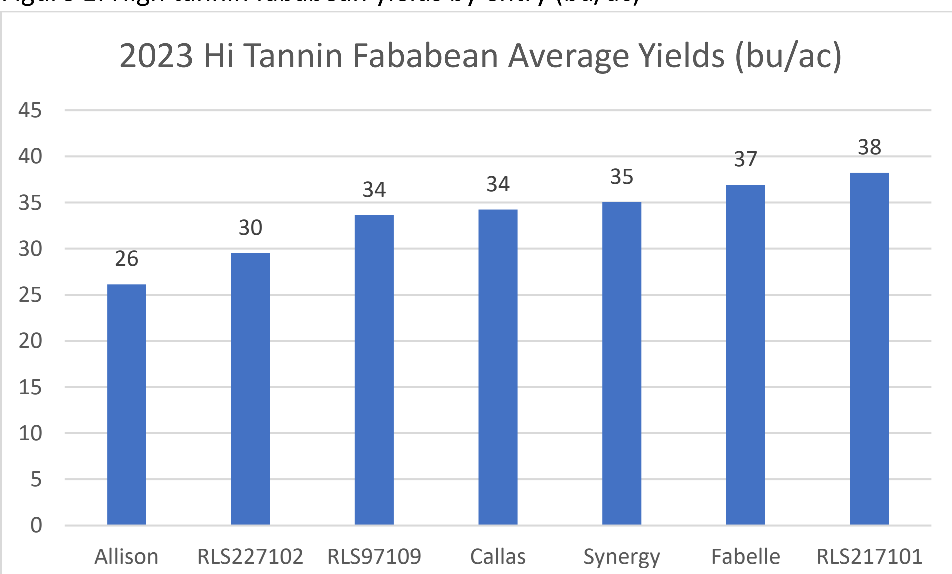
Fababean High and Low Tannin Variety Evaluation

Project duration: May 2023 – September 2023
Objectives: Evaluate
Collaborators: Jaret Horner, Crop Development Centre, University of Saskatchewan

Background (adapted from *Historical review of faba bean improvement in western Canada*)
Faba bean (Vicia faba L.) was considered a minor crop in the Canadian prairies until recently, but its potential for cultivation is increasing due to its positive environmental impact and economic value. Although traditional breeding methods have proved useful, in the last decade, faba bean improvement has benefited from advances in genetics, biochemistry and molecular breeding tools. The overall breeding goal is to develop high yielding germplasm with improved agronomic characteristics that will be of economic value to the emerging faba bean sectors, including the plant protein industry. To maximize value and acceptance by producers, processors and the food industry as a source of protein and dietary fibre, future faba bean varieties need to be high-yielding, have diverse seed size classes, disease resistance, genetically low vicine–convicine concentration, and have wider adaptation to different agro-ecological zones of Canada.

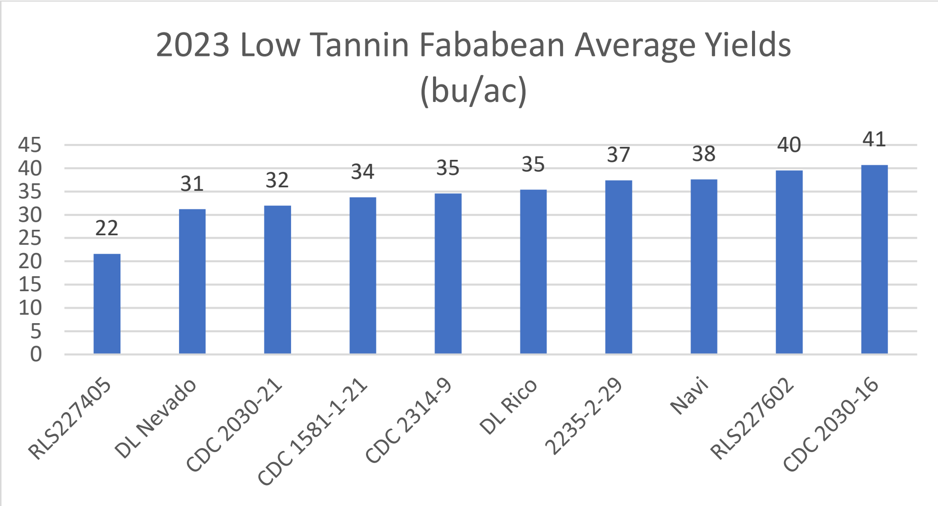
Results
The yield results (bu/ac) for the Roblin site are shown in Figures 1 and 2.

Figure 1: High tannin fababean yields by entry (bu/ac)



Yields adjusted to 16% moisture

Figure 2: Low tannin fababean yields by entry (bu/ac)



Yields adjusted to 16% moisture

Materials and methods

Experimental Design:	Random Complete Block Design
Entries:	17 varieties
Seeding:	May 11
Harvest:	Sept 19

Data collected	Date collected
Yield:	Sept 19
Moisture:	Sept 19

Agronomic information	
Previous year's crop:	Millet
Soil Type:	Erickson Clay Loam
Landscape:	Rolling with trees to the east
Seedbed preparation:	Direct seed

Table 1: Fertility Information

	Available	Added (actual)	Type
N	57 lb/ac	-	46-0-0
P	38 ppm	10 lb/ac	11-52-0-0
K	528 ppm	-	-

Inoculated with Nodulator FB Pea; P banded with seed

Table 2: Pesticide Application

Crop stage	Date	Product	Rate
Pre-emerge	May 9	Glyphosate	640 ml/ac
		Authority	118 ml/ac
In season	June 23	Basagran Forte	910 ml/ac
		Assure II	300 ml/ac

Saskatchewan Pulse Growers Fababean Variety Evaluation

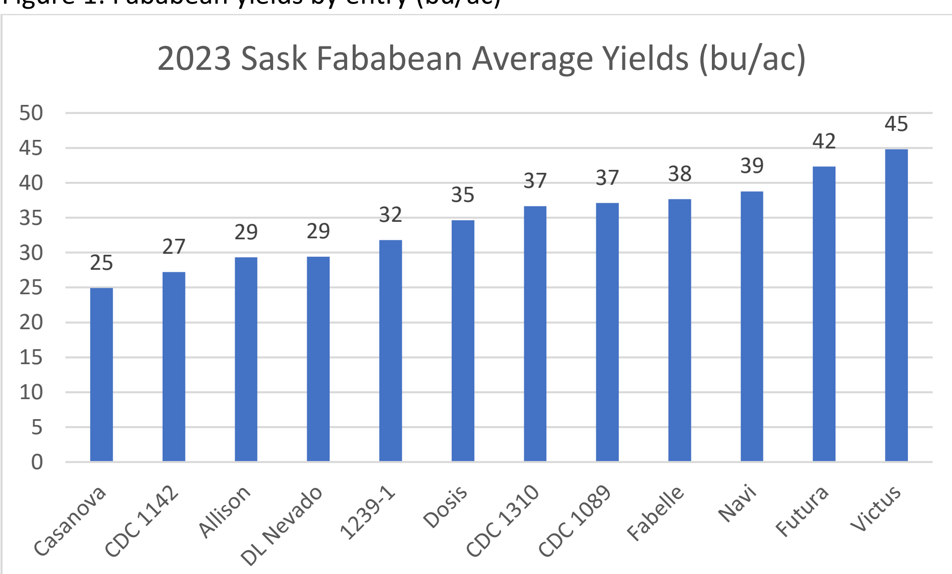
Project duration: May 2023 – August 2023
Objectives: To evaluate fababean entries for the Saskatchewan Pulse Growers (SPG)
Collaborators: Laurie Friesen, SPG

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.

(Adapted from the SaskSeed Guide) Fababean regional trials began in 2006 to accommodate growing interest in this crop as a nitrogen-fixing high protein food and feed grain in moist areas. White-flowered types are zero-tannin. All coloured flower types have seed coats that contain tannins and may be suitable for export food markets if seed size and quality match customer demand. Low vicine white flower types have expanding demand in the plant-based protein extraction industry. Plant breeders are moving rapidly to eliminate vicine and convicine (vc) through the introduction of a gene in new varieties that reduces vc by 99 per cent.

Results
The average yield for fababean 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: Fababean yields by entry (bu/ac)



Yields adjusted to 16% moisture

Materials and methods

Experimental Design:	Random Complete Block Design
Entries:	12 varieties
Seeding:	May 11
Harvest:	Sept 29

Data collected	Date collected
Yield:	Aug 28
Moisture:	Aug 28

Agronomic information	
Previous year's crop:	Millet
Soil Type:	Erickson Clay Loam
Landscape:	Rolling with trees to the east
Seedbed preparation:	Direct seed

Table 1: Fertility Information

	Available		Added (actual)	Type
N	57	lb/ac	-	46-0-0
P	38	ppm	10	11-52-0-0
K	528	ppm	-	-

Inoculated with Nodulator FB Pea; P banded with seed

Table 2: Pesticide Application

Crop stage	Date	Product	Rate
Pre-emerge	May 9	Glyphosate	640 ml/ac
		Authority	118 ml/ac
In season	June 23	Basagran Forte	910 ml/ac
		Assure II	300 ml/ac

Saskatchewan Pulse Growers Pea Variety Trial

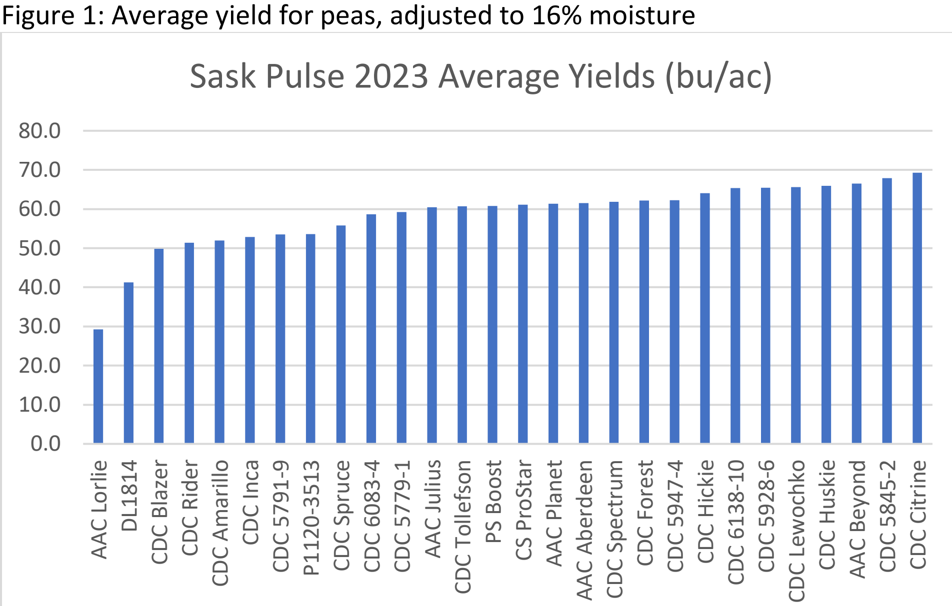
Project duration: May 2023 – August 2023
Objectives: To evaluate pea entries for the Saskatchewan Pulse Growers (SPG)
Collaborators: Laurie Friesen, SPG

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.

