PESAI ANNUAL REPORT 2024

TABLE OF CONTENTS

Who we are?

Website: www.mbdiversificationcentres.ca
Email: prairies.east@gmail.com

The Prairies East Sustainable Agriculture Initiative Inc. (PESAI) is a not-for-profit organization established in December 2005. Serving the Interlake and Eastern Prairie region of Manitoba, PESAI operates as one of the four Manitoba Diversification Centres. Other center's include:

- Parkland Crop Diversification Foundation (PCDF): Parkland Region
- Westman Agriculture Diversification Organization (WADO): Southwest Region
- Manitoba Crop Diversification Centre (MCDC): Central Region

Our Mission

PESAI is a collaborative effort involving agricultural communities in Interlake and Eastern Manitoba, along with Manitoba Agriculture. The initiative focuses on advancing applied production research, fostering crop diversification, and exploring value-added opportunities in the region. PESAI's core funding is provided through the Agricultural Sustainability Initiative and Sustainable Canadian Agricultural Partnership programs, supplemented by contributions from the Manitoba Crop Variety Evaluation Trials (MCVET) committee and other industry partners. These partnerships support contract plot work and enhance PESAI's ability to deliver valuable services.

Operations and Areas of Focus

With its headquarters in Arborg and additional research conducted at the Beausejour site, PESAI specializes in:

- Applied field research
- Innovation and crop diversification
- Value-added initiatives in agriculture
- Advanced agricultural technologies
- Sustainability / regenerative Ag research

These efforts directly benefit local producers. Research findings are disseminated through a variety of extension programs, including plot demonstrations, crop tours, seminars, workshops, annual reports, and updates on the Manitoba Diversification Centre's website.

2024-2025 Board of Directors

PESAI's activities are guided by an elected Board of Directors comprising agricultural producers and entrepreneurs from the Eastern Prairie region.

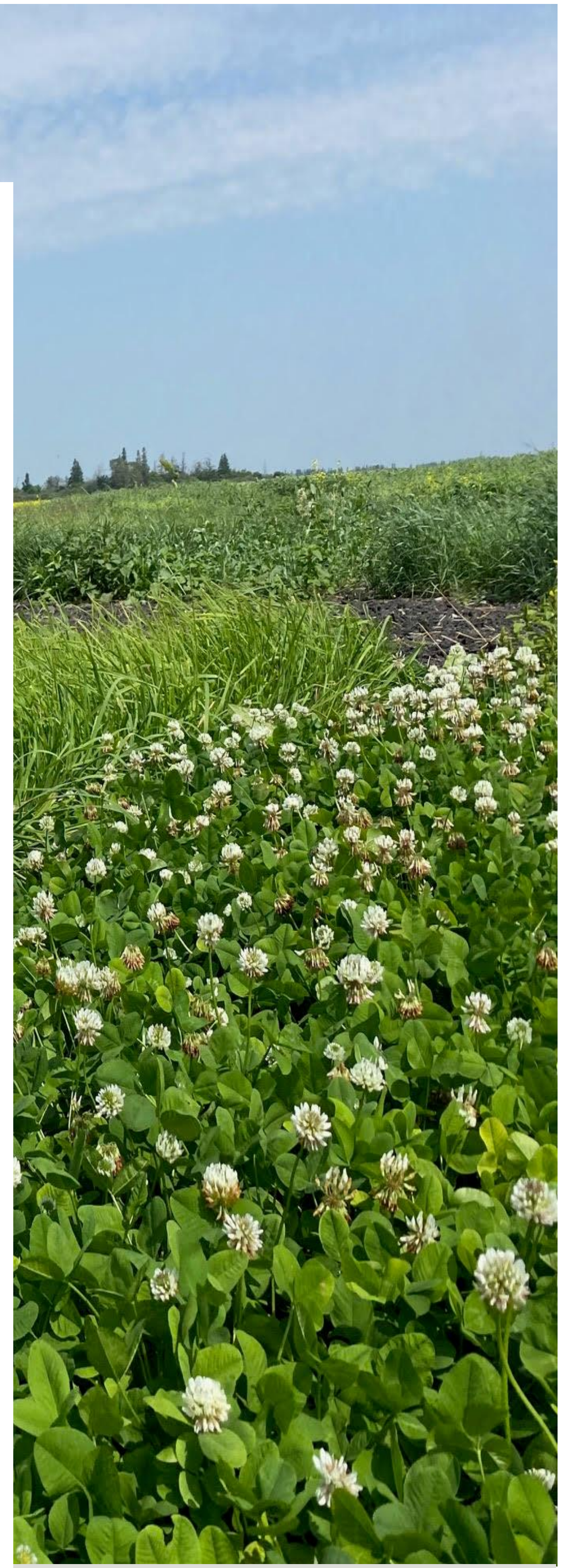
Position	Name	Area
Chair	Brian Kurbis	Beausejour
Vice-Chair	Paul Grenier	Woodridge
Treasurer	Andy Buehlmann	Arborg
Secretary	Scott Duguid	Arnes
Director	Wayne Foubert	St. Anne
Director	Paul Gregory	Fisher Branch
Director	Gary Naurocki	Tyndal
Director	Lorne Boundy	Arborg
Director	David King	Arborg

PESAI and Manitoba Agriculture Staff (2024 Crop Season)

Position	Name	Organization
Applied Research Specialist	Dr. Nirmal Hari	Manitoba Agriculture
Applied Research Technician	James Lindal	Manitoba Agriculture
Research Technician	Brett Sigurdson	PESAI
Summer Research Assistant	Connor Bishop	Manitoba Agriculture
Research Technician	Shaun Kendrick	PESAI
Summer Research Assistant	Emily Mazur	PESAI
Summer Research Assistant	Calvin Buehlmann	PESAI

2024 Project Collaborators

- Agassiz Soil & Crop Improvement Association (ASCIA)
- Nutrien Ag Solutions, MB
- Manitoba Crop Alliance (MCA)
- Manitoba Crop Variety Evaluation Team (MCVET)
- Manitoba Pulse & Soybean Growers Asso. (MPSG)
- Manitoba Agriculture
- Parkland Crop Diversification Foundation (PCDF)
- Seed Manitoba
- Department of Biosystems Engineering, U of M
- Saskatchewan Crop Development Centre
- Westman Agricultural Diversification Org. Inc. (WADO)
- Ducks Unlimited
- BASF
- Brian Kurbis Farms (Near Dencross, MB)
- Western Ag Lab
- Department of Plant Sciences, University of Manitoba
- Department of Soil Sciences, University of Manitoba
- SeCan
- Manitoba Forage & Grassland Association
- Syngenta
- AAFC Brandon
- Assiniboine College



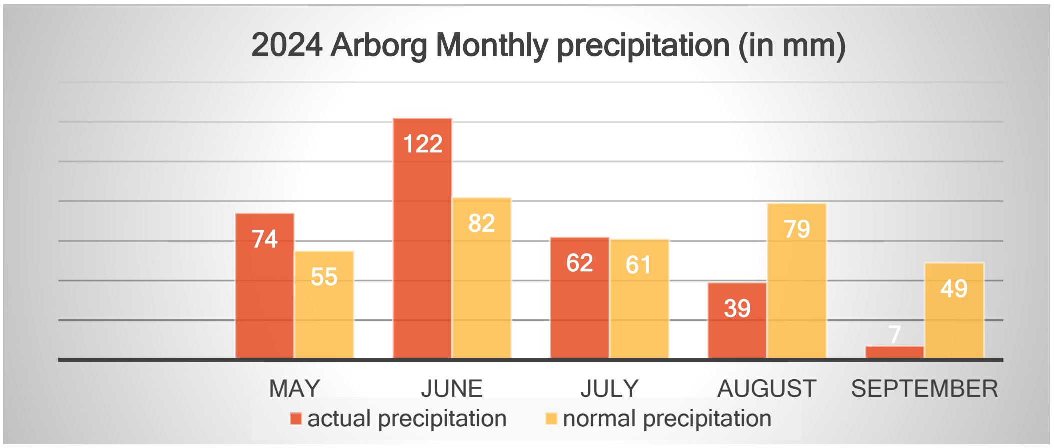
2024 Weather Summary

Arborg Site

Weather data was taken from the Manitoba Agriculture weather station located at the PESAI Research Site in Arborg.

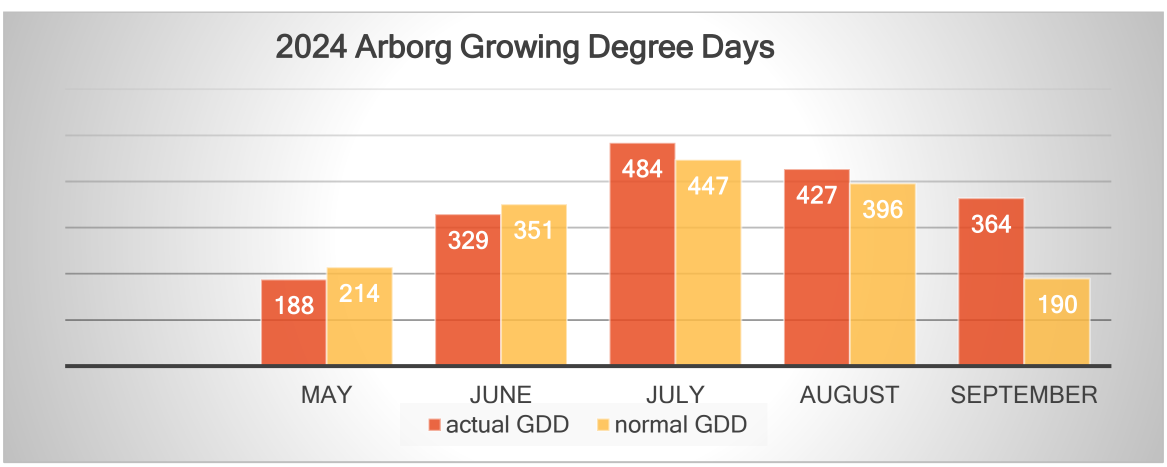
Rainfall

During the 2024 growing season (May 1-Sept 30), the Arborg site received 94% of the normal precipitation. The Arborg site received well above average precipitation for the months of May (135%) and June (148%), while the month of July (102%) was slightly above normal and August (49%) and September (14%) months were well below normal. The wet spring affected seeding operations and crop germination in some trials. The dry fall affected winter cereal germination.



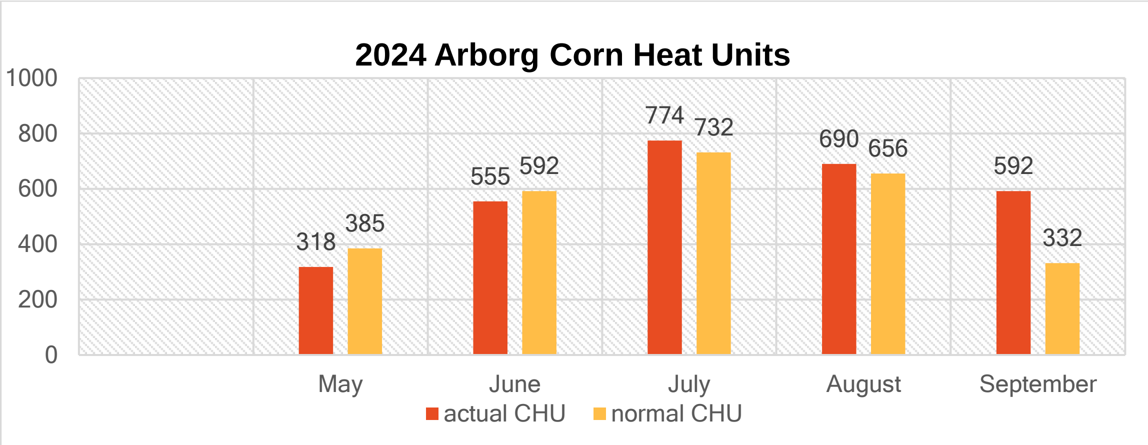
Growing Degree-Days

During the 2024 growing season (May 1-Sept 30), Arborg site received 112% of normal growing degree-days. The months of May and June had below average growing degree days (88% & 94%, respectively) while July (109%) and August (108%) saw slightly above average growing degree days. September had well above average growing degree days (189%). The spring was virtually frost free except for low temperature of -0.5C on May 14 and May 23, 2024. First fall frost was not until October 3, 2024 (-4.4C).



Corn Heat Units

During the 2024 growing season (May1-Sept 30), Arborg site received 109% of the normal corn heat units. The months of May and June received below average corn heat units (May - 83% and June - 94%), while the months of July and August received slightly above average corn heat units. September received well above normal corn heat units (178%).



2024 Arborg Seasonal Weather Summary

In 2024, the Arborg site saw a wet May and June which affected seed germination in some trials. Teff did not germinate due to wet conditions. The wet conditions during spring also had negative effect on canola in some trials. This resulted in delayed weed / flea beetle control. The balance of the growing season saw below normal precipitation and above normal temperatures. The dry fall conditions have affected winter cereal germination and growth.

Table 1. Weather conditions at Arborg site during 2024 (May 1 – Sep 30).

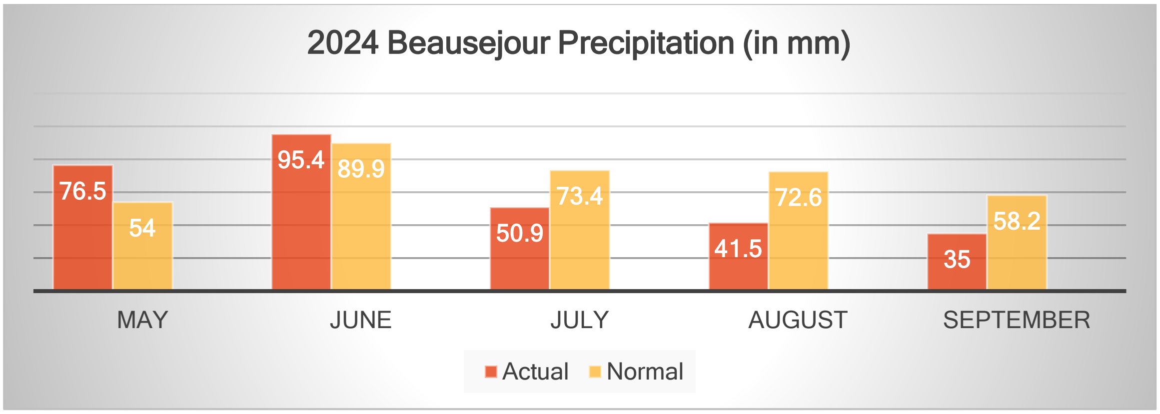
	Actual	Normal	% Normal
Growing Degree Days	1748	1557	112
Corn Heat Units	2854	2622	109
Precipitation (mm)	303	321	94

Beausejour Site

Weather data was taken from the Manitoba Agriculture Weather Station located seven miles east and four miles north of the Beausejour Research Site.

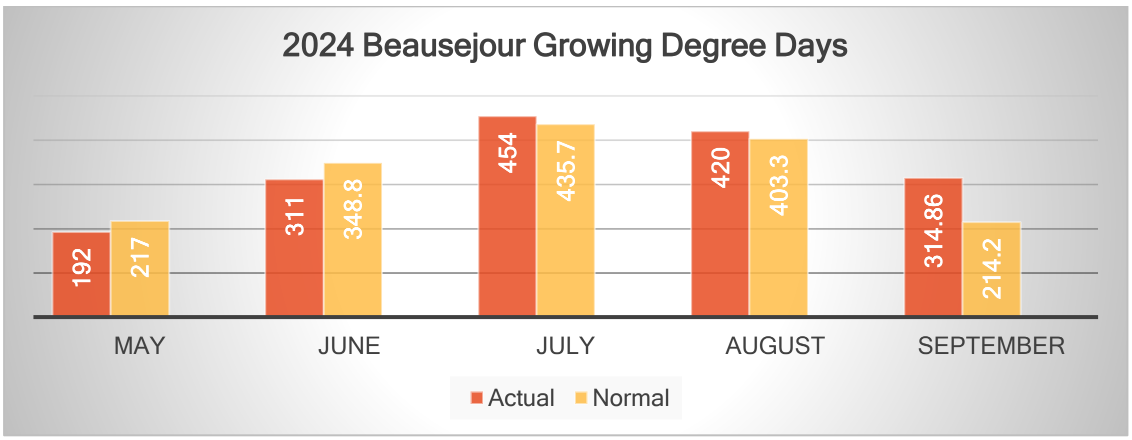
Rainfall

During the 2024 growing season (May 1-Sept 30) Beausejour site received 86% of normal rainfall. Beausejour received well above normal rainfall in May with 142% of normal rainfall. June received slightly above normal rainfall (106%) and July and August were below normal with 69% and 57%, respectively. September was also below normal receiving only 60% of normal precipitation.



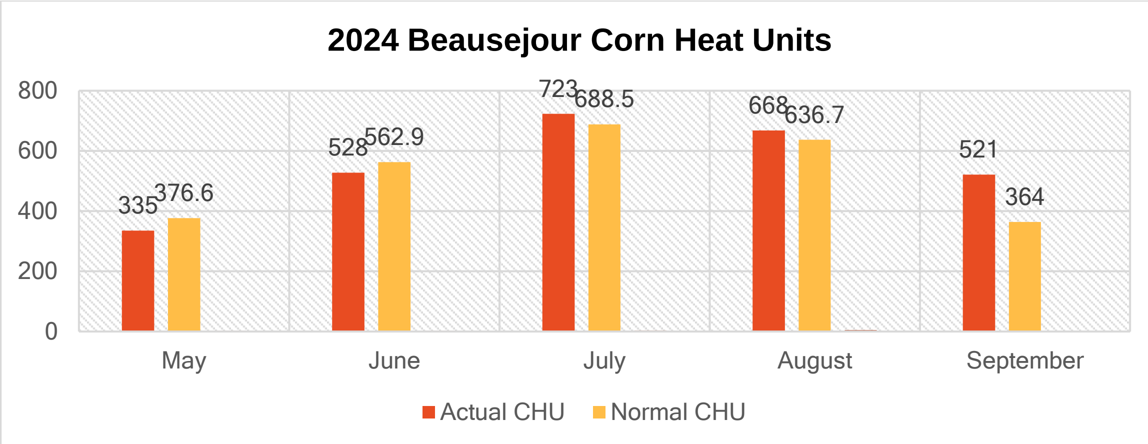
Growing Degree Days

During the 2024 growing season (May 1-Sept 30), Beausejour received 108% of normal growing degree days. May and June received below normal growing degree days (May 88% and June 89%, respectively). However, the months of July and August received slightly above normal growing degree days (both at 104%). September was well above normal with 172% of normal growing degree days.



Corn Heat Units

During the 2024 growing season (May 1-Sept 30), Beausejour site received 109% of normal corn heat units. Similar to growing degree days, the months of May and June received below normal corn heat units (May - 89% and June - 93%). July had slightly above normal corn heat units. August had slightly above normal with 104% while September had well above normal with 164% of normal corn heat units.



2024 Beausejour Seasonal Weather Summary

In 2024, Beausejour site received above normal rainfall in May and June but below normal rainfall for the balance of the season. The site had received below normal temperatures in the spring but above normal temperatures in the summer, while the fall received well above normal temperatures. The wet spring resulted in the change of plot sites and PESAI moved all research program to one site off Road 38E.

Table 2. Weather conditions at Beausejour site during 2024 (May 1 – Sep 30).

	Actual	Normal	% Normal
Growing Degree Days	1746	1619	108
Corn Heat Units	2853	2629	109
Precipitation (mm)	299	348	86

How Variable Precipitation Measurements might be within two miles?

Weather plays a crucial role in farming, and it has a direct impact on crop growth, yield, and many farm management decisions. Manitoba Agriculture operates a network of over 100 weather stations across the province which provide hourly information on many weather parameters including precipitation and temperature.

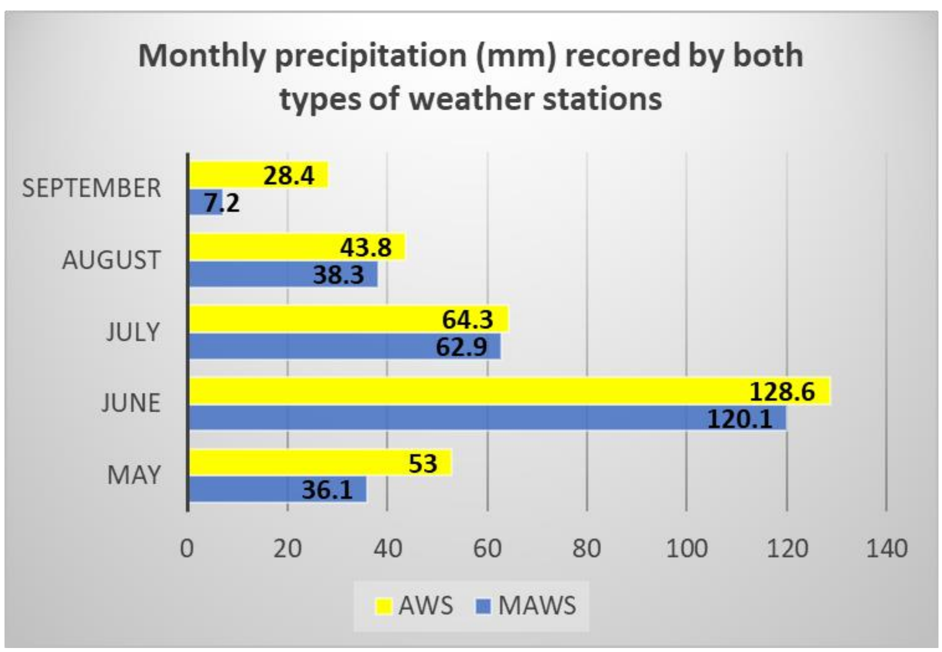
Weather parameters like precipitation, sometimes vary greatly over short distances. In the current study, we measured average daily temperature and precipitation with an Automatic weather station (AWS) and compared this data with nearby Manitoba Ag Weather station (MAWS). AWS was stationed almost two miles away from Manitoba Ag weather station, which was located at PESAI site in Arborg, MB.

Pearson correlation coefficient (r) was used to assess the strength of association between the measurements from both type of weather stations. The values of *r* range between +1 and −1, with 1 showing that there is a perfect/positive linear correlation, 0 showing no linear correlation, and −1 showing there is a negative linear correlation. We also analyzed daily differences for average daily temperature and precipitation between both weather station.

Results

The average daily temperature (during May 24 – September 26) was measured slightly higher by AWS (17.63°C) than MAWS (17.52°C), however, the differences were insignificant. A highly positive correlation coefficient (r = 0.974, p<0.0001) depicted agreement between both weather stations for temperature measurement. Daily differences were less than 1°C for most days with only five days when the differences were more than 1.5°C. The highest difference was 1.7°C on September 23.

There were 57 days during May 24 – September 26, when at least one weather station recorded precipitation (a minimum of 0.1mm). Overall, precipitation measurement was similar by both type of weather stations with a positive correlation coefficient (r = 0.757, p<0.0001). However, there were six days when the rainfall measurements differed by 5 mm or more between both weather stations. The maximum



difference was 16.8 mm on September 14. These differences were significant during the months of May and September (see figure).

Conclusions

1) Both weather stations were quite consistent in measuring average daily temperature.
2) However, precipitation estimates seem to be unrelatable on few days from weather stations which were two miles apart. During the entire season, AWS recorded almost two inches higher rainfall than by MAWS.
3) This emphasizes the need for more localized weather stations to be installed around research plots for measuring weather parameters.

PESAI Extension Activities (2024-25)

Please visit - www.mbdiversificationcentres.ca for PESAI research results.

Here is the list of extension / outreach activities PESAI did during 2024-25:

- PESAI accepts innovative research proposals from local organizations and PESAI Board decides to fund some of them every year. An announcement of PESAI's project submission deadline was advertised in Eastern and Interlake areas, as well as on social media. The following one project was granted funding –
    1) Testing IMOS (Indigenous Micro Organisms Solutions) for building soil health on field scale ($3300) – Lochwood Farms. However, this project could not be initiated due to wet conditions prevailed during crop season.

- PESAI's 2024-25 Annual Report was compiled and uploaded on Diversification Centre (DC)'s website (www.mbdiversificationcentres.ca).

- Individual project reports (from 2024) were also uploaded on DC's website. A total of 21 project reports are available on DC's website.

- During 2024-25, DC's website received 11,174 views, which were 17% greater than views in previous fiscal year. The start of monthly DC's Newsletter made a significant difference, as it alone received 3,347 views in the fiscal year. PESAI is contributing to this newsletter every month. PESAI home page was visited by 194 users.