(Adapted from the SaskSeed Guide) Yellow peas are the most widely grown peas in Saskatchewan, followed by green peas and specialty types such as dun, maple, marrowfat and forage peas. Most varieties have white flowers and are suitable for human consumption or livestock feed markets. Nearly all varieties have a semi-leafless leaf type with tendrils instead of leaflets, which help provide better standability. Marrowfat varieties have large, blocky, green seeds. Forage peas are grown for biomass, typically in mixture with barley, oat or triticale. Red peas have red cotyledons. Maple peas have purple flowers, pigmented seed coats with mottled pattern and yellow cotyledons. Dun peas have purple flowers, pigmented seed coats (without a mottled pattern) and yellow cotyledons. They are dehulled and sold in human consumption markets like yellow pea varieties.

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 peas, adjusted to 16% moisture



Yields are adjusted to 16% moisture

Materials and methods

Experimental Design: Random Complete Block
Entries: 28 entries; 3 replications
Seeding: May 8
Harvest: Sep 19

Table 1: Varieties included in trial

CDC Lewochko	CDC Spectrum	CDC Hickie	CDC Forest
CDC Amarillo	CDC 5947-4	CDC Spruce	CDC Tollefson
CDC Inca	CDC 5779-1	5845-2	CDC Rider
CDC Huskie	AAC Lorlie	CS ProStar	P1120-3513
CDC Citrine	AAC Beyond	CDC 5791-9	CDC 5928-6
AAC Planet	AAC Julius	PS Boost	DL 1814
CDC 6083-4	CDC 6138-10	CDC Blazer	AAC Aberdeen

Data collected	Date collected
% Plant Stand:	post emergence
Yield:	Sep 19
Moisture:	Sep 19

Agronomic info

Previous year's crop: Millet
Soil Type: Erickson Clay Loam
Landscape: Rolling with trees to the east
Seedbed preparation: Direct seeded

Table 2: Spring 2023 Soil Test

	Available		Added (actual)	Type
N	27	lb/ac	-	-
P	34	ppm	10 lb/ac	11-52-0-0
K	269	ppm	-	-

Inoculant added with seed; P banded with seed

Table 3: Pesticide Application

Crop stage	Date	Product	Rate
Pre-emerge	May 9	Glyphosate	640 ml/ac
		Authority	118 ml/ac
In-crop	Jun 15	Clethodim	150 ml/ac
		Basagran	710 ml/ac
		Viper ADV	400 ml/ac
		UAN 28%	810 ml/ac
	Jun 23	Basagran Forte	600 ml/ac
		Assure II	300 ml/ac

Evaluating Insecticide Pea Seed Treatments for Pea Leaf Weevil Management

Adapted from a report by Laura Schmidt, Production Specialist – West, MPSG

Project duration: May 2023 – October 2023

Objectives: To evaluate the efficacy of pea seed treatments in controlling pea leaf weevil in field peas.

Collaborators: Manitoba Pulse and Soybean Growers (MPSG)

Background

Pea leaf weevils (PLW) were first confirmed in Manitoba in 2019. Since then, they have quickly become established in western Manitoba and are found further east every year (Figure 1).

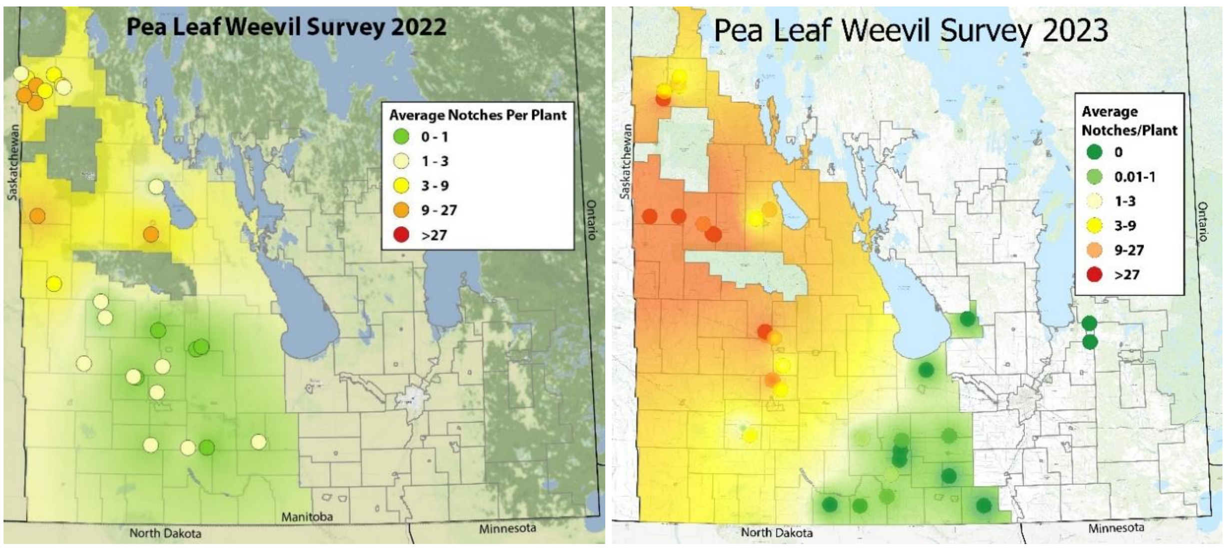


Figure 1. Pea leaf weevil distribution in Manitoba in spring 2022 (L) and 2023 (R).

PLW adults overwinter in perennial legumes and shelterbelts. In the spring they emerge and fly to their host crops, peas and faba beans. Adult PLW feed on the leaf edges of these crops leaving behind a distinct notching shape (Figure 2).


Figure 2. Adult pea leaf weevil feeding on pea leaf edges, with distinct leaf notches. This defoliation does not cause yield loss.

Once PLW adults have begun feeding on the crop, they lay eggs on the soil surface. Those eggs hatch and their larvae burrow below ground to the root nodules of the crop to feed. Larvae hollow out root nodules, robbing the plant of biological nitrogen fixation (Figure 3). These feeding wounds also often result in an increase in root rot infections, further damaging the plant.

Figure 3. Pea leaf weevil larvae feed on root nodules, robbing the plant of nitrogen fixation and creating wounds for root rots to infect.

Economic thresholds are available for foliar insecticide applications, however, foliar applications do not prevent yield loss since eggs have already been laid in the field and there are multiple migrations of PLW adults into the field. As a result, foliar applications are considered 'revenge sprays' since they do not actually prevent the larvae from feeding.

Previous research has indicated that preventative insecticide seed treatments are a more effective option to managing PLW. However, it is uncertain at what PLW population level we can expect to see a return on investment to using an insecticide seed treatment in peas. The goal of this research is to compare existing registered insecticide pea seed treatments for PLW control (Table 1) and to compare results with PLW population pressure to determine when we may see a return on investment to these products.

Table 1. Available registered seed treatments for pea leaf weevil control in peas.

Trade Name	Active Ingredient	Rate (mL/100 kg seed)
Cruiser 5FS	thiamethoxam	83
Stress Shield 600	imidacloprid	208
Lumivia CPL	chlorantraniliprole	96

Results

In 2023, small-plot trials were established at Roblin with PCDF and Swan River with New Era Ag comparing untreated peas to peas treated with Cruiser 5FS (thiamethoxam), Stress Shield 600 (imidacloprid) or Lumivia CPL (chlorantraniliprole). One field-scale on-farm trial was also established near Roblin with MPSG's On-Farm Network comparing untreated peas to those treated with imidacloprid and Rancona trio (a fungicide seed treatment).

Results presented here are preliminary and these trials are planned to continue for another two years. Peas were seeded late in 2023 due to delays getting the trial established.

At V6, total leaf notches per plant were counted on 10 plants in each plot to provide an indication of pea leaf weevil predation and population (Figure 4). There were no differences in PLW predation among seed treatments and the untreated check at Roblin or at the on-farm trial in 2023. At Swan River, PLW predation was reduced with Cruiser (thiamethoxam) seed treatment compared to untreated peas.

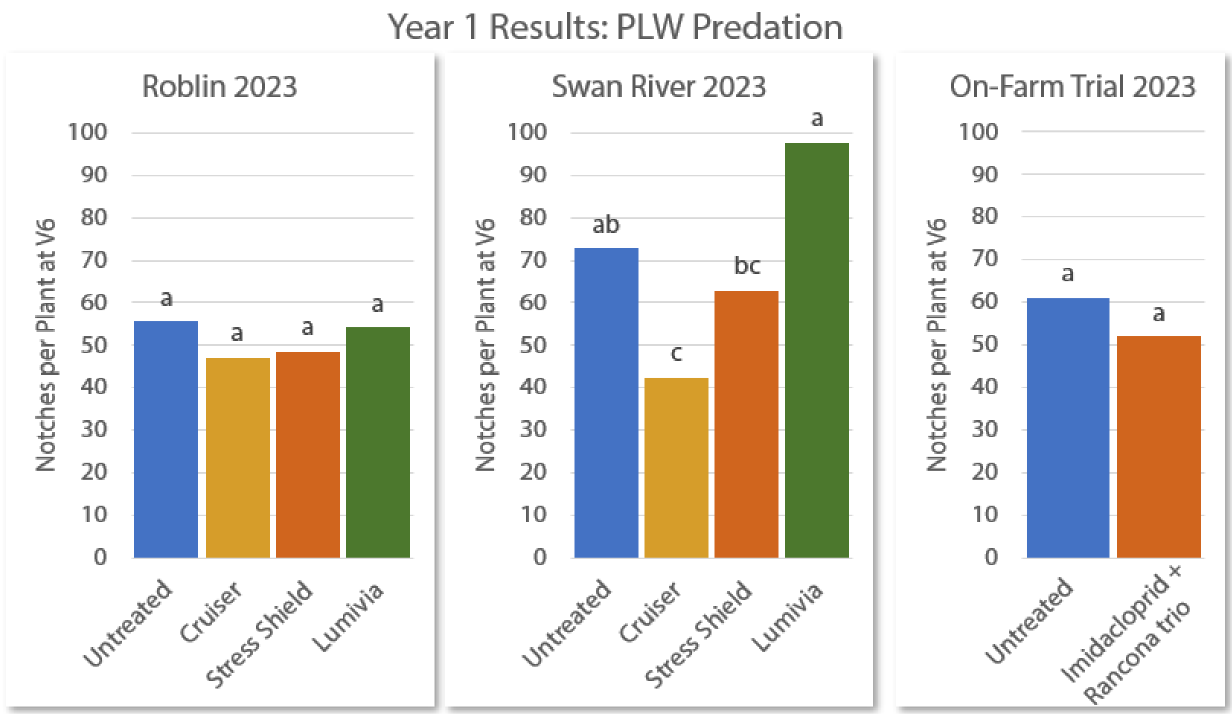


Figure 4. Average total leaf notches per plant at V6 at Roblin PCDF, Swan River and at an on-farm trial near Roblin in 2023. Within each site-year, bars followed by different letters are significantly different at $p < 0.05$.

There were no statistically significant differences in yield among pea seed treatments and the untreated check at either Roblin or Swan River in 2023 (Figure 5). Yields were poor at Roblin due to late seeding into dry soils followed by challenging growing season conditions.

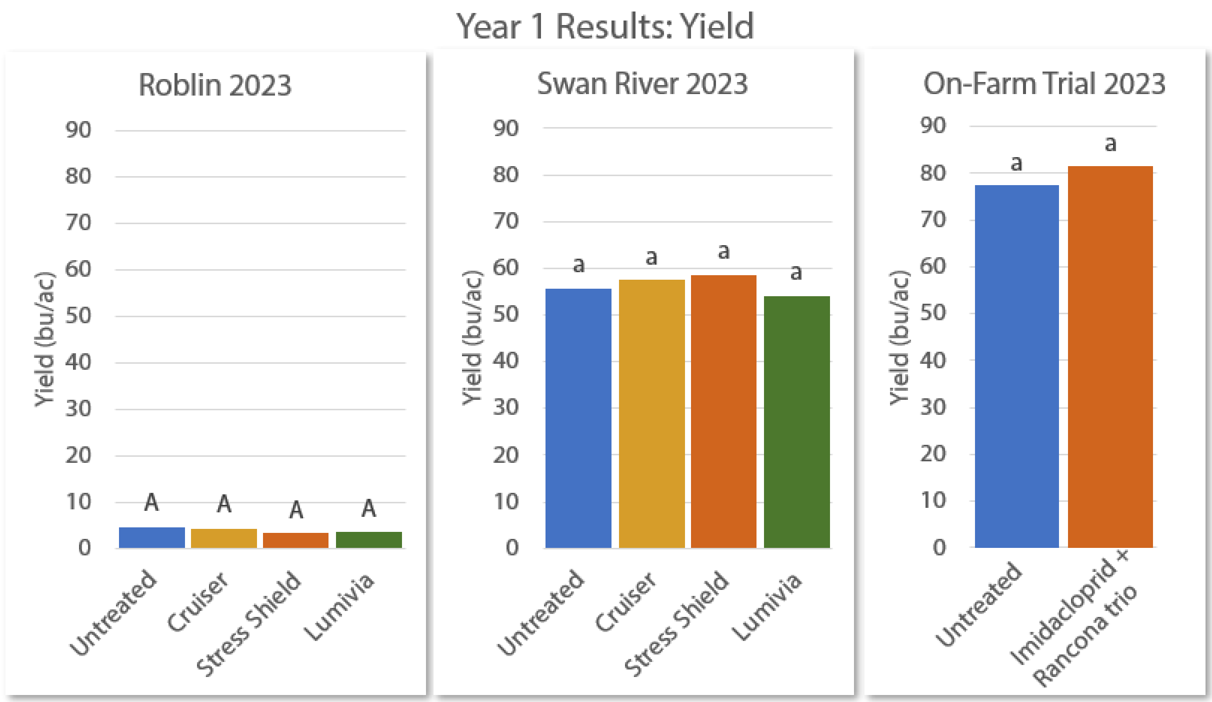


Figure 5. Average pea yield (bu/ac at Roblin PCDF, Swan River and at an on-farm trial near Roblin in 2023. Within each site-year, bars followed by different letters are significantly different at *p <0.05.*

These results are preliminary, summarizing only a single year of data. There is a trend of reduced PLW predation with Cruiser (thiamethoxam) and Stress Shield (imidacloprid) seed treatments, but this did not translate to any yield improvements in 2023.

Small-plot trials are planned to continue for another two years at Roblin (PCDF) and Swan River (New Era Ag). On-farm trials will continue with any interested farmers who would like to test insecticide seed treatments in peas. Please reach out to MPSG's On-Farm Network if you would like to participate.

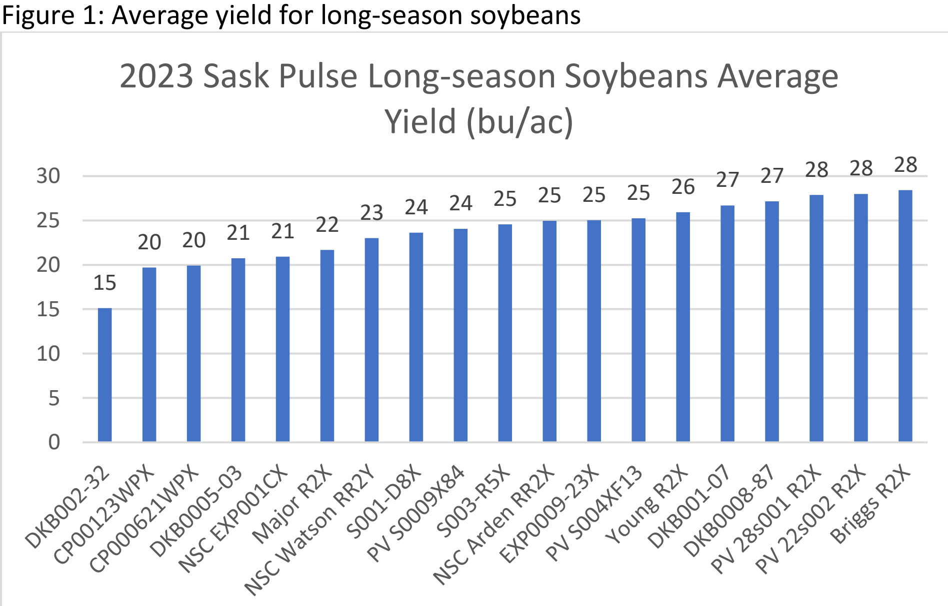
Saskatchewan Pulse Growers Long-Season and Short-Season Soy Variety Trial

Project duration: May 2023 – October 2023
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 some of the long and short-season (i.e., most northern-adapted) glyphosate-tolerant soybean lines.

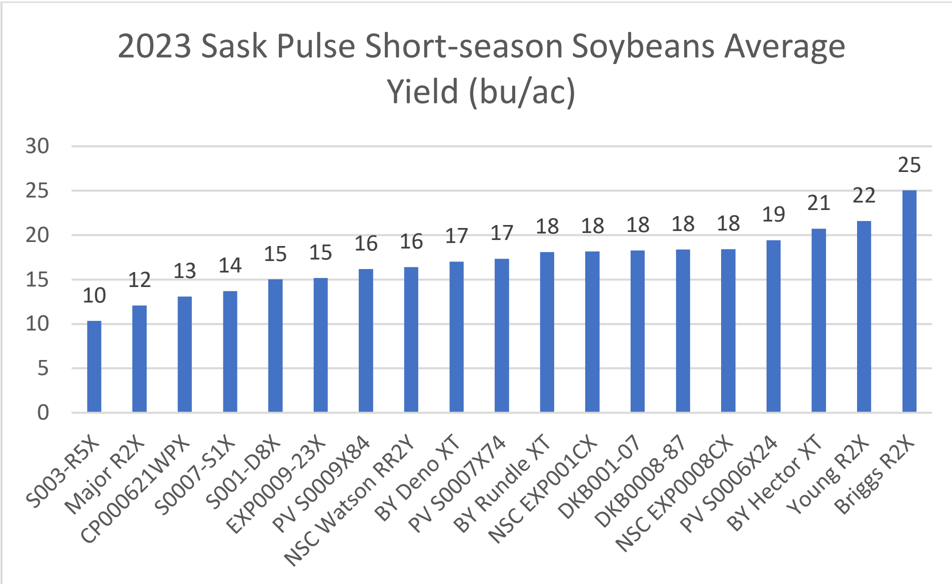
Results
The average yield for long-season soybean entries is shown in Figure 1 and the average yield for short-season soybean entries is shown in Figure 2. The average height for long-season soybean entries is shown in Figure 3 and the average height for short-season soybean entries is shown in Figure 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 soybeans



Yields adjusted to 14% moisture

Figure 2: Average yield for short-season soybeans



Yields adjusted to 14% moisture. Results for varieties DKB0005-03 and S0009-F2X are excluded due to harvest error.