- PESAI tweeted 12 times about its research and extension / job activities during 2024-25. These tweets made 8,846 impressions. The posts were retweeted 18 times. PESAI tweets can be accessed using twitter handle @PESAIresearch.

- A soybean research tour was organized at PESAI plot site in Beausejour on September 19, 2024, where 25 people attended. Soybean variety selection and soybean agronomic issues were discussed during the tour.

- A sunflower and grain corn research tour was organized at PESAI plot site in Beausejour on September 13, 2024 where 25 people attended. Sunflower and corn variety selection and desiccation & harvesting challenges of sunflowers were discussed during the tour.

- PESAI manned a booth entitled “Manitoba’s Diversification Centres” at Ag Days (Jan 2025), with its counterparts from other areas of the province: Parkland Crop Diversification Foundation (PCDF) – Parkland Region, Westman Agriculture Diversification Organization (WADO) – Southwest Region and Manitoba Crop Diversification Centre (MCDC) – Central Region.

- PESAI had its Annual Crop tour held on July 31, 2024, at Arborg site. More than 40 participants attended the tour, and they interacted with speakers on tile drainage, nitrogen fertility in cereals and other talks.

Table 1. List of the speakers and the topics covered at PESAI Crop tour.

Use of fungicides to control foliar diseases of Peas	Sandeep Singh & Harpreet Kaur, AC
Considerations for Sunflower production in Interlake	Daryl Rex, Manitoba Crop Alliance
Nitrogen Fertility & GHG emissions in Winter Wheat	Alex Griffith, Ducks Unlimited
Linking optimal nitrogen management to soil moisture practices	Carlie Johnston, AAFC Brandon
Managing adequate soil moisture using controlled tile drainage	Dr Sri Ranjan, Univ. of Manitoba

- PESAI’s Annual General Meeting was held on April 10, 2024, at Fort Garry Brewery in Winnipeg. Denis Tremorin, Director of Sustainability (Pulse Canada) presented during the AGM.

.

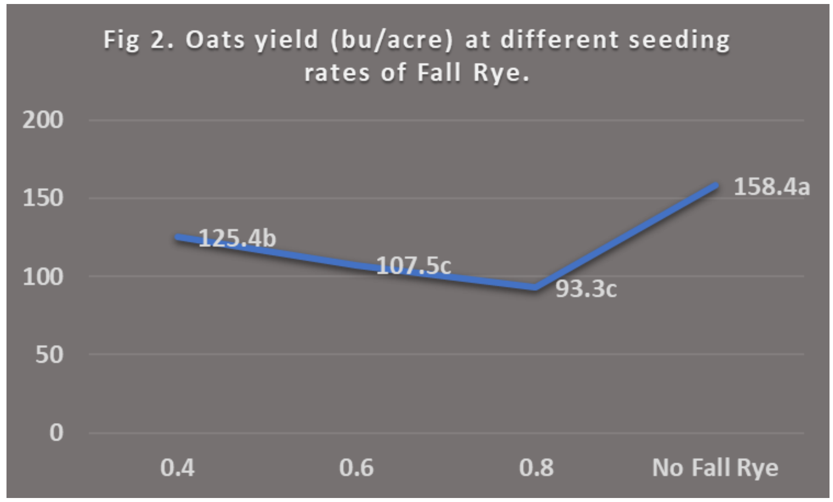
- PESAI set up its booth at Brokenhead River Ag Conference (Feb 5, 2025), and Arborg Grain information Day (Jan 29, 2025).

Testing Oats/Fall rye mixed cropping system for grain production
(Partner Project)

Project Duration: 2023-2024

Collaborators: Kurbis Farms, near Dencross

Objectives: To test spring seeded oats / fall rye mixed cropping for yield potential in Manitoba.



Background

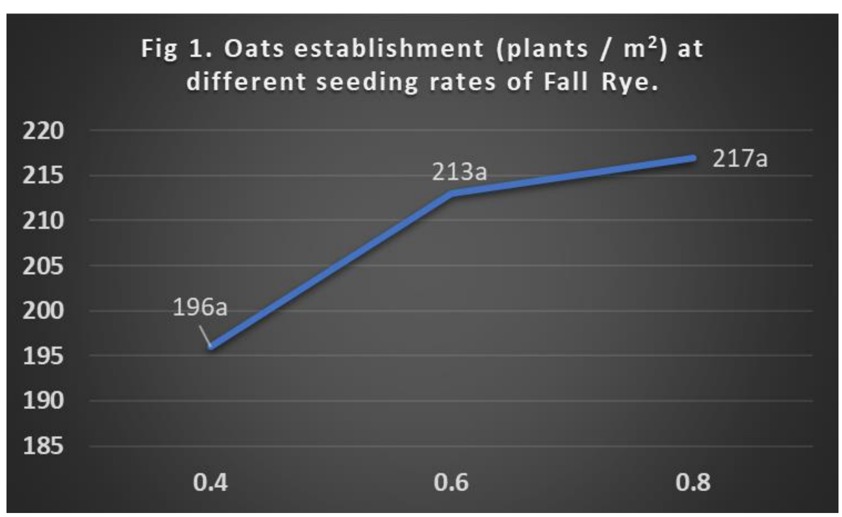
Mixed cropping offers various benefits, but there is potential to expand the concept of mixed cropping by simultaneously planting two crops and gaining economic advantages over two growing seasons. The annual crop is harvested in the fall of the first year, generating grain yield income, while the biennial crop overwinters and yields grain in the second year. The stubble from the annual crop helps reduce the risk of winterkill for the second crop by trapping snow and conserving moisture.

Planting two crops simultaneously lowers fuel costs and emissions, while enhancing soil health by keeping roots in the soil for a longer period and providing grain yield income over two years.

Cereal crops are well-suited for many mixed cropping systems. Spring seeded fall rye and winter triticale tend to be more productive in the autumn than winter wheat for forage production (Alberta Agriculture, 1993). However, leaving the spring cereal to be harvested for grain will weaken and thin-out the under-seeded winter cereals, substantially reducing regrowth by the winter cereal. In the current study, oats and fall rye were seeded together in the spring to examine their feasibility for producing grain yield over two years. Fall rye were seeded at varying seeding rates during the first year.

Results

During the first year, fall rye seeding rate did not have any effect on oat establishment (Fig 1). Oat plant counts were 196 – 217 / m^2 at different seeding rates of fall rye. However, fall rye created crop competition and resulted in yield reduction in oats (Fig 2). Greater yield losses were recorded when fall rye was seeded at higher seeding rates.



After the oats were taken off, fall rye regained growth and grown quite well in the fall of 2023. Three fall rye strips were cut and baled in the fall. Average wet forage yield was 2000 lbs / acre. A different section of the fall rye field was grazed from Sept 20 to Oct 20. Cows did well on it but stocking rate could have been significantly higher.

However, poor emergence of fall rye was observed in spring of 2024. Main factor appeared to be remaining dense growth from 2023 which inhibited emerging new growth. Poorest area was the area that was neither grazed nor cut for baling. The strips where fall rye was cut or grazed, showed better germination in the spring of 2024. Head counts of fall rye were similar regardless of any seeding rate used (456 – 674 / m^2). Fall rye yields in 2024 were statistically similar (about 50 bushels/acre) among all the seeding rates used. The difference from the highest to lowest yield was 4.6 bushels / acre.

Fall Rye crop in different strips during 2024 (Early July).

It looks like lower seeding rate (0.4 units) of fall rye is better suited to reduce competition for oats in the first year. Grazing or baling in the fall will keep fall rye growth under control and appears to be beneficial for its spring regrowth. The one question that might remain is whether higher seeding rates are required if the poor spring emergence issue can be overcome, and the fall rye could reach its full potential.

Research in Saskatchewan explored the feasibility of mixed intercropping an annual cereal crop with a short-lived perennial forage seed crop (SFSDC, 2024). Perennial ryegrass can be successfully established alongside oats without compromising the yield of the companion crop. However, environmental conditions play a crucial role in the successful establishment, overwintering, and spring growth of the forage grass crown roots. Additionally, proper straw management of the companion crop should be considered.

Oats and fall rye growing during Sep 2023.

References

1) Alberta Agriculture, Food and Rural Development (1993) Winter Cereals for Pasture. https://open.alberta.ca/dataset/b63f504d-4f40-4595-a7d0-f6bc8aaa8e0d/resource/4340f7f7-065f-4fa6-a92c-218fb77b9e1b/download/1993-133-20-1.pdf
2) SFSDC (2024) Demonstration of intercropping perennial ryegrass (PRG) with oat. https://www.saskforageseed.com/research-projects/demonstration-of-intercropping-perennial-ryegrass-prg-with-oat

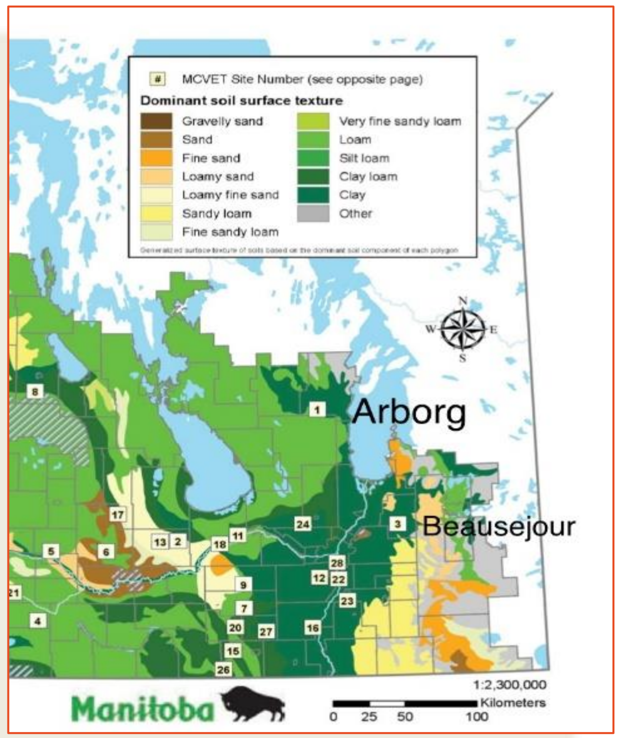
Materials and Methods

This project was conducted at Kurbis Farms (SE19-15-8E1) in Beausejour area of the province. Sixty-eight feet wide strips of oats and fall rye mixed together were seeded on May 6, 2023, using a morris air drill. For all strips, oats were planted at a seeding rate of 3 bushels / acre, whereas fall rye was planted at three different seeding rates – 0.4, 0.6 and 0.8 units / acre. Each seeding rate arrangement was replicated three times. The yield was taken from 30 feet wide strips to avoid spraying tracks. One unit of Fall Rye contains about 1 million seeds (247 plants / m^2). Both oats and fall rye were seeded in the same row.

The soil test showed 169 lbs of nitrogen and 26 ppm of phosphorous per acre in the soil. The soil had an organic material of 5.5%. Additionally, a fertilizer mixture of 50-0-05 (lbs/acre) was broadcasted before planting. A fertilizer mixture of 8-36-0-0 was also applied during seeding. Momentum and MCPA Ester 600 @ 0.33 L / acre were sprayed on June 7, 2023, for the weed control. No weed control was done on fall rye during 2024.

2024 Manitoba Crop Variety Evaluation Trials

PESAI manages two sites (Arborg & Beausejour) of the MCVET program. MCVET facilitates variety evaluations of different crop types at various sites within Manitoba. The purpose of the MCVET trials is to grow both familiar (check varieties) and new varieties side by side in a replicated manner to compare and contrast various variety characteristics such as yield, maturity, protein content, disease tolerance, and many others. From each MCVET site across the province, yearly data is collected, combined, and summarized in the 'Seed Manitoba' guide. Seed Manitoba guide and the websites www.seedinteractive.ca and www.seedmb.ca provide valuable variety performance information for Manitoba farmers.



PESAI managed two MCVET sites (Arborg and Beausejour) during 2024 growing season. Variety trials of spring wheat, winter wheat, fall rye, oats, barley and soybeans (both herbicide tolerant and conventional) were conducted at both sites (Table 1), whereas trials of peas, silage corn, annual forages & flax were conducted only at Arborg site. Grain corn & sunflower plots were done only at Beausejour site. The data from the majority of MCVET trials were accepted and published except for silage corn (Arborg site), grain corn and barley (Beausejour site). This was due to high CV's which were caused by wet spring conditions. Please visit SEED MANITOBA's website for MCVET testing results from Arborg & Beausejour sites.

Table 1. Agronomic information for MCVET trials done during 2024 at PESAI sites.