Materials and methods

Experimental Design:	Random Complete Block
Entries:	Long-season 19 entries, short-season 22 entries; 3 replications each
Seeding:	May 23
Harvest:	Oct 11

Data collected	Date collected
% Plant Stand:	Jun 19
Yield:	Oct 24
Moisture:	Oct 24

Agronomic info

Previous year's crop:	Millet
Soil Type:	Erickson Clay Loam
Landscape:	Rolling with trees to the east
Seedbed preparation:	Direct seeded

Table 1: Spring 2023 Soil Test

	Available		Added	Type
N	66	lb/ac	-	-
P	48	ppm	10 lb/ac	11-52-0-0
K	194	ppm	-	-

Inoculant added with seed; P banded with seed

Table 2: Pesticide Application

Crop stage	Date	Product	Rate
Pre-emerge	May 26	Glyphosate	640 ml/ac
		Heat	30.0 g/ac
In-crop	Jun 15	Clethodim	150 ml/ac
		Basagran	710 ml/ac
		Viper ADV	400 ml/ac
		UAN 28%	810 ml/ac

Quinoa

Phillex Quinoa Variety Trial

Project duration: May 2023 – September 2023
Objectives: To evaluate varieties of quinoa for Phillex Ltd.
Collaborators: Percy Philips, Phillex Ltd
Westman Agricultural Diversification Organisation (Melita)
Parkland Crop Diversification Foundation (Roblin)
Prairies East Agricultural Sustainability Initiative (Arborg)

Background

Quinoa is an ancient grain of the amaranth family, prized as a high-protein, gluten-free food. Originating in the Andean region, the crop has been successfully introduced to Manitoba. The Manitoba Diversification Centres collaborated with Phillex Ltd to grow six varieties of quinoa, evaluating their suitability to Manitoba's growing conditions.

Due to its adaptation to cool, dry environments, the crop is tolerant to early planting. In Manitoba, where quinoa is threatened by a host of insects that are not present in its native environments, early planting can also help the crop to reach key developmental stages before it is damaged by pests. Key insect pests include the diamondback moth, goosefoot groundling moth, lygus bugs, bertha armyworm, and grasshoppers.

The trial was established at Arborg, Melita and Roblin. However, this report only provides yield data for Melita. The trial was discontinued at Arborg due to critically low moisture at seeding, resulting in poor establishment. At Roblin, severe weed pressure reduced yields and resulted in high % CV. Agronomic information is provided for both Melita and Roblin. However, yield results are only shown for Melita.

Materials and methods

Experimental Design: Random Complete Block Design
Entries: 6
Seeding rate: 10 lb/ac

	Melita	**Roblin**
Seeding date	May 3	May 24
Harvest date	Sept 14	Sept 21
Herbicide	(Pre-emerge) Glyphosate @ 0.67 L/ac May 31 Arrow @ 150 mL/ac plus Xact 0.5%	(Pre-emerge) Glyphosate @ 0.67 L/ac Hand-weeded
Insecticide	June 7 (grasshoppers), Aug 1 (Lygus bugs), Aug 7 (grasshoppers) Matador @ 34 mL/ac	None
Desiccation	Sept 5 Reglone @ 0.65 L/ac plus LI700 0.25%	None

Table 1: Fertility information

	Melita		Roblin	
	Available	Added	Available	Added
N	24 lb/ac	114 lb/ac	27 lb/ac	110 lb/ac
P	30 ppm	35 lb/ac	34 ppm	20 lb/ac
K	415 ppm	25 lb/ac	269 ppm	-

P banded with seed; N side-banded

Table 2: Agronomic summary

	Melita	**Roblin**
Soil series	Waskada Loam	Erickson Clay Loam
Previous crops	(2021) LL canola, (2022) spring wheat	(2021) RR canola (2022) millet silage
Soil moisture at seeding	Excellent	Fair
Seeding depth	0.5 inch	0.5 inch
Seedbed prep	Harrowed, direct seeded	Direct seeded

Results

The yields for all varieties are shown in Figure 1.

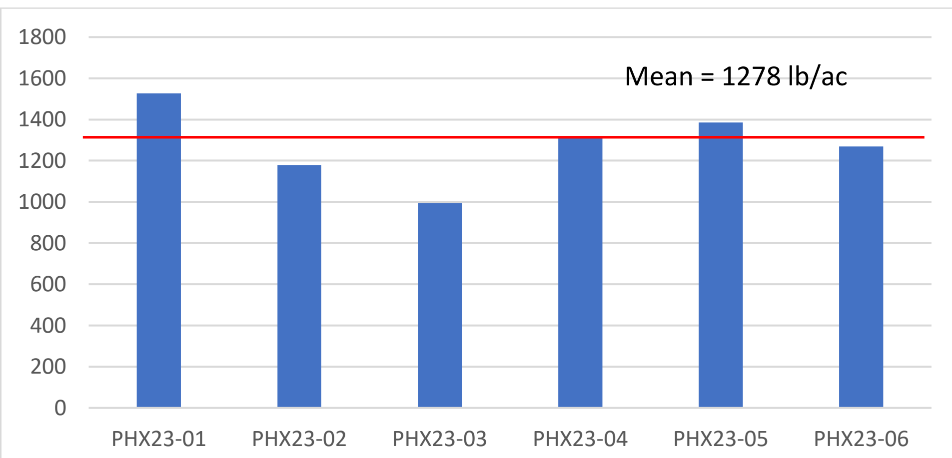


Figure 1: Average yield (lb/ac, 13% moisture) by variety at Melita

Discussion

Quinoa has developed a small, but valuable niche within the crop rotations of Manitoba producers. Strong demand from consumers remains a strong driver; however, first-time producers interested in growing quinoa should seek out agronomic advice to address the challenges associated with the crop, including field preparation, pest management and harvest strategies.

Wheat

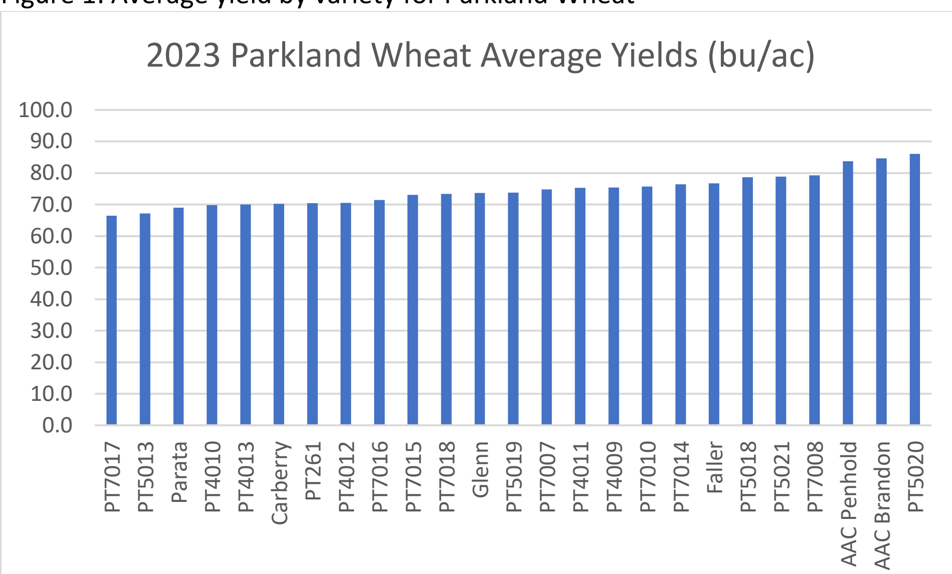
Parkland Coop Wheat Variety Evaluation

Project duration: May 2023 – August 2023
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 by variety for Parkland Wheat



Yields adjusted to 14.5% moisture

Materials and methods

Experimental Design:	Lattice
Entries:	25 varieties
Repetitions:	3
Seeding:	May 12
Harvest:	Aug 28

Table 1: Varieties included in trial at Roblin, 2023

AAC Brandon	AAC Penhold	PT4009	PT4012	PT5021
Carberry	PT5013	PT4010	PT4013	PT7015
Glenn	PT7007	PT7010	PT5018	PT7016
Parata	PT7008	PT7014	PT5019	PT7017
Faller	PT261	PT4011	PT5020	PT7018

Agronomic information

Previous year's crop:	Millet
Soil Type:	Erickson Clay Loam
Landscape:	Rolling with trees to the east
Seedbed preparation:	Direct Seeded

Data collected	Date collected
Height:	Beginning of August
Lodging:	Aug 28
Yield:	Aug 28
Moisture:	Aug 28

Table 2: 2023 Fertility Information

	Available	Added (actual)	Type
N	66 lb/ac	123 lb/ac	46-0-0
P	48 ppm	10 lb/ac	11-56-0-0
K	194 ppm	-	-

Table 3: 2023 Pesticide Application

Crop stage	Date	Product	Rate
Pre-emerge	May 12	Glyphosate	640 ml/ac
		Authority	118 ml/ac
In-crop	Jun 19	Axial	500 ml/ac
		Basagran	910 ml/ac

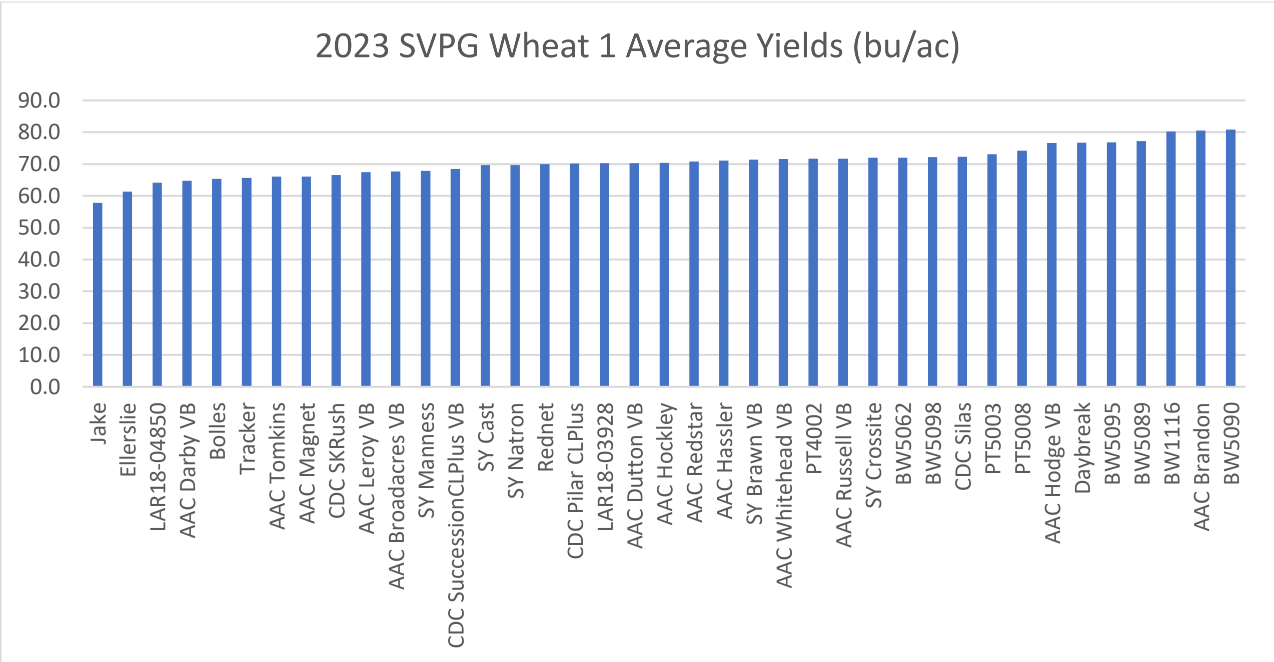
SVPG Wheat Variety Evaluation 1 (CWRS) and Evaluation 2 (HY)

Project duration: May 2023 – August 2023
Objectives: Two tests to evaluate spring wheat varieties for the Saskatchewan Variety Performance Group
Collaborators: Mitchell Japp, 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.

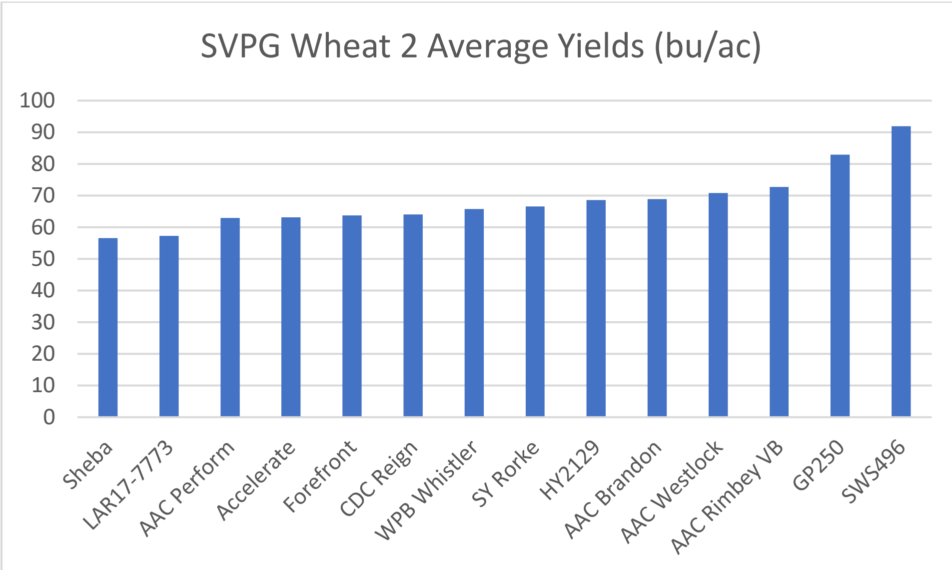
Results
The average yield for spring wheat entries in Evaluation 1 (Canadian Western Red Spring) is shown in Figure 1. The average yield for entries in Evaluation 2 (High Yielding) is shown in Figure 2. The results are for one site-year only, and should be interpreted with caution. Consult a seed guide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

Figure 1: Wheat 1 average yield by variety



Yields adjusted to 14.5% moisture

Figure 2: Wheat 2 average yield by variety



Yields adjusted to 14.5% moisture

Materials and methods

Experimental Design:	Random Complete Block Design
Entries:	Wheat 1, 39 entries; Wheat 2, 14 entries
Seeding:	May 11
Harvest:	Wheat 1 Aug 28; Wheat 2 Aug 21

Table 1: Varieties included in SVPG Wheat Variety Evaluation 1

AAC Leroy	Daybreak	SY Manness	AAC Dutton VB	AAC Hodge VB
AAC Hassler	Ellerslie	LAR18-04850	Tracker	AAC Tomkins
AAC Whitehead VB	CDC SuccessionCLPlus VB	AAC Russell VB	AAC Magnet	AAC Redstar
BW5062	BW5090	CDC SKRush	Rednet	SY Crossite
CDC Pilar CLPlus	Bolles	SY Natron	BW5098	PT5008
PT4002	Sy Brawn VB	Jake	CDC Silas	PT5003
LAR18-03928	BW5095	AAC Broadacres VB	BW1116	AAC Brandon
SY Cast	AAC Darby VB	AAC Hockley	BW5089	

Table 2: Varieties included in SVPG Wheat Variety Evaluation 2

AAC Brandon	Accelerate	HY2129
AAC Perform	CDC Reign	LAR14-7773
AAC Rimbey VB	Forefront	Sheba
AAC Westlock	GP250	SWS496
SY Rorke	WPB Whistler	

<u>Agronomic information</u>

Previous year's crop:	Millet
Soil Type:	Erickson Clay Loam

Landscape: Rolling with trees to the east
Seedbed preparation: Direct seeded

Data collected	Date collected
Maturity:	Aug 13 - 17
Lodging:	At harvest
Yield:	At harvest
Moisture:	At harvest

Table 3: 2023 Fertility Information

	Available	Added (actual)	Type
N	66 lb/ac	123 lb/ac	46-0-0
P	48 ppm	10 lb/ac	11-56-0-0
K	194 ppm	-	-

Table 4: 2023 Pesticide Application

Crop stage	Date	Product	Rate
Pre-emerge	May 12	Glyphosate	640 ml/ac
		Authority	118 ml/ac
In-crop	Jun 19	Axial	500 ml/ac
		Basagran	910 ml/ac

Optimizing Nitrogen Fertility in Winter Wheat Varieties

(Adapted from a report by McKenzie Rowe, WADO)

Project duration: Fall 2023 – August 2024

Objectives: (1) Update the winter wheat fertility recommendations in the Manitoba Soil Fertility Guide.
(2) Compare spring broadcast only application, to fall and spring split application of nitrogen for yield and protein.
(3) Examine varietal differences in nitrogen use efficiency between Wildfire and Vortex.

Collaborators: Ducks Unlimited Canada (Ken Gross, Alex Griffiths, Elmer Kaskiw), Manitoba Agriculture & Resource Development (John Heard)

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, especially for nitrogen and phosphorus, remains the integral part of the overall management package aimed at achieving higher yields in winter wheat (Halvorson et al. 1987). Recommended fertilizer management differs widely in winter wheat production, but the crop’s nitrogen demand is correlated to yield potential and availability of moisture in dryland productions 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).

Developing an ideal fertility management package would help counteract the escalating cost of production per unit area. There is still a knowledge gap on the rates, as well as timing of application of nitrogen fertilizer, particularly in Western Canada, that would result in improved yield without compromising the quality of grain 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, sulfur and micronutrients available in the soil, offers great yield potential when nitrogen needs of the crop are met. More efficient returns on investment potential can be achieved as fertility management is optimized.

Materials and Methods

This study was established in Arborg, Carberry, Melita and Roblin in the fall of 2023. The trial design consisted of two variety and 7 fertility treatments, replicated three times, that were laid out factorially in a complete randomized block design.

Plot Treatments:

1. Wildfire – Highest yielding winter wheat on the market
2. Vortex – New Emerson replacement with great disease resistance and winter hardiness

Subplot Plot

1. Check – No fertility except starter phosphorus
2. 60 Kg ha-1 (53.5 lbs ac-1) nitrogen, split 50:50
3. 90 Kg ha-1 (80.3 lbs ac-1) nitrogen, split 50:50
4. 120 Kg ha-1 (107.1 lbs ac-1) nitrogen, split 50:50
5. 150 Kg ha-1 (133.8 lbs ac-1) nitrogen, split 50:50
6. 180 Kg ha-1 (160.6 lbs ac-1) nitrogen, split 50:50
7. 120 Kg ha-1 (107.1 lbs ac-1) nitrogen all applied in spring

The soil test results and the applied fertilizer amounts are listed for each site in Table 1a. All 5 split applications had 50% of the rate being applied in the fall, and 50% of the rate being applied in the following spring. Specific treatment nitrogen rates using granular ESN/urea (50:50 blend) were placed at approximately 1.25-inch depth in a separate pass before seeding the wheat. Seeding target density was 325 plants m^{-2}. Germination was 95% for both varieties. Treatment-specific nitrogen rates were top-dressed in the early spring, as urea coated with Agrotain. The spring nitrogen application of 120kg ha^{-1} is the currently producer fertility practice when growing winter wheat representing treatment 7.

Each site where this trial was grown used slightly different agronomic practices and had different field conditions which are outlined in the following Tables 1b and 1c.

Data collected throughout the growing season included soil tests at time of seeding, emergence counts, lodging scores, heights, yield, grain moisture, test weight, and protein. Data was analyzed with Minitab 18.1 statistical software using a GLM ANOVA with Fishers Least Significant Difference at a 0.05 level of significance. A test for equal variance was used to determine if data could be combined.

Table 1a. Fall soil test results by site and fertilizer treatments for winter wheat in the 2022/2023 season.