Crop Type	Stubble	N-P (lbs/ac) from soil testing	Seeding Date	Fertilizer Applied (N - P:lbs/ac)	Harvest Date	No of Plots
ARBORG						
Spring Wheat	Soybean	8-21	9-May	70-20	Aug 20	72
Oats	Soybean	8-21	9-May	70-20	Aug 21	42
Barley	Soybean	8-21	9-May	70-20	Aug 14	48
Winter Wheat	Canola	13-18	19-Sep	30-20 (at seeding) 75-0 (broadcasting in spring)	12-Aug	18
Fall Rye	Canola	13-18	19-Sep	30-20 (at seeding) 75-0 Broadcasting in spring	12-Aug	18
Peas	Wheat	42-31	10- May	0-15	Aug 19	60
Conv. Soybeans	Wheat	42-31	23-May	0-15	Oct 2	36
HT Soybeans	Wheat	42-31	23-May	0-15	Oct 2	123
Silage Corn	Soybeans	66-42	21-May	100-15 (broadcasted)	Sep 25	90
Flax	Soybeans	8-21	21-May	60-20	Sep 3	27
Annual Forages	Soybeans	NA	13-May / June 9	80-35 (broadcasted)	Aug 1 & 27	45
BEAUSEJOUR						
Winter Wheat	Fallow	12-6	20-Sep	30-20 (at seeding) 75-0 (broadcasting in spring	Aug 13	18
Fall Rye	Fallow	12-6	20-Sep	30-20 (at seeding) 75-0 (broadcasting in spring	Aug 13	18
Spring Wheat	Soybeans	NA	June 8	70-20	Sep 12	42
Oats	Soybeans	NA	June 8	70-20	Sep 12	27
Barley	Soybeans	NA	June 8	70-20	Sep 12	39
Conv. Soybeans	Wheat	74-12	30-May	0-15	3-Oct	36
HT Soybeans	Wheat	74-12	30-May	0-15	3-Oct	123
Grain Corn	Wheat	74-12	May 29	100-15	Oct 17	126
Sunflowers	Wheat	74-12	May 29	90-15	Oct 10	54

Testing Corn/Legume Intercrops for Forage Production

Project Duration: 2024

Objectives: Assessing the effect of corn and legume (soybeans, peas, berseem clover & faba beans) intercrops on forage production and quality.

Results

Forage yield: Legume intercrops did not have any effect on the height of corn at harvest. Similarly, forage yield did not increase / decrease with the addition of any legume species with corn (Table 1). Corn-legume intercrops produced similar forage yields regardless of the legumes either planted with the corn or planted three weeks after corn.

Table 1. Effect of corn-legume intercrops on the forage yield at Arborg site.

Intercrop Treatment	Corn Height at harvest (inches)	Dry Matter Forage Yield (tons/ac)	Crop stage at harvest (legumes)
Corn	81.8 a	6.67 a	
Corn/Berseem Clover	79.2 a	7.31 a	Late Flowering
Corn/Soybeans	80.7 a	6.51 a	70% brown pods
Corn/Peas	77.5 a	5.53 a	R8
Corn/Faba beans	80.3 a	5.98 a	All pods turned black
Corn/Berseem Clover Delayed	82.8 a	7.07 a	Early – Mid flowering
Corn/Soybeans Delayed	79.8 a	6.32 a	50% Yellow pods
Corn/Peas Delayed	82.7 a	6.16 a	R8
Corn/Faba beans Delayed	82.5 a	6.63 a	Top 1/3rd pods – green Bottom 2/3rd pods - black
Sig. Difference	No	No	
P Value	0.776	0.617	

Forage quality: The results on forage quality in terms of crude protein, ADF, NDF, TDN and RFV are presented in Table 2. Legume intercrops did not have any effect on quality parameters and the intercrops were comparable to corn mono crop. Forage from mono and intercrop treatments had RFV > 142 showing their good quality for animal nutrition.

Usually, addition of legumes will enhance forage quality in terms of better crude protein. However, in the current study, legume species did not improve forage protein levels. Only corn-soybean delayed treatment had protein levels of > 8 %. Current testing did not see any forage yield improvement with the addition of legumes to corn.

Table 2. Effect of corn-legume intercrops on forage quality parameters.

Intercrop Treatment	Crude Protein (%)	ADF %	NDF%	TDN%	RFV
Corn	7.36	22	42.1	75.2	159
Corn-Soybean	6.72	26.2	44.7	70.6	142
Corn-Peas	7.84	23.6	44.5	73.4	147
Corn - Berseem clover	7.04	21.9	38.6	75.2	173
Corn – Faba beans	7.47	19	36.5	78.3	189
Corn-Soybean Delayed	8.23	20	37.3	77.3	183
Corn-Peas Delayed	7.41	23.6	41.8	73.4	157
Corn-Berseem clover Delayed	6.88	22.1	41.1	75	162
Corn-Faba beans Delayed	6.82	22.8	41	74.3	162

Background/ References/ Additional Resources

Corn forage can fit well in the grazing system as it meets the nutritive requirements of beef cows in mid- and late-stage pregnancy (Omokanye, 2019). Usually corn forage had lower CP content than other cereal crops across the Canadian prairie environments (Lardner et al., 2017). Several studies have indicated that corn forage protein concentrations would not normally be adequate for beef cattle diet at all physiological stages (Lardner et al., 2017; Omokanye, 2016).

Intercropping corn with legumes provides several advantages such as improved forage yield and forage nutritive value. Corn intercropped with cowpea (*Vigna ungiuculata*) and bean (*Phaseolus vulgaris*) were far more effective than monocrop corn to produce higher dry matter yield and roughage for silage with better quality (Geren at al 2008). In a recent study from Alberta, Omokanye et al (2020) reported that crude protein levels were improved in several corn-legume intercrops as compared to corn mono crop. Forage yield, however, did not increase with the intercropping.

The current study was designed to assess viability of corn (*Zea mays L.*) - legume intercrops to improve the forage crude protein (CP) of corn forage for beef cattle production. A corn monocrop was compared with four corn-legume intercrops.

Definitions -

Acid detergent fibre (ADF) – a chemical analysis that estimates the total fibre (including indigestible lignin) in the feed. A high ADF indicates reduced digestibility and likely lower voluntary feed intake.

Crude protein (CP) – an estimate of the total protein content of a feed determined by analyzing the nitrogen content of the feed and multiplying the result by 6.25. Crude protein includes true protein and non-protein nitrogen sources such as ammonia, amino acids and nitrates.

Neutral detergent fibre (NDF) – an insoluble fraction containing all plant cell wall components left after boiling a feed sample in a neutral detergent solution. A high NDF indicates lower digestibility and voluntary feed intake.

Total Digestible Nutrients (TDN) - The sum of the digestible fiber, protein, lipid, and carbohydrate components of a feedstuff or diet. TDN is directly related to digestible energy and is often calculated based on ADF.

Relative Feed Value (RFV) - is intended to reflect how well an animal will eat and digest a particular forage if it is fed as the only source of energy. Relative Feed Value is calculated from ADF and NDF content of a forage.

Materials and Methods

The trial was established on soybean stubble in heavy clay soil. Plots were organized in a randomized complete block design with nine treatments and three replicates. Corn was seeded on May 13 using R-Tech plot seeder with row spacing of 18 inches. Legumes were seeded either with corn (on May 13) or on June 10 for delayed seeding treatment with row spacing of 9 inches. There were 3 rows of corn and 6 rows of legumes in each plot.

Corn was seeded at full rate whereas legumes were seeded at 50% of the recommended seeding rate.

Treatment	Crop Variety	Seeding rate / acre
Corn (100)	CP1440VT2P/RIB	32,000 plants
Corn-Soybean (100:50)	CP1440VT2P/RIB - OAC Prudence	32,000 plants - 90,000 plants
Corn-Peas (100:50)	CP1440VT2P/RIB - CDC Lewchko	32,000 plants - 160,000 plants
Corn - Berseem clover (100:50)	CP1440VT2P/RIB - Winner brand	32,000 plants - 6 lbs
Corn – Faba beans (100:50)	CP1440VT2P/RIB - CDC 1142	32,000 plants - 90,000 plants

Fertilizer was broadcasted at the rate of 80N-35P / acre before seeding. We applied glyphosate at 1L/acre (pre-emerge) and Basagran Forte at 0.91L/acre (in crop) for the weed control. Data on plant stand, corn plant height, forage yield and forage quality were recorded.

References

1) Geren H, Avcioglu R, Soya H and Kir B (2008) Intercropping of corn with cowpea and bean: Biomass yield and silage quality. ***African Journal of Biotechnology*** Vol. 7 (22), pp. 4100-4104.
2) Lardner, H. A., Pearce, L., & Damiran, D (2017) Evaluation of low heat unit corn hybrids compared to barley for forage yield and quality on the Canadian Prairies. ***Sustainable Agriculture Research***, 6, 90–102.
3) Omokanye, A. (2019) Cover crop cocktails for livestock feed. In: ***Cocktail Cover Crop Workshop***, Debolt, Alberta. 5 Feb. 2019. High Prairie, AB: Peace Country Beef and Forage Association.
4) Omokanye, A. (2016) Peace corn field trials: Research update. In: ***East Peace Beef Cattle Day***, High Prairie, AB. 30 Nov. 2016. High Prairie, AB: Peace Country Beef and Forage Association.
5) Akim Omokanye, Buthaina Al-Maqtari, Herbert A. Lardner, Guillermo Hernandez, Kabal S. Gill, Lekshmi Sreekumar, Alan Lee (2020) Forage potential of corn intercrops for beef cattle diets in northwestern Alberta. ***Crop Forage & Turfgrass Mgmt.*** https://acsess.onlinelibrary.wiley.com/doi/epdf/10.1002/cft2.20056

Testing mixed cropping of Oats / Italian Ryegrass / Berseem Clover for Forage Production

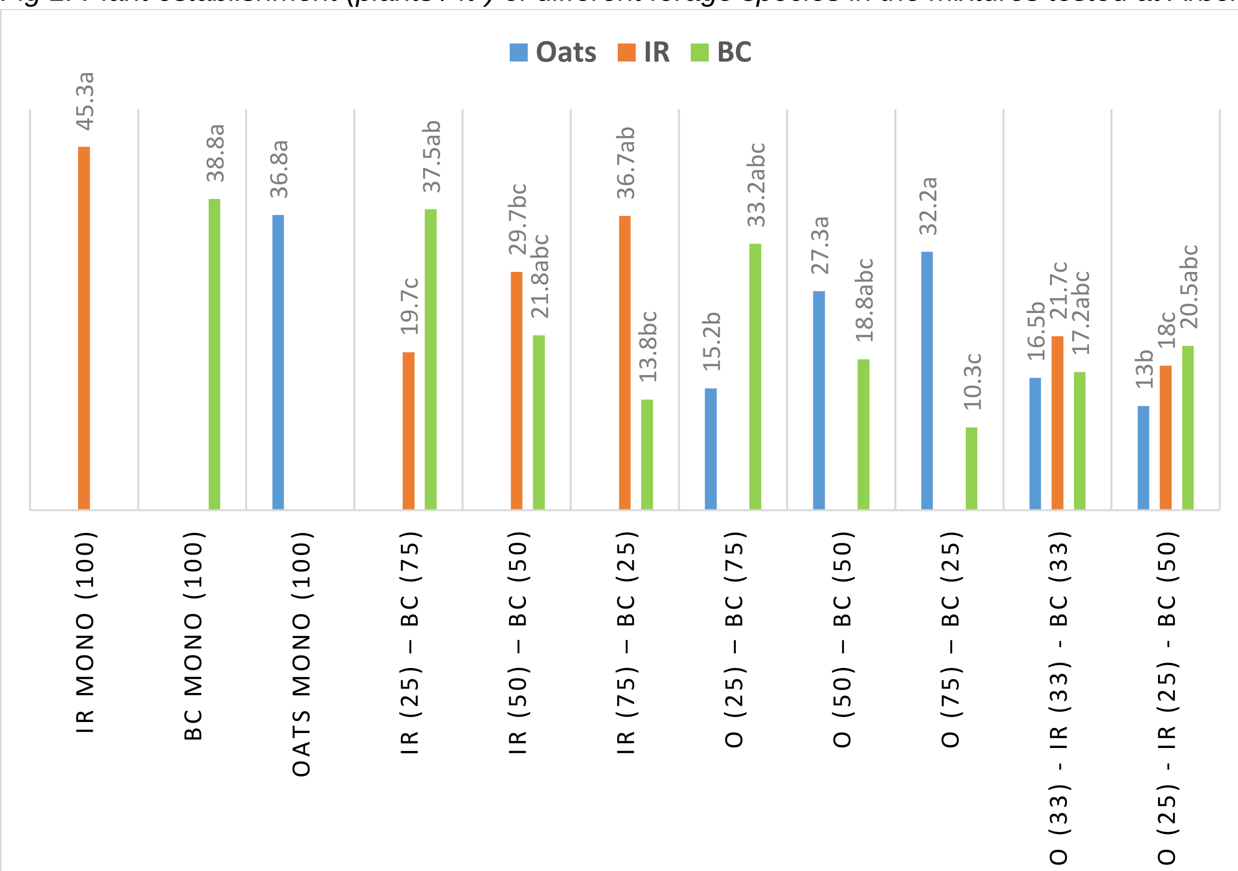
Project Duration: 2022 - 2024

Objectives: To evaluate different seeding rates of oats / Italian ryegrass / berseem clover mixed crops for forage yield potential in comparison to their mono crops.

Results

Plant establishment: Oats were quite competitive with other crops in the mixtures and oats plant stand did not decrease even when mixed only at 50% of the recommended seeding rate (Fig 1; Blue bars). Plant establishment was significantly less when oats were mixed up at 33% or 25% of the recommended seeding rates. Similarly, Italian ryegrass plant populations were less when it was mixed at 50% or less seeding rate in the mixtures (orange bars). Berseem clover was not competitive with Italian ryegrass and oats when the later crops were mixed at 75% of their recommended seeding rate (green bars).

Fig 1. Plant establishment (plants / ft²) of different forage species in the mixtures tested at Arborg site.



Plant height and forage yield: There were no effect on plant height of oats and Italian ryegrass when these were grown in the forage mixtures. However, berseem clover plants were shorter when it was mixed with 50% and 75% seeding rate of oats (Fig 2).

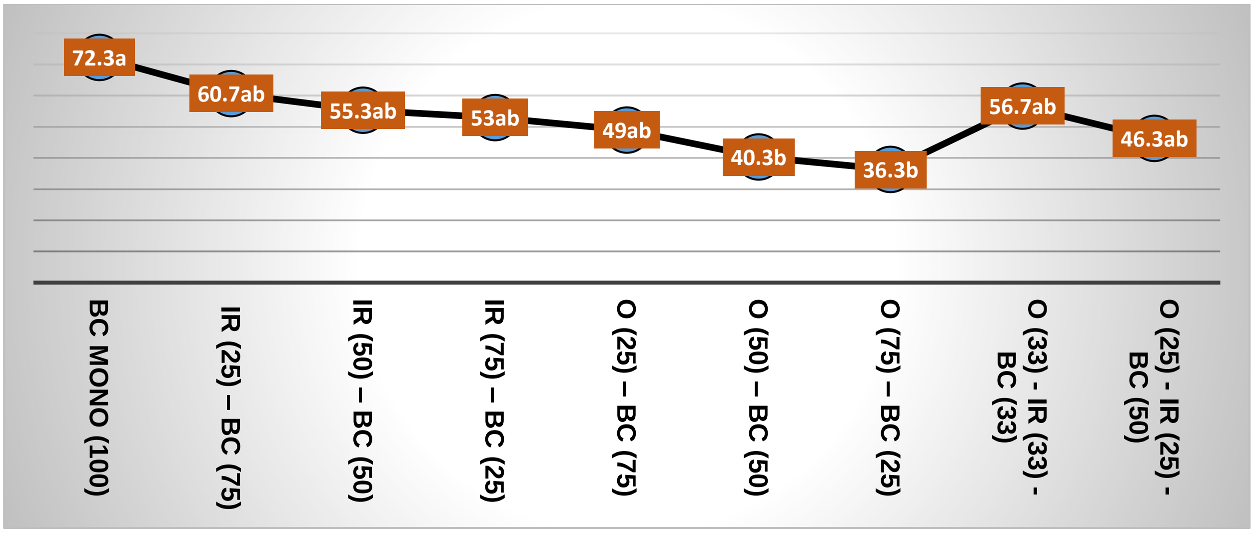


Figure 2. Plant height (in centimeters) of Berseem clover in different forage mixtures.

Forage yield varied significantly among different treatments both in first as well as second cut. However, when the yield data were pooled for both cuts, yield differences were not significant (Table 1). During first cut, Italian ryegrass and berseem clover plots had significantly less forage yield. It looks like oats were essential in the mixtures to produce better yield. Oats even at 25 % of the recommended seeding rate in the mixtures resulted in significantly higher yields. Arborg had a wet spring, and oats are known to prefer wet and cool conditions to grow.

Oats did not grow during the second cut, so in oats – berseem clover mixtures, forage yield is primarily from berseem growth. Both Italian ryegrass and berseem grew well during second cut. Although it was relatively dry spell during the second cut, but both mono as well as mixture crops of Italian ryegrass and berseem produced significantly higher forage yields. However, oats - berseem mixtures produced less forage yield during second cut as only berseem grew in these plots. All forage treatments produced 7.6 – 10.8 tons / ha dry matter forage when the data were pooled for both cuts.

In conclusion, mixtures of oats / berseem clover / Italian ryegrass were similar to their mono crops in producing forage yield over the entire season. However, inclusion of berseem might improve nutritional value of the forage as reported in the previous studies.

Table 1. Forage yield from different cropping treatments in the test at Arborg site.

	Dry Matter Forage Yield (tons /ha)		
Cropping treatment	*First cut*	*Second cut*	*Total*
Italian Ryegrass mono (100)	*4.4 bc*	*4.7 a*	*9.0 a*
Berseem Clover mono (100)	*2.7 c*	*4.9 a*	*7.6 a*
Oats mono (100)	*9.9 a*	*-*	*9.9 a*
IR (25) – BC (75)	*4.7 bc*	*5.6 a*	*10.3 a*
IR (50) – BC (50)	*5.4 bc*	*4.9 a*	*10.3 a*
IR (75) – BC (25)	*5.6 bc*	*5.2 a*	*10.8 a*
O (25) – BC (75)	*7.8 ab*	*2.5 bc*	*10.4 a*
O (50) – BC (50)	*7.9 ab*	*1.6 c*	*9.5 a*
O (75) – BC (25)	*8.1 ab*	*0.9 c*	*9.0 a*
O (33) - IR (33) - BC (33)	*6.3 abc*	*3.8 ab*	*10.5 a*
O (25) - IR (25) - BC (50)	*6.7 abc*	*3.9 ab*	*10.2 a*
P	*<0.0001*	*<0.0001*	*0.280*
Significant Difference	*YES*	*YES*	*NO*

Background / References / Additional Resources

Annual forage crops can be used as a good source of quality forage. There are many annual crops and options available to producers, but these choices also depend on the weather conditions. There is evidence that cool and warm season annual cereals differ in their yield potential depending on the crop season (McCartney *et al.* 2009). If the growing season is cool and wet, it benefits oats and barley. However, when it is warm and wet, it favors some of the millets.

In Alberta, Omokanye *et al.* (2019) compared annual crop mixtures and monoculture cereal crops (controls) for forage yield and quality for beef cattle production. They suggested that growing an annual crop mixture with diverse plant functional groups compared to a monoculture cereal, can be used to improve forage production.

Berseem clover is a valuable, high-yielding annual forage legume and well adapted to a wide range of environments for grazing and hay production. Intercropping berseem clover with cereals has increased the yield and quality of cereal forage crops (Singh et al., 1989). In research conducted in north-central Alberta, berseem out-performed six other clovers in yield and ability to compete with weeds (Ross et al. 2001). Oats have frequently been used as a companion crop for forage legumes.

In the current study, we compared mixtures of oats, Italian ryegrass & berseem clover for their forage potential. These crops were included at different seeding rates to examine the effects of seeding rate on forage yield.

References

1. McCartney, D., Fraser, J. and Ohama, A. (2009) Potential of warm-season annual forages and *Brassica* crops for grazing: A Canadian Review. *Can. J. Anim. Sci.* 89: 431- 440.

2. Omokanye, A., Lardner, H., Sreekumar, L., and Jeffrey, L. (2019) Forage production, economic performance indicators and beef cattle nutritional suitability of multispecies annual crop mixtures in North western Alberta, Canada. *Journal of Applied Animal Research* 47: 303-313.

3. Ross, S. M., King, J. R., Izaurralde, R. C. and O'Donovan, J. T. 2001. Weed suppression by seven clover species. Agron. J. 93: 820–827.

4. Singh, V, Joshi, Y. P. and Verma, S. S. 1989. Studies on the production of Egyptian clover and oats under intercropping. Exp. Agric. 25: 541–544.

Materials and methods

Experimental design: Randomized complete block design
Replications: Three
Treatments:

Crops: Italian ryegrass (*Lolium multiflorum*), Oats (*Avena sativa*), Berseem clover (*Trifolium alexandrinum*)

Seeding rates (lbs/ac) for different treatments:

Italian Ryegrass mono (100)	*20 (full rate)*
Berseem Clover mono (100)	*12 (full rate)*
Oats mono (100)	*100 (full rate)*
IR (25) – BC (75)	*5 / 9*
IR (50) – BC (50)	*10 / 6*
IR (75) – BC (25)	*15 / 3*
O (25) – BC (75)	*25 / 9*
O (50) – BC (50)	*50 / 6*
O (75) – BC (25)	*75 / 3*
O (33) - IR (33) - BC (33)	*33 / 6.7 / 4*
O (25) - IR (25) - BC (50)	*25 / 5 / 6*

Plot size: 8.2 – 10.4m^2
Data collected – plant stand, plant height at harvest, forage yield
Agronomic information
Stubble, soil type: soybeans, Heavy clay
Fertilizer applied: N - 80 lb /acre; P - 35 lb/acre (broadcasted and incorporated before seeding)
Seeding date: May 13, 2024
Harvesting date: Aug 1, 2024 (First cut), Sep 23, 2024 (Second cut)

Forage library established successfully at PESAI site

Project Duration: 2023-2026

Objectives: To establish various forage species for the purpose of demonstration.

Results

During 2023, PESAI took on a project from Ducks Unlimited to establish various forage species as a part of a forage library. The plots were seeded in June 2023. This library has five native grasses, 20 grass species, 10 legume species and five grass-legume blends (see Table).

The blends were tested with and without adding any phosphorous. Most of the plots were established and overwintered except plots of Valerio Perennial Ryegrass and Birdsfoot Trefoil as they did not survive winter of 2023. Plots of Orchard grass, Alsike Clover and Sainfoin were also severely affected by winter.

The following table illustrates the forage species along with wet forage yields (tones/acre) from the first cut during 2024.

Native grasses	Grasses		Legumes	Blends
Purple Prairie Clover (1.9)	Tall Fescue Rough (6.6)	Saltlander + Green Wheatgrass (9.7)	Birdsfoot Trefoil (2.7)	Exceed Alfalfa & AC Knowles HB (10.9)
Slender Wheatgrass (7.9)	Orchard grass (1.4)	Hybrid Brome (12.6)	Sainfoin (1.4)	Premium Hay Max (Northstar) (9.5)
Blue Grama (0.3)	Meadow Fescue (7.6)	Tall Wheatgrass (16.6)	Alfalfa tap root variety (9.6)	Dual Purpose Blend (Brett Young) (11.0)
Side-oats Grama (2.7)	Creeping Red Fescue (7.5)	Festulolium (9.5)	Alfalfa creeping root variety (9.9)	Hay Blend (Brett Young) (9.6)
Canada Milkvetch (4.7)	Saltlander (7.4)	Tall Fescue Satin (8.2)	Red Clover (8.9)	Pasture Blend (Brett Young) (11.2)
	Fleet Brome (10.5)	Valerio Perennial Ryegrass (0.0)	Alfalfa (8.4)	
	Russian Wildrye (3.7)	Pubescent Wheatgrass (12.6)	White Clover (4.2)	
	Intermediate Wheatgrass (13.1)	Crested Wheatgrass (9.0)	Exceed - Branch Root (10.5)	
	Preval or Tetrax Meadow Fescue (3.9)	Timothy (8.8)	Alsike Clover (4.1)	
	AC Killarney Orchard grass (10.0)	Kentucky Blue (2.2)	Revolution - low lignin/tap root (9.9)	
		Carlton Smooth Brome (11.8)		

Testing MCVET Annual Forages in Interlake

Project Duration: 2024

Collaborators

- Manitoba Crop Variety Evaluation Team (MCVET)
- Shawn Cabak, Livestock & Forage Extension Specialist, Manitoba Agriculture

Objectives

Evaluating annual plant species for forage yield and feed quality.