Fall Soil Test and Fertilizer Application (Actual lbs/ac)					
		Soil Supply	Applied*	Total	Product Type
Melita	N	31	120	151	Urea, 40 rock
	P	32	30	62	40rock
	K	72	20	92	Potash
	S	112	0	112	
	Zn	0.48	1	1.48	Zinc sulfate
Roblin	N	32	120	152	Urea, MAP
	P	61	15	76	MAP
	K	94	0	94	
	S	17	0	17	
	Zn	0.69	0	0.69	
Carberry	N	23	120	143	Urea, MAP
	P	17	35	52	MAP
	K	32	50	82	Potash
	S	21	0	21	
	Zn	0.78	0	0.78	
Arborg	N	23	120	143	Urea, MAP
	P	23	30	53	MAP
	K	41	30	71	Potash
	S	14	0	14	
	Zn	0.17	0	0.17	
*Note: Applied nitrogen value is the soil test recommended value for treatments 4 & 7 as a baseline and took into account nitrogen sources from phophorous products.					

Table 1b. Description of Site fields in the 2023 Ducks Unlimited Winter Wheat Fertility Trial in Melita, Roblin, Carberry, and Arborg.

Location	Melita	Roblin	Arborg	Carberry
Cooperator	WADO	PCDF	PESAI	CMDC
Legal	NW10-4-26W1	NE20-25-28W1	RL-37-22-02E	14W1
Rotation	Canola	Canola/Millet	Canola	Soybean/Canola
Soil Series	Sand	Loam	Heavy Clay	Loam
Soil Test	Yes	Yes	Yes	Yes
Field Prep	Harrowed	Direct Seed	Direct Seed	Direct Seed
Stubble	Canola	Millet	Canola	Canola
Burn off	Yes	Yes	No	Yes

Table 1c. Agronomic practices and Description of Sites in the 2023 Ducks Unlimited Winter Wheat Fertility Trial in Melita, Roblin, Carberry and Arborg.

Location	Melita	Roblin	Arborg	Carberry
(Date/Rate per acre/Products)	Glyphosate (0.67L/ac) + Koril (0.2L/ac) 16-Sep-22	Glyphosate (0.6 L/ac) + Heat LQ (37 ml/ac) + Merge (0.4 L/ac) 13-Sep-22	None	Round up (0.67 L/ac) + Heat (29 g/ac) Sep-14-22
Moisture at Seeding	Excellent	Very Dry	Excellent	Excellent
Seed Date	16-Sep-22	13-Sep-22	14-Sep-22	14-Sep-22
Seed depth (in)	0.5"	0.5"	0.5"	1"
Seeder	Air Drill	Disc Drill	Disc Drill	Disc Drill
Seeding Errors	None	None	None	None
Topdressing Date	11-May-23	end of May	06-May-23	27-Apr-23
Herbicides: (Date, Rate/ ac, Name)	Mextrol (0.5L/ac) + Achieve (0.2L/ac) + Turbocharge (0.5%) 29-May	None	Pardner @ 480 ml/acre (Sep 22)	Glyphosate (0.67L/ac) 08-Sep-22, Fitness (120mL/ac) 14-Jun, Buctril M (0.4L/ac) + Axial (0.5L/ac) 21-Jun
Fungicides	None	None	Prosaro (325 ml/ac) 30-Jun	Prosaro @ 325mL/ac Jun-29
Insecticides	None	None	Matador (34 mL/ac) 15-Jul	None
Desiccation	Reglone (0.5L/ac) 01-Aug	None	None	None
Harvest Date	14-Aug-23	15-Aug-23	17-Aug-23	30-Aug-23
Total Precip. (Seeding to Harvest)	370mm	226mm	253mm	271mm

Results and Discussion

In Arborg, the variety used was found to have a significant ($P < 0.001$) effect on winter wheat yield in 2023 (Table 1d). Wildfire winter wheat produced the highest yield at that site (3159 kg ha^{-1}) and was significantly different from the yield of Vortex winter wheat (2701 kg ha^{-1}) at Arborg. Protein content was also found to be significant ($P = 0.001$) between varieties at Arborg; Vortex had higher protein (15.0%) than Wildfire (14.3%). The variety used also had a significant ($P = 0.042$) effect on the test weight of the winter wheat. The variety Vortex had a higher test weight (67.0 kg hL^{-1}) than Wildfire (65.6 kg hL^{-1}) at Arborg. Plant population was also found to be significant ($P = 0.002$) between the two varieties grown. Fertility treatment was not found to have a significant effect on yield, protein, test weight, or plant population at the Arborg site. The effects of both variety and fertility treatment together were found to have a significant ($P = 0.040$) effect on winter wheat yield at the Arborg site as well. Interestingly, the treatment that had the highest yield overall (3593kg ha^{-1}) was Wildfire grown with no extra fertility treatment (treatment 1,1). While the highest, the yield of that treatment was not significantly different from the yield of Wildfire grown with the fertility treatments of 120 and 180 kg ac^{-1} of nitrogen split between spring and fall, and 120 kg ac^{-1} of nitrogen applied in the spring. The treatment with the lowest yield (2245 kg ha^{-1}) was shown to be Vortex grown with 120 kg ac^{-1} of nitrogen with a split application; this yield was not significant from four other treatments in the trial. While significant (P = 0.036), the plant population did not vary as much between treatments; it is important to consider the plant population when evaluating yield differences between treatments.

In Carberry, the winter wheat variety Wildfire produced higher yields (5803 kg ha^{-1}) than Vortex winter wheat (5426 kg ha^{-1}), though the difference was not significant (P = 0.196) (Table 1d). Vortex winter wheat also had a higher protein content (13.5%) than Wildfire (11.8%); these values were significant (P < 0.001). Plant population was found to be significant (P = 0.003) between the two varieties. Test weight of the grain was not found to be significantly different (P = 0.093) between the two varieties at Carberry in 2023. When evaluating fertility, yield and test weight again were not found to be significant. Protein content was found to be significant (P < 0.001) between fertility treatments. The split application of 180 kg ac^{-1} of nitrogen was shown to have the highest protein content (13.7%), though it was not significantly different from the split applications of 120 and 150 kg ac^{-1} nitrogen or the spring application of 120 kg ac^{-1} nitrogen. The plots were only start phosphorous was applied (checks) along with the low rate of split nitrogen (60 kg ac^{-1}) both produced the lowest protein content (11.7%) of the trial at Carberry. The protein content of those treatments was not significantly different from the protein content of the split application of 90 kg ac^{-1} nitrogen (12.1%). Plant population was found to be significant (P = 0.009) between fertility treatments in Carberry; this is important to consider when evaluating yield. At the Carberry site, none of the evaluated characteristics were found to be significant when looking at the effects of both variety and fertility. Though not significant, Wildfire with a split nitrogen application of 60 kg ac^{-1} had the highest yield (6186 kg ha^{-1}), while Wildfire with no nitrogen application (check) had the lowest yield (4573 kg ha^{-1}) in the trial.

In Melita, the variety used was found to have a significant (P = 0.004) effect on winter wheat yield in 2023 (Table 1d). Wildfire winter wheat produced the highest yield at that site (4783 kg ha^{-1}) and was significantly different from the yield of Vortex winter wheat (4370 kg ha^{-1}). Protein content was also significantly (P = 0.001) affected by variety choice at Melita. Vortex winter wheat had a protein content of 12.7%, which was significantly higher than that of Wildfire winter wheat (12.3%). Variety choice did not influence test weight or plant population. The fertility treatment used was found to have a significant (P = 0.001) effect on yield of winter wheat and only at Melita in 2023 compared to all other sites. The treatment of a split nitrogen application of 120 kg ac^{-1} was shown to have the highest yield (5086 kg ha^{-1}), which was not significantly different from the split nitrogen applications of 90, 150, and 180 kg ac^{-1}. The check fertility treatment had the lowest yield (3826 kg ha^{-1}) which was not significantly different from the yields of split nitrogen applications of 60, 150, or 180 kg ac^{-1} or 120 kg ac^{-1} of nitrogen applied in the spring. Fertility had a significant (P < 0.001) effect on protein content at Melita. Winter wheat grown with 120 kg ac^{-1} nitrogen applied in the spring had the highest protein content (13.3%) which was not significantly different from the protein content when 150 and 180 kg ac^{-1} of nitrogen was split between the fall and spring. In Melita, fertility was also found to have a significant (P = 0.005) effect on test weight in 2023. The plots that had no nitrogen applied (checks) were found to have the highest grain test weight (80.9kg hL^{-1}) which was not significantly higher than the test weights of the treatments including split nitrogen applications of 60, 90, 120, and 150 kg ac^{-1}. Together, variety choice and fertility treatment were not found to have any significant effects. While not significant, Wildfire grown with a split nitrogen application of 120 kg ac^{-1} had the highest yield (5230 kg ha^{-1}) while the Vortex grown with no additional nitrogen had the lowest yield (3539 kg ha^{-1}). Interestingly, the higher protein contents were seen in the spring nitrogen application of 120 kg ac^{-1} for both Vortex (13.5%) and Wildfire (13.1) varieties at the Melita site in 2023.

In Roblin, the variety used was found to not have a significant effect on winter wheat yield in 2023 (Table 1d). Variety choice was found to have a significant ($P < 0.001$) effect on protein content. The protein content of Vortex winter wheat (12.9%) was significantly different from that of Wildfire (11.8%). The fertility treatment was also found to only have a significant ($P < 0.001$) effect on protein content. The application of 120 kg ac^{-1} nitrogen was shown to produce the highest protein content (13.3%), though not significant from three other fertility treatments included in the trial. While not found to be significant, the split application of 150 kg ac^{-1} of nitrogen produced the highest yield (5631 kg ha^{-1}) at Roblin. When the effects of variety and fertility were evaluated together, no significance was found in any factor. While not significant, the variety Vortex grown with a split application of 120 kg ac^{-1} of nitrogen had the highest yield (6166 kg ha^{-1}) of the treatments grown at Roblin. The variety Wildfire grown with a split application of 180kg ac^{-1} of nitrogen produced the lowest yield (4786 kg ha^{-1}) of the treatments grown at Roblin in 2023. Wildfire grown without additional nitrogen had the lowest protein content (10.1%), while Vortex with a spring application of 120 kg ac^{-1} nitrogen produced the highest protein content (13.9%). The trend was similar for the grain test weight. At the Roblin site, the plant counts were more inconsistent than at the other sites; this could indicate issues with the plant stand and vigor, such as high weed pressure.