Results

Forage species/ mixtures differed in dry matter forage yield, relative feed value (RFV), crude protein (CP) and total digestible nutrients (TDN) when tested at Arborg site during 2024 (Table 1). Proso and Foxtail millet had the lowest forage yield whereas sorghum species produced the highest forage yield overall. Sorghum species had the lowest relative feed value while barley and pea/cereal mixtures had the highest. Foxtail millet had higher crude protein whereas barley varieties had lower protein content.

Table 1. Relative performance of different annual forages (& mixtures) at Arborg site in 2024.

Crop	Variety	DM Yield	RFV%	CP%	TDN%
Oats	CDC Arborg	4.2	97	6.3	58
Oats	CDC Endure	3.3	115	7.8	63
Oats	CDC Westgate	4.0	88	7	56.9
Oats	ORe Boost	4.0	87	6.5	54.7
Oats	ORe Ruminator	4.4	95	7.9	58.7
Oat Average		**4.0**	**99**	**7.1**	**58.3**
Barley	AB Advantage	4.1	127	7.5	66.5
Barley	AB Tofield	4.2	109	6.3	61.5
Barley	CDC Renegade	4.1	138	6.3	67.8
Barley Average		**4.1**	**125**	**6.7**	**65.4**
Peas/Barley	CDC Lewochko - AB Advantage	4.4	128	12	64.2
Peas/Oats	DL Delicious - CDC Arborg	4.7	121	9.9	61.6
Pea/Cereal Average		**4.6**	**125**	**11**	**62.9**
Spring Tritcale	T301	**4.3**	**113**	**9.3**	**62.4**
Proso Millet	Crown	2.3	90	10.6	61.3
Foxtail Millet	Siberian	2.4	98	14	62
Millet Average		**2.4**	**94**	**12.3**	**61.7**
Sorghum Sudangrass	Common	7.6	87	7.4	57.3
Forage Sorghum	Common	7.6	87	8.7	56.3
Sorghum Average		**7.6**	**87**	**8.1**	**56.8**
Grand Mean (tonnes/acre)		4.4			
CV %		10.1			
LSD (0.05)		0.7			
Significant Difference	Yes				
Seeding Date	May 13 & June 8				
Harvest Date	Aug 1 & 27				

Project Findings

The 2024 growing season had above average rainfall at the time of seeding. The wet spring was followed by hot and dry conditions carrying through until harvest. Some of the species showed greater adaptability to these conditions while others did not (see table 1). Millet species had significantly low forage yields. Barley, pea/barley mixtures, oats and pea/oat mixtures produced moderate yields. Sorghum and sorghum sudangrass produced the highest yields. Many forage species or mixtures produced forage with a relative feed value (RFV) greater than 100 except from the plots of foxtail and proso millet, sorghum sudangrass, forage sorghum and oats (excluding variety CDC Endure). Barley & sorghum plots produced forage with relatively low crude protein, whereas pea / barley mixtures had the highest crude protein content. All barley varieties had very good relative feed values, whereas sorghum plots were low in relative feed value.

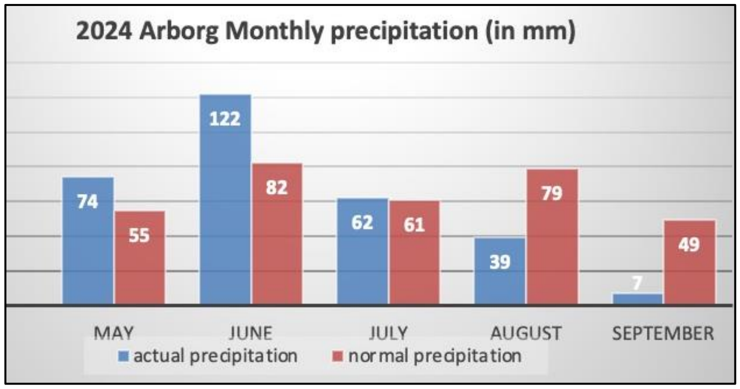


Figure 1. Monthly average precipitation (mm) at Arborg site during 2023.

Table 2. Performance of annual forage species (& mixtures) at Arborg site during 2022-24.

Crop Type	*Variety (s)*	*Dry Matter Forage Yield (tonnes/acre)* 2022	2023	2024
Oats	*CDC Endure*	*3.3 de*	*4.9 b*	*3.3 b*
	CDC Arborg	*3.8 cde*	*5.8 b*	*4.2 c*
Barley	*AB Advantage*	*3.2 bc*	*6.1 b*	*4.1 c*
Peas / Barley	*CDC Lewochko - AB Advantage*	*3.5 cd*	*6.1 b*	*4.4 c*
Peas / Oats	*CDC Jasper (21), CDC Lewochko (22/23), DL Delicious (24) - CDC Arborg*	*4.4 e*	*5.8 b*	*4.7 c*
Spring Triticale	*Pronghorn (22/23) T301 (2024)*	*4.0 de*	*3.2 a*	*4.3 c*
Foxtail millet	*Golden German (21/22) Siberian (23/24)*	*1.5 a*	*2.8 a*	*2.4 a*
Proso millet	*Crown*	*1.0 a*	*2.7 a*	*2.3 a*
Sorghum-Sudangrass	*Common*	*2.8 b*	*6.0 b*	*7.6 d*
Seeding / Harvesting dates		*May 24 / July 29-Aug 25*	*May 16 / July 26-Aug 24*	*May 13 & Jun 8 / Aug 1 & Aug 27*
Precipitation* (% of normal)		*189*	*56*	*130*

**Precipitation values from May 15 – Aug 15.*

Table 2 presents the summary of annual forage testing during 2022-2024 at Arborg site. The most predominant factor in the yield variance throughout the years were weather conditions. 2022 & 2024 years exhibited high amounts of precipitation in comparison to the historical average rainfall during May 15 – August 15 period.

Overall, pea-barley and pea-oats mixtures produced relatively good forage yield during all years despite wet and dry conditions. Similarly, CDC Arborg variety of oats was also resilient to moistures conditions and produced good forage yields during the testing years.

Both proso and foxtail millets produced lower yields during all the years. Spring triticale had good forage yield during wet years, but it suffered significant yield losses during dry year.

Sorghum sudangrass produced higher forage yields during 2023 & 2024. This crop is susceptible to wet conditions, but it yielded greater forage yield in 2024. One possible explanation is that this crop was seeded late on June 8. Arborg site had relatively normal or lower rainfall after the month of June, and this might have positive effect on the growth and yield of sorghum sudangrass.

Background / References / Additional Resources

Cool season annual forage crops such as oats, fall rye, rye grass, barley, wheat, winter triticale, winter wheat are being used and researched extensively in Canada. (McCartney et al 2008). Warm season annual forage crops include corn, sorghum, sorghum-sudangrass, millets, brassica crops, hybrids, turnips and other root crops are being considered as potential and need to be researched for forage use in Canada (McCartney et al 2009). Sudan grass, Proso millets and hybrids had also advantage over corn for their drought tolerance (McCartney et al 2009). Proso millet is considered advantageous to replace a failed seeded crop as it matures rapidly.

In previous testing in Manitoba, higher forage yield was recorded either in cereals grown alone or in blends (with oats or barley), however, higher protein content was recorded in cereal / peas blends (PESAI Annual report 2020). The current project is aimed to test different annual forages for production and feed quality.

References

1) McCartney, D., Fraser, J. and Ohama, A. 2008. Annual cool season crops for grazing by beef cattle. A Canadian Review. **Can. J. Anim. Sci.** 88: 517-533

2) McCartney, D., Fraser, J. and Ohama, A. 2009. Potential of warm-season annual forages and Brassica crops for grazing: A Canadian Review. **Can. J. Anim. Sci.** 89: 431-440.

3) PESAI Annual Report (2020) Comparing annual forages for productivity. Pp 64-66. https://mbdiversificationcentres.ca/wp-content/uploads/2021/04/PESAI-ANNUAL-REPORT-2020.pdf

Materials and methods

The trial was established in Arborg on soybean stubble in heavy clay soil. Plots were organized in a randomized complete block design (with 3 replications) in which 15 forage species (or blends) were tested (Table 1). Most plots were seeded on May 16th with R-Tech double disc plot seeder. Sorghum and millet plots were seeded on June 8.

Seeding rates used for forage species -

Oats	220 viable seeds / m^2
Barley	250 viable seeds / m^2
Peas	80 viable seeds / m^2
Triticale	265 viable seeds / m^2
Millets / Sorghum	20 lbs / acre
Mixtures	50% of standard: 110 oats / 40 peas, 125 barley / 40 peas

Fertilizer blend of N:80 – P:35 (lbs/acre) was broadcasted and incorporated pre-seed. The plots were sprayed with Basagran Forte at 0.91L/ac on June 14th for weed control.

The 8.22m^2 plots were harvested during Aug 1 & Aug 27. Sorghum and sorghum-sudangrass plots were harvested on Aug 27 whereas most of other plots were harvested by first week of August.

Crop stage at harvest -

- **Barley:** early dough
- **Oats:** late milk to early dough
- **Triticale:** milk to early dough
- **Millets / Sorhgum:** early heading
- **Peas:** between flat pod & full pod stage
- **Mixtures:** when earliest crop was soft dough stage

Data were collected on plot forage yield and dry matter content. Forage samples were sent to Central testing laboratory for quality testing.

Effects of Sub-Surface Drainage & Seeding rate on the Crop Growth & Yield of Peas

Project duration: 2024

Objectives: To evaluate the effect of tile drainage & seeding rate on the crop growth & yield of peas.

Results

Seeding rate did have significant effect on pea plant survival (Table 1). When peas were grown at recommended seeding rate (7.5 plants / ft^2), it resulted in greater plant establishment than when seeded at 75% of this rate. However reduced seeding rate also had sufficient plant populations established. Drainage and seeding rate did not have any effect on days to maturity, plant height and grain yield of peas.

Table 1. Comparison of peas grown over tiled vs non-tiled land with recommended and reduced seeding rates at Arborg site.

Treatment	*Plant establishment (no. of plants / ft^2)*	*Days to maturity*	*Plant height at harvest (inches)*	*Grain Yield (bu/acre)*
Drainage effects				
Peas on tiles	*11.9a*	*89.8a*	*33.7a*	*61.2a*
Peas on non-tiled land	*13.5a*	*90.0a*	*32.4a*	*60.1a*
Significant Difference	*NO*	*NO*	*NO*	*NO*
P	*0.115*	*0.594*	*0.152*	*0.816*
Seeding rate effects				
Recommended (100%)	*14.2a*	*89.3a*	*32.8a*	*63.6a*
Reduced (75%)	*11.3b*	*90.0a*	*33.3a*	*57.7a*
Significant Difference	***YES***	*NO*	*NO*	*NO*
P	***0.007***	*0.594*	*0.625*	*0.221*

During this study (May 15 - Aug 15), Arborg site received 130% of the normal rainfall. The site was extremely wet after seeding. Usually, peas are susceptible to excess moisture during crop growth, but this was not exhibited from the current test. Peas grown on even non-tiled land did not exhibit any moisture stress symptoms. One possible explanation for the lack of differences is that non-tiled land had good surface drainage.

During previous years, tile drainage had a positive influence on the pea yield. Pea plots grown over tiles produced greater grain yield irrespective of seeding rate (2023 testing).

Peas grown even at 75% of the recommended seeding rate yielded as good as with 100% of the recommended seeding rate. Similar results were recorded in 2023 test. Plant establishment was good in all the treatments, and this might be an explanation for relatively good yield even at reduced seeding rate.

Background / References

Pea harvested acreage increased from 67,000 acres in 2015 to 224,000 acres in 2021 (Manitoba Agriculture, 2021), mostly covering the western part of the Manitoba. This can be partially attributed to the establishment of a pea protein processing plant built by Roquette.

Peas thrive in relatively dry soil conditions and are susceptible to root rot in wet soils. It is recommended to choose fields with well-drained, coarse textured soils that are not prone to waterlogging (Manitoba Pulse & Soybean Growers, 2021). However, soils in the eastern &

Interlake regions of the province have more clay content and have issues with sub-surface drainage.

Tile drainage has been utilized successfully to improve sub-surface drainage in many states of the US. This has not been used frequently in the Canadian Prairies; however, an increasing frequency of extreme moisture events has caused farmers to install tile drains at an accelerated rate to tackle the unprecedented waterlogging conditions at their farms (Asante & Ashton, 2021). The cost of installing a tile drainage structure varies significantly in different areas and is very site specific. Costs of installation with a contractor in Western Canada can vary from $900 - $1200/acre, generally 2/3 material costs and 1/3 labor costs (Asante & Ashton, 2021).

PESAI site has plots in which tile drainage has been installed at 30 feet intervals. The tiles are about three feet deep in the soil. This enabled us to explore if tiles can benefit pea cultivation in heavy clay soils of Interlake region. Peas are recommended to plant at a seeding rate of 7-8 plants/ft^2 in Manitoba (Manitoba Pulse & Soybean Growers, 2021), but here in this study we have also evaluated a reduced seeding rate to determine its effects on crop growth & yield.

References

1. Michael Asante & Bill Ashton (2021). ADAPTING RISK TO RESILIENCE. RURAL DEVELOPMENT INSTITUTE. Brandon University, Brandon, MB *https://www.brandonu.ca/rdi/files/2021/08/Report-2-Study-Report-of-Economic-Costs-and-Benefits.pdf*

2. Manitoba Pulse & Soybean Growers (2021). Pea Production guidelines. *https://www.manitobapulse.ca/wp-content/uploads/2017/04/Pea-Production-Guidelines-June-2018-FINAL_WR.pdf*

3. Manitoba Agriculture (2021) The Manitoba Advantage in Pea Protein. *https://www.gov.mb.ca/agriculture/protein/protein-supply/peas.html*

Materials and Methods

Experiment design: randomized block design

Treatments:

1) *Peas grown on tiled land with 100% of the recommended seeding rate (7.5 plants/ft^2)*

2) *Peas grown on tiled land with 75% of the recommended seeding rate*

3) *Peas grown on non- tiled land with 100% of the recommended seeding rate*

4) *Peas grown on non-tiled land with 75% of the recommended seeding rate*

Replications: three
Seeding depth – ¾"
Variety: AAC Carver
Fertilizer: N-P: 0-15 lbs/acre applied with the seed
Pesticides sprayed:

May 8 – glyphosate @ 0.67L/acre pre-emerge
June 14 – Basagran Forte @ 0.91L/acre
July 10 – Centurion @ 150 ml/acre

Data collection

Emergence, plant establishment, Days to maturity, plant height, grain yield
Seeding / Harvesting dates: May 14 & August 19

Tile Drainage & Seeding rate effects on the Crop Growth & Yield of Faba beans

Project Duration: 2024

Objectives: To evaluate the effect of tile drainage & seeding rate on the crop growth & yield of faba beans.

Results

Drainage did have significant effect on plant height and days to maturity of faba beans during the current study (Table 1). Faba beans plants were shorter on drainage plots, and they matured later than on plots without drainage. However, tile drainage did not have any effect on grain yield of faba beans. Reduced seeding rate (75%) had sufficient plant populations established in the plots and these plots also yielded similar to plots where faba beans were seeded at recommended seeding rate.

Table 1. Comparison of faba beans grown over tiled vs non-tiled land with recommended and reduced seeding rates at Arborg site.

Treatment	*Plant establishment (no. of plants / ft²)*	*Days to maturity*	*Plant height at harvest (inches)*	*Grain Yield (bu/acre)*
Drainage effects				
Faba beans on tiles	*7.9a*	*113.2a*	*37.8a*	*67.3a*
Faba beans on non-tiled land	*9.0a*	*110.4b*	*39.9b*	*67.6a*
Significant Difference	*NO*	***YES***	***YES***	*NO*
P	*0.315*	***<0.0001***	***0.009***	*0.846*
Seeding rate effects				
Recommended (100%)	*8.9a*	*111.5a*	*38.9a*	*66.8a*
Reduced (75%)	*8.0a*	*112.1a*	*38.8a*	*68.1a*
Significant Difference	*NO*	*NO*	*NO*	*NO*
P	*0.393*	*0.287*	*0.954*	*0.535*

In the current study, faba beans performed equally well on non-tiled land although Arborg site received 130% of the normal rainfall between May 15 – September 15. Good surface drainage at the site might have contributed for similar yields from non-tiled plots. Faba bean is best adapted to the moist agriculture areas and does best under relatively cool growing conditions (Saskatchewan Agriculture 2024). Faba bean responds very well to irrigation providing surface drainage is effective.

Faba beans grown at 75% of the recommended seeding rate yielded as good as when grown at recommended seeding rate. Plant establishment (> 8 plants / square feet) was good even at 75% seeding rate and this might be an explanation for similar yields at both seeding rates.

Background / References

The faba bean (*Vicia faba* minor) is an ancient small-seeded relative of the Chinese broad bean (*V. faba* major). The crop is grown in the Mediterranean region where it is a common food. In Europe, the faba bean is grown primarily as a livestock feed. Commercial production of faba bean in Western Canada first occurred in 1972, and since then, the area under production has fluctuated.

Canada typically grows 95,000 acres of faba beans annually, but area has fluctuated considerably. Alberta accounts for over half of the seeded area. Production has ranged from 70,000 to 125,000 tonnes from 2019 to 2023. Canadian faba beans have included tannin and low-tannin varieties, with low-vicine and convicine varieties released recently (Saskatchewan Pulse Growers 2024).

Tile drainage has been utilized successfully to improve sub-surface drainage in many states of the US. This has not been used frequently in the Canadian Prairies; however, an increasing frequency of extreme moisture events has caused farmers to install tile drains at an accelerated rate to tackle the unprecedented waterlogging conditions at their farms (Asante & Ashton, 2021).

PESAI site has plots with 30' wide tiles underneath. This enabled us to explore if tiles can benefit faba bean cultivation in heavy clay soils of Interlake region. We have also evaluated a reduced seeding rate to determine its effects on crop growth & yield of faba beans.

References

1. Michael Asante & Bill Ashton (2021). ADAPTING RISK TO RESILIENCE. RURAL DEVELOPMENT INSTITUTE. Brandon University, Brandon, MB *https://www.brandonu.ca/rdi/files/2021/08/Report-2-Study-Report-of-Economic-Costs-and-Benefits.pdf*

2. Saskatchewan Agriculture (2024) Growing Faba Beans. *https://www.saskatchewan.ca/business/agriculture-natural-resources-and-industry/agribusiness-farmers-and-ranchers/crops-and-irrigation/field-crops/pulse-crop-bean-chickpea-faba-bean-lentils/faba-bean*

3. Saskatchewan Pulse Growers (2024) Faba bean market opportunities. *https://saskpulse.com/growing-pulses/faba-beans/faba-bean-market-opportunities/#:~:text=Production,focus%20on%20solely%20long%2Dterm*.

Materials and Methods

Experiment design: randomized block design

Treatments: Faba beans grown -

5) *On tiled land with 100% of the recommended seeding rate (7.5 plants/ft^2)*
6) *On tiled land with 75% of the recommended seeding rate*
7) *On non- tiled land with 100% of the recommended seeding rate*
8) *On non-tiled land with 75% of the recommended seeding rate*

Replications: three

Seeding depth – 1 inch

Variety: CDC 1142

Fertilizer: N-P: 0-15 lbs/acre applied with the seed

Pesticides sprayed:

May 8 – glyphosate @ 0.67L/acre pre-emerge

June 14 – Basagran Forte @ 0.91L/acre

July 10 – Centurion @ 150 ml/acre

Data collection

Emergence, plant establishment, Days to maturity, plant height, grain yield

Seeding / Harvesting dates: May 14 & September 27

Pea-Oats Intercropping: Effects of Seeding Rate and N fertilization on Grain Yield

Project Duration: 2022-2024

Objectives: To determine the effects of seeding rate and N fertilization on pea-oats intercrops in comparison to their mono crops.

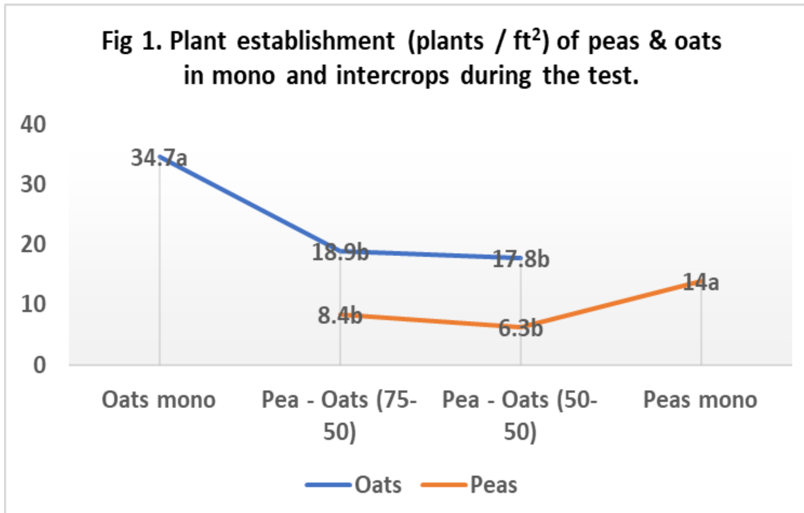
Results

Plant establishment, Plant Height, Days to Maturity and Lodging

Both oats and peas exhibited competition when grown together in intercrops (Fig 1). Both crops had highest plant population/ft^2 when grown as mono crops. Nitrogen application did not have any effect on plant establishment of any crop (data not shown).

Intercropping did not affect plant height of any crop (data not shown) and both peas and oats had similar heights in intercrops as they had in their respective mono crops.

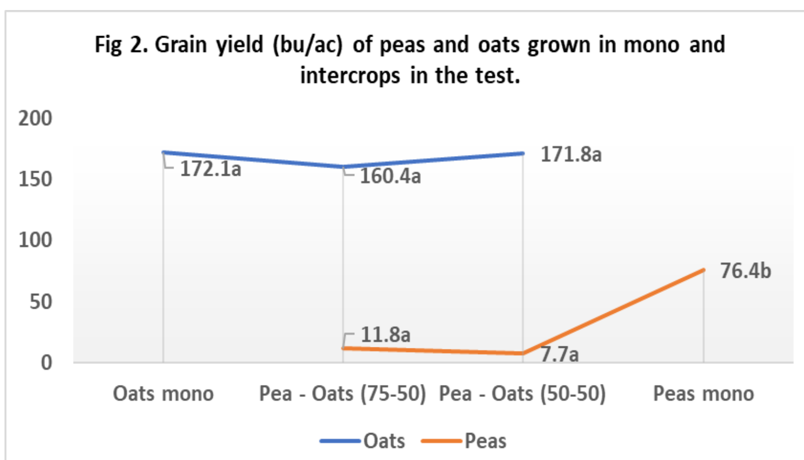
However, oat plants were significantly shorter (100 cm) when grown without nitrogen application (0N treatment). Plants were taller in the plots where nitrogen was applied at the rate of 40N (110 cm) & 80N (112 cm) per acre.



Nitrogen applications did not affect days to maturity for both crops. However, peas took 3-4 less days to mature when grown in intercrops (data not shown). Pea mono crop had higher lodging (mean ratings of 2.5), whereas peas grown in intercrops did not lodge (a ratings of 1.0). Nitrogen applications did not have any effect on lodging of both crops.

Grain Yield, Land equivalent ratio (LER) & Revenues

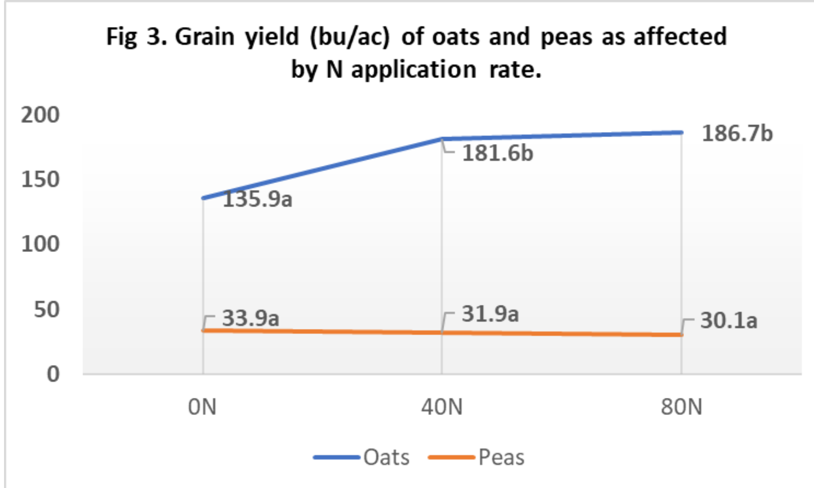
Peas were not competitive with oats and its grain yield was significantly reduced in intercrops when compared with pea mono crop (Fig 2). However, oats did not suffer any yield reduction even in intercrop plots.