When the data from all four sites was combined, variety choice was shown to have significant ($P = 0.016$) effect on yield (Table 1e). Across all sites, the variety Wildfire had the highest yield (4772 kg ha^{-1}). Variety choice was also found to have a significant ($P < 0.001$) effect on protein content across all trial sites. The variety Vortex produced the higher protein content (13.5%), while Wildfire produced the lower protein content (12.6%). Across all four sites, fertility treatment was only found to have a significant ($P < 0.001$) effect on protein content of the grain. Two treatments produced the highest protein content (13.7%); split application of 180 kg ac^{-1} nitrogen and spring application of 120 kg ac^{-1} nitrogen. Across all four sites, when variety and fertility were evaluated together, no factors were found to be significant. Though not significant, the variety Wildfire grown with a split application of 150 kg ac^{-1} nitrogen produced the highest yield (4986 kg ha^{-1}). The variety Vortex grown without additional nitrogen produced the lowest yield (4114 kg ha^{-1}) over all trial sites.

When comparing the overall yield, protein, test weight, and plant population for each site to each other, all four factors were found to be significant (Table 1f). The Carberry trial site yielded the highest (5614 kg ha^{-1}) overall, though it was not significantly different from the overall yield at Roblin (5379 kg ha^{-1}) and Melita (4576 kg ha^{-1}). Three of the four sites responded to nitrogen in terms of protein content, all three of which reponded significantly and consistantly to all fertilizer applied in spring (trt 7) compared to split application treatments. The Arborg trial site had the highest overall protein content (14.7%), which was significantly ($P < 0.001$) higher than the other sites. The Melita trial site produced the highest overall test weight (80.1 kg hL^{-1}) though not significantly different from the test weights at the Roblin site (76.8 kg hL^{-1}). The Carberry trial site had significantly ($P = 0.003$) higher plant counts (334 ppms) from the rest of the sites and above target rates indicating that data collection was skewed. All four sites were seeded with the same target plant population at seeding time; there may have been some discrepancies in counting plants between the sites. The main reason for significant differences found between the four sites is the seasonal growing conditions in each site. These conditions will all influence the crop differently.

The weather differed slightly at each site across the province. In the fall, Arborg received 125% of normal rainfall and Carberry received their normal average amount, while the Melita and Roblin sites only received around half of the normal rain fall for the area in that time frame (Table 1g). All four sites received significantly higher growing degree days than they normally get in that time frame. In the spring until harvest, all four sites received only 50-61% of normal rainfall (Table 1h). The four sites also received 111-114% of normal growing degree days for their area at that time of year. The crops at all sites may have been subjected to stressful conditions with low precipitation amounts, and higher than normal heat.

Table 1d. Results including yield, protein, and test weight from the 2023 in Arborg, Carberry, Melita, and Roblin.

Treatment		Factor	Location															
			Arborg				Carberry				Melita				Roblin			
			Yield (kg ha^{-1})	Protein (%)	Test Wt. (kg hL^{-1})	Plants (ppms)^	Yield (kg ha^{-1})	Protein (%)	Test Wt. (kg hL^{-1})	Plants (ppms)^	Yield (kg ha^{-1})	Protein (%)	Test Wt. (kg hL^{-1})	Plants (ppms)^	Yield (kg ha^{-1})	Protein (%)	Test Wt. (kg hL^{-1})	Plants (ppms)^
Variety	Wildfire	1	3159a	14.3b	65.6b	229b	5803	11.8b	70	323b	4783a	12.3b	79.9	205	5318	11.8b	76.8	132
	Vortex	2	2701b	15.0a	67.0a	292a	5426	13.5a	70.5	345a	4370b	12.7a	80.2	222	5440	12.9a	76.7	140
Fertility	Check	1	3184	14.3	66.4	235	4685	11.7c	70.3	325bc	3826d	11.6c	80.9a	226	5261	11.0d	76.4	108
	60	2	2870	14.2	66.5	678	6012	11.7c	69.7	321c	4524bc	11.7c	80.3a	214	5489	12.1bc	76.9	157
	90	3	2841	14.5	66.2	298	5776	12.1bc	69.7	326bc	4935ab	12.4b	80.6a	219	5308	11.8c	78.1	178
	120	4	2793	14.8	66.4	258	5923	13.0ab	70.8	349ab	5086a	12.4b	80.3a	235	5529	12.6ab	77.0	127
	150	5	2686	15.0	64.9	250	6101	13.0ab	70.7	366a	4687abc	13.0a	79.9ab	200	5631	12.9ab	75.7	139
	180	6	3157	14.9	66.8	251	5547	13.7a	69.9	323bc	4629abc	13.1a	79.2b	197	4921	12.9a	74.5	158
	Spring 120	7	2979	15.0	66.9	266	5256	13.3a	70.3	325bc	4347c	13.3a	79.2b	202	5515	13.3a	78.8	85
Variety x Fertility		1,1	3593a	13.7	66.4	213cd	4573	10.8	69.5	310	4113	11.4	80.6	222	5175	10.1	75.9	119
		1,2	2761cde	14.1	64.5	304abc	6186	11.0	69.1	304	4731	11.7	80.1	229	5795	11.7	79.4	148
		1,3	2994bcd	14.4	64.9	232bcd	6216	11.0	69.7	326	5195	12.1	80.1	199	4916	11	77.5	155
		1,4	3340ab	14.0	65.4	257bcd	6171	12.0	70.5	346	5230	12.2	80.3	202	4892	12.1	74.6	129
		1,5	2813cd	14.6	64.1	189d	6136	12.4	70.3	353	4869	12.8	79.8	183	6124	12.1	76.4	157
		1,6	3348ab	15.0	66.4	181d	6164	13.0	70.4	308	4982	12.8	79.2	190	4786	12.6	74.6	137
		1,7	3266abc	14.6	67.3	227bcd	5174	12.3	70.2	311	4360	13.1	79.0	209	5540	12.7	79.5	78
		2,1	2773cd	14.9	66.4	257bcd	4796	12.5	71	341	3539	11.8	81.2	231	5347	11.8	76.9	98
		2,2	2979bcd	14.3	68.4	232bcd	5838	12.5	70.3	338	4317	11.8	80.4	199	5182	12.5	74.4	166
		2,3	2689de	14.5	67.6	363a	5336	13.2	69.7	326	4675	12.6	81.2	239	5700	12.5	78.7	201
		2,4	2245e	15.5	67.4	259bcd	5674	14.0	71.1	351	4942	12.7	80.3	267	6166	13	79.4	125
		2,5	2559de	15.3	65.7	310ab	6066	13.6	71.1	379	4505	13.1	80.1	218	5138	13.6	75.0	121
		2,6	2966bcd	14.9	67.1	321ab	4931	14.4	69.5	338	4277	13.3	79.1	204	5056	13.2	74.4	178
		2,7	2696de	15.4	66.6	304abc	5338	14.3	70.4	339	4335	13.5	79.4	195	5490	13.9	78.1	92
P-Values		Variety	**<0.001**	**0.001**	**0.042**	**0.002**	0.196	**<0.001**	0.093	**0.003**	**0.004**	**0.001**	0.150	**0.045**	0.710	**<0.001**	0.881	0.615
		Fertility	0.072	0.088	0.783	0.663	0.142	**0.004**	0.287	**0.009**	**0.001**	**<0.001**	**0.005**	0.146	0.925	**<0.001**	0.389	0.082
		V x F	**0.040**	0.174	0.637	**0.036**	0.792	0.964	0.341	0.737	0.875	0.894	0.911	0.061	0.571	0.776	0.339	0.810
		CV %	10.4	3.9	3.4	22.3	16.4	7.5	1.3	6.6	9.4	2.7	1.0	12.3	19.6	5.3	4.4	39.3

Values followed by the same letter are not significantly different by Fisher's mean separation method at 95% confidence. ^Plants per meter squared.

Table 1e. Results including yield, protein, test weight, and plant counts from all the sites included combined for the 2023.

Treatment		Factor	Yield (kg ha^{-1})	Protein (%)	Test Wt. (kg hL^{-1})	Plants (ppms)^
Variety	Wildfire	1	4772**a**	12.6**b**	73.1	222**b**
	Vortex	2	4484**b**	13.5**a**	73.6	250**a**
Fertility	Check	1	4239	12.1**d**	73.5	224
	60	2	4744	12.4**cd**	73.4	240
	90	3	4715	12.7**c**	73.7	255
	120	4	4833	13.2**b**	73.6	242
	150	5	4776	13.5**ab**	72.8	239
	180	6	4564	13.7**a**	72.6	232
	Spring 120	7	4524	13.7**a**	73.8	219
Variety x Fertility		1,1	4364	11.5	73.1	216
		1,2	4909	12.1	73.4	246
		1,3	4830	12.1	73.0	228
		1,4	4909	12.6	72.7	234
		1,5	4986	13.0	72.7	221
		1,6	4820	13.4	72.6	204
		1,7	4584	13.2	74	206
		2,1	4114	12.8	73.9	232
		2,2	4579	12.7	73.4	234
		2,3	4600	13.2	74.3	282
		2,4	4757	13.8	74.6	251
		2,5	4567	13.9	73.0	257
		2,6	4307	14.0	72.5	260
		2,7	4465	14.3	73.6	233
P-Values	Variety		**0.016**	**<0.001**	0.114	**<0.001**
	Fertility		0.117	**<0.001**	0.342	0.155
	V x F		0.973	0.512	0.506	0.154

*Values followed by the same letter are not significantly different by Fisher's mean separation method at 95% confidence. ^Plants per meter squared.

Table 1f. Results including yield, protein, test weight, and plant counts over each site in 2023.

		Yield (kg ha^{-1})	Protein (%)	Test Wt. (kg hL^{-1})	Plants (ppms)^
Site	Arborg	2942b	14.7a	66.3b	261ab
	Carberry	5614a	12.7b	70.2b	334a
	Melita	4576ab	12.5b	80.1a	213b
	Roblin	5379a	12.4b	76.8a	136b
P-Value	Site	<0.001	<0.001	<0.001	0.003
*Values followed by the same letter are not significantly different by Fisher's mean separation method at 95% confidence. ^Plants per meter squared.					

Table 1g. Seasonal precipitation and growing degree days from the fall seed date to November 15th, 2022, in Arborg, Carberry, Melita, and Roblin Sites.

		Normal Precipitation (mm)	Actual Precipitation (mm)	% of Normal Precipitation	Normal GDD	Actual GDD	% of Normal GDD
Site	Arborg	61	76	125	103	207	201
	Carberry	55	54	98	107	208	194
	Melita	59	31	53	119	208	175
	Roblin	67	37	55	83	157	188
Information obtained from: https://web43.gov.mb.ca/climate/SeasonalReport.aspx							

Table 1h. Seasonal precipitation and growing degree days from April 1st, 2023, to the harvest date in Arborg, Carberry, Melita, and Roblin.

		Normal Precipitation (mm)	Actual Precipitation (mm)	% of Normal Precipitation	Normal GDD	Actual GDD	% of Normal GDD
Site	Arborg	264	156	59	1216	1344	111
	Carberry	292	170	58	1336	1518	114
	Melita	299	148	50	1234	1379	112
	Roblin	243	147	61	1070	1219	114
Information obtained from: https://web43.gov.mb.ca/climate/SeasonalReport.aspx							

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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 crosses that 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 taste 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.

Results

Birds are a problem for both fruits and appropriate measures must be taken to prevent the loss of berries. Sour cherries tend to yield more biennially (that is, yield is higher every other year), so 2020 was a lower year than 2019. A comparative chart below shows successive yields since 2016.

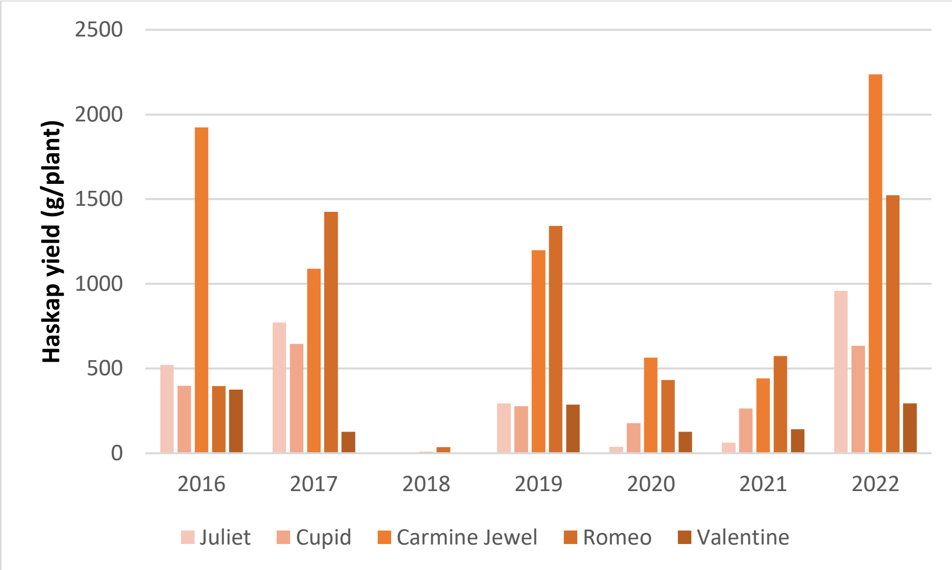

Figure 1: Roblin Sour Cherry Performance 2016-2022 (lb/plant)

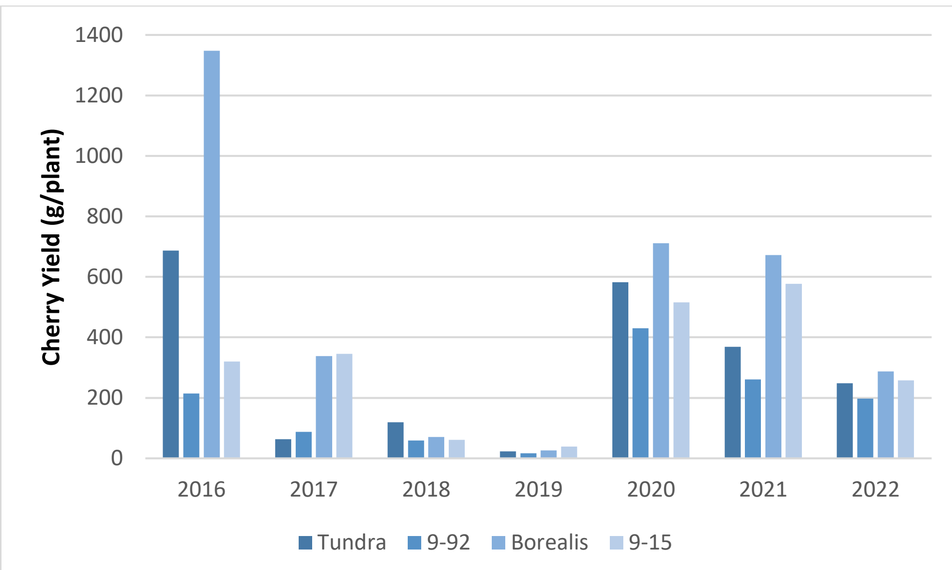

Figure 2: Roblin Haskap Performance 2016-2022 (lb/plant)

Yields in 2023 were extremely low for both haskaps and cherries, likely due to low moisture and high temperatures. PCDF will continue to collect data on fruit yield in future years.

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

Disease and Insect Monitoring

Fusarium Headblight Risk Map Monitoring Program

Dates: 2019 – 2023

Objectives: To track growth stages of cereal crops and track infection rates of fusarium headblight

Collaborator: University of Manitoba

Summary

The University of Manitoba maintains a risk mapping tool for cereal crops in western Canada. The online tool is designed to supply farmers with timely information that will aid in the decision to apply fungicides on their crops. Since 2019, PCDF has been contributing to the data collection that was used to develop the models behind the tool.

You can access the online tool here:

https://umanitoba.ca/agricultural-food-sciences/fusarium-head-blight-risk-mapping-tool

The tool is built and enhanced using data collected from wheat, barley, winter wheat and durum, and includes the following:

1. Anthesis dates
2. Heading dates
3. FHB ratings on 50 heads per 10.8m2 area at three weeks post anthesis

PCDF will continue to assist with data collection in future years, as needed.

Wheat Midge Pheromone Trap Monitoring Program

Dates: 2021 - 2023
Objectives: To track growth stages of cereal crops and monitor and trap male orange blossom wheat midge
Collaborator: Dr. Tyler Wist - Agriculture Agrifood Canada

The Orange Blossom Wheat Midge fly emerged as a major pest of wheat on the Canadian prairies in the 1980s and quickly spread from there to also cause major wheat yield damage in Minnesota, North Dakota, Montana and pockets in Idaho and British Columbia. According to Montana State University Extension, "Spring wheat fields that normally would have yielded 80-90 bushels per acre instead produced less than 2 bushels".

The Parkland has seen very high populations of wheat midge. For more than five years, PCDF has cooperated with the Entomology Department at the University of Manitoba and the Parkland Coop Wheat Variety Evaluation trial (University of Alberta) to collect samples of wheat heads for analysis of midge populations. The results have consistently shown wheat midge high populations.

In the spring of 2022, PCDF established a two-acre intercrop of wheat and phacelia (a flowering plant that is attractive to pollinators), with the aim of observing the behaviour of the beneficial wasp, Macroglenes penetrans. This parasitoid wasp lays its eggs inside of the wheat midge eggs, which are found in orange clusters inside the developing young heads of wheat. The developing wasp feeds on the midge larva with no observable outward change, remaining dormant within the midge cocoon during the winter. Only when larval emergence occurs in the spring is it known whether a midge or a wasp will emerge from the egg. This predatory behaviour reduces the following year's midge population by up to 30-40% (Think Wheat Midge).

Because midge populations are highly dependent on variable weather conditions, as well as the previous years' populations, it can be difficult to achieve successful pesticide application to control wheat midge. For example, in 1995, 1.25 million acres of cropland in Saskatchewan were sprayed, but the province still saw an overall crop loss of $130 million. Manitoba Agriculture does not advise spraying unless midge populations are above the economic threshold. The proper use of varietal blends is one of the most important means of reducing crop damage from wheat midge, but other biological controls, including crop rotation and integrated pest management, can help to control these pests.

An additional disincentive to spraying pesticides is that they can harm beneficial insects. The Macroglenes wasp emerges approximately five days after the wheat midge, and spraying at this point can result in wiping out the wasp, even though the wheat midge will have already damaged the wheat. In addition to the Macroglenes wasp, 14 species of ground beetle have been identified that feed on the midge cocoons (Prairie Soils & Crops Journal). In short, pesticide application may have the unintented effect of increasing wheat midge populations, by unintentionally killing insects that help to control wheat midge.

Figure 1: (left) Glue trap in the PCDF wheat field, which uses a pheromone emitter to attract the bright orange male midge to the trap; and (right) the flattened glue trap with grids for convenient counting.

PCDF staff monitor midge populations throughout the period of midge activity using glue traps to which pheromone. In August 2022, PCDF staff also had the opportunity to work with the University of Manitoba's Entomology Wheat Midge Lab to dissect the sampled wheat heads from the PCDF site. Midge larvae were pulled out of the glumes, counted, and stored in soil containers for artificial "overwintering" at the University in order to observe how many midge and how many wasps emerge from the soil in controlled lab conditions. Damaged kernels were also counted.

In 2023, three farmers' fields were monitored for wheat midge with pheromone traps operating between June 21 and July 25, with the highest numbers observed in the last week of June. PCDF intends to continue monitoring wheat midge populations in 2024.

PCDF

Parkland Crop Diversification Foundation

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