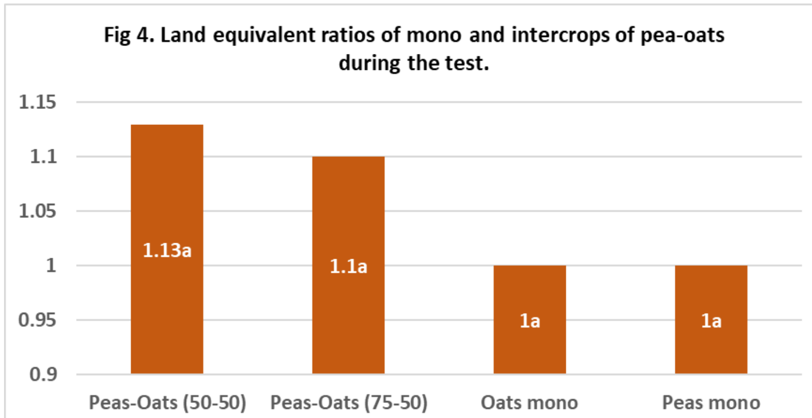


Nitrogen application had no effect on pea yield, whereas oats had lower yield when no nitrogen was applied in the plots (Fig 3). However, the differences in oat grain yield were insignificant between nitrogen rates of 40 & 80 lbs/acre.

Land equivalent ratios (LER) were above 1.00 in both pea-oat intercrop treatments indicating that intercrops produced more than mono crops (Fig. 4). The differences were insignificant though.

Intercrops and mono crops of pea & oats did not differ for marginal revenues. Pea mono crop had the lowest marginal revenue ($536), whereas oat mono crop had the highest ($631). Both intercrops had marginal revenue in between pea and oats mono crops. However, nitrogen applications (both rates) did improve marginal revenues ($622 – 631) over plots where no nitrogen was applied ($540).





Project Findings

The benefits of crop intercropping often include weed and disease suppression, reduced lodging and better resource use (Bailey-Elkin et al. 2022). Intercropping can also lead to increased yields and gross returns, as well as reduced risk of total crop failure (Martin-Guay et al. 2018). Although mixed grain intercropping can provide agronomic benefits, it also poses several practical challenges with respect to crop production, harvest, and grain handling (Struckman *et al.* 2021).

PESAI is testing pea-oats intercropping system for grain production since 2022. In the first two years, tests were done to find out the correct seeding rate ratio for both crops to have economical returns. During 2024, different rates of nitrogen were compared if the applied fertility increases the grain yield from intercrops.

Peas did not compete well with oats, and they suffered yield reduction in intercrop treatments regardless of any seeding rate used. Peas seeded at full seeding rate (2022) did not provide any yield advantage or gain in marginal revenues. When peas were seeded at reduced seeding rates (75% in 2022 & 50% in 2023), it resulted in better marginal revenues for the intercrop. During 2024, peas seeded at 75% or 50% of recommended seeding rate had similar marginal revenue as of pea mono crop (100% seeding rate).

Oats at 50% of the recommended seeding rate in the intercrop did well in terms of marginal revenues & Land Equivalent Ratio (LER). In fact, 50-50% seeding rate combination of pea-oats in 2023 was the top producer with significant higher LER values. Similar conclusions were made by other studies, when they recommended that oat seeding rates in pea-oats intercrop should not exceed 60% of standard oat monocrop rates. Otherwise, oats will tend to crowd out the peas in the stand as the growing season progresses.

Oats had been reported to support lodge-prone pea varieties throughout the growing season until harvest. This has been seen in the PESAI tests during 2023-2024 when pea lodging was significantly less in intercrops.

Pea yields were reduced when oats were incorporated in the mixture at any seeding rate. Oats also suffered yield losses in the intercrops during 2022-2023 testing, but not in 2024. Nitrogen application had positive effect on grain yield of oats, however, applying 40lbs/acre of nitrogen was as good as applying 80lbs/acre (see figure 3). The site was very poor in soil nitrogen levels before starting the test in 2024.

LERs were greater than one in intercrop plots during all three years. This is promising as it means that growing these two crops together might be more economical than growing mono crops.

No herbicides are labelled for simultaneous use in pea-oats intercrops. Therefore, weeds must be well-controlled during the previous growing season and/or through a pre-emergence herbicide ahead of seeding.

Background / References / Additional Resources

Intercropping refers to growing a mixture of two or more crops. Intercropping has several benefits, such as yield stability and reduced risk of crop failure due to crop diversity, lower input costs due to less fertilizer and pesticide usage, improved grain yield and economic returns and grain quality (Sahota & Malhi, 2012).

Previous study from Ontario showed that without applied nitrogen, grain yields, protein concentration and sustainability of economic returns improved with barley-pea intercropping compared to barley and pea sole crops (Sahota & Malhi, 2012). Another study done on oat-pea intercropping across the prairies and North Dakota (Struckman *et al.* 2021) concluded that this intercrop has a potential to reduce nitrogen fertilizer use. They also mentioned that oat-pea intercrops provide benefits to farm cash crop rotations and soil health, such as producing large amounts of biomass, increasing cash crop diversity and helping to mitigate adverse weather conditions through combining two different cash crops that thrive in varying soil moisture conditions.

On the other hand, these intercrops also have downside. Struckman et al (2021) cited crop insurance as one major obstacle to oat-pea intercropping (and mixed intercropping in general), since most insurance policies only allow for a limited acreage of novel cash crops each season. Weed control can be a serious issue since no herbicides are labelled for use with both crops in-season. On-farm storage can be another obstacle. Mixed intercrops must be stored separately from monocrops. Oat-pea mixed grain takes up significantly more storage space than other mixed grain intercrops (such as canola-pea) due to the bulkiness of grain oats. Along the same lines, separation is more difficult in comparison to other intercrops due to the large size of oat and pea seeds and the possibility of peas splitting during cleaning and separation.

The objectives of the current study were to investigate the effects of intercropping oats with pea on grain yield, land equivalency ratio and economic returns in Interlake region of Manitoba.

References

1. Will Bailey-Elkin, Michelle Carkner, and Martin H. Entz (2022) Intercropping organic field peas with barley, oats, and mustard improves weed control but has variable effects on grain yield and net returns. ***Can. J. Plant Sci.*** 102: 515–528. dx.doi.org/10.1139/cjps-2021-0182

2. Martin-Guay, M.-O., Paquette, A., Dupras, J., and Rivest, D. (2018) The new Green Revolution: Sustainable intensification of agriculture by intercropping. ***Sci. Total Environ.*** 615: 767–772. doi:10.1016/j.scitotenv.2017.10.024.

3. Struckman L. *et al.* (2021). Oat-Pea Mixed Grain Intercropping on the Canadian Prairies and U.S. Northern Plains. https://oatnews.org/oatnews_pdfs/2020/Oat-Pea%20Report_May%202021.pdf

4. Sahota TS & Malhi SS (2012). Intercropping barley with pea for agronomic and economic considerations in northern Ontario. ***Agricultural Sciences*** 3(7): 889-895.

Materials and Methods

A field trial was established on a heavy clay soil in Arborg, Manitoba. Twelve treatments were arranged in a Randomized Complete Block Design and replicated three times. The treatments were intercrops (pea mono, oats mono, pea-oat intercrops at 75%-50% & 50%-50% of recommended seeding rates) and three fertility treatments (untreated, 40 & 80 lbs N/acre). Pea variety, CS Prostar and oat variety, CS Camden were used for the test.

Recommended seeding rate for oats & peas were 250 & 80 plants/m^2, respectively. The plots were seeded on May 9 and harvested on August 20. Nitrogen was applied with mid row banders, whereas phosphorous (15 lbs / acre) was side banded in all the plots. Weeds were controlled using a pre-emergent application of 1L glyphosate/acre (May 8).

***Data collection* -** Plant establishment, plant height, days to maturity, lodging, grain yield

Marginal revenues are based on the following input costs -

Seed cost: Oats -$30 / acre, Peas - $88/acre

Fertilizer – N - $0.680 / lb ($690 / tonne Urea); P - $0.851 / lb ($1140 / tonne MAP)

Pesticides – glyphosate @ 0.67 L/acre ($4.5/acre)

Seed separation cost - $0.25 / bushel

Profit margins were calculated as follows: Gross revenue ($/ac) = Yield x Market price

***Marginal revenue** ($/ac) = Gross revenue – Seed – Fertilizer – Pesticide – Separation cost ($0.25/bu)*

(Market prices from Manitoba Agriculture 2025 Costs of Production: $8.75/bu peas, $4.10/bu oats)

*** Land equivalent ratio (LER) =* $\frac{\text{yield of intercrop species 1}}{\text{yield of monocrop species 1}} + \frac{\text{yield of intercrop species 2}}{\text{yield of monocrop species 2}}$

Integrating legume cover crops in winter wheat

Project duration: 2023-2025

Collaborators

Anne Kirk, Manitoba Agriculture

James Frey (PCDF), Scott Chalmers (WADO), Nirmal Hari (PESAI), and Haider Abbas (MCDC)

Background

There is increased interest in cover crops for soil health benefits, nitrogen contribution, and the potential for grazing or silage. Relay cropping provides an opportunity to incorporate legume crops into a cropping system without sacrificing a whole season of grain production. Relay cropping may have a good fit with winter wheat since winter wheat is typically harvested in late July to early August, leaving time for cover crop growth prior to frost. The success of the relay crop is dependent on the ability of the cover crop to establish in the winter wheat crop, and to produce enough biomass in the fall to provide a benefit to the soil and main crops.

Objectives

1) To evaluate the establishment and dry matter production of legume cover crops in winter wheat.
2) To assess the effects of these cover crops on grain yield of the winter wheat.
3) To assess the nitrogen fixation potential of the legume cover crops.
4) To assess the effect of legume cover crops on performance of canola in the following year.

Materials and Methods

This study was established at Arborg, Carberry, Melita and Roblin sites in September 2023. The experimental design was a randomized complete block design with four replicates. Winter wheat was planted in September 2023, with cover crop treatments seeded in the fall and spring. Fall seeded cover crops were seeded in the same row and depth as the winter wheat, while spring seeded cover crops were broadcast as early as possible. Established cover crops will continue to grow in 2025 when canola will be direct seeded into the trial area.

Treatments included four different legume cover crops, a non-legume cover crop, and no cover crop. See Table 1 for a complete treatment list. Data collection in year one includes winter wheat and legume plant populations, winter wheat yield and protein, dry matter production of the legume crop, and nitrate nitrogen (N) in late fall. Protein and nitrate N were measured on composite samples and therefore do not have any statistical analysis associated with these results.

Table 1. *Treatment list.*

Trt	Cover crop	Cover crop timing	Fertilizer rate in year 2 (% of recommended rate)
1	No cover crop	n/a	0%
2	No cover crop	n/a	100%
3	No cover crop	n/a	60%
4	Sweet clover	Fall	60%
5	Alfalfa	Fall	60%
6	Red clover	Fall	60%
7	White clover	Fall	60%
8	Sweet clover	Spring	60%
9	Alfalfa	Spring	60%
10	Red clover	Spring	60%
11	White clover	Spring	60%
12	Perennial ryegrass	Fall	60%

Table 2. *Agronomic information for different sites.*

	Arborg	Carberry	Melita	Roblin
Soil Series	Peguis Clay	Wellwood Loam	Waskada Loam	Erickson Loamy Clay
Winter wheat/fall legume seeding date	Sept 19, 2023	Sept 15, 2023	Sept 6, 2023	Sept 27, 2023
Legume spring seed date	May 14, 2024	May 14, 2024	April 15, 2024	April 25, 2024
Fertility (lb/ac)	Background N topped up to 150 lb/ac, 30 lb/ac P2O5			
Herbicides	May 10, 2024 – Refine SG @ 12 g/acre	Sept 12, 2023 – Glyphosate @ 0.7 L/ac; June 20, 2024 – Basagran Forte @ 0.9 L/ac	Sept 2023 – Glyphosate @ 0.67 L/ac, Heat LQ @ 40 ml/ac; May 2, 2024 – Achieve @ 0.2 L/ac, Basagran @ 0.91 L/ac	Sept 25, 2023 – Glyphosate @ 0.64 L/ac
Winter wheat harvest date	Aug 12, 2024	Sept 19, 2024	Aug 6, 2024	Sept 4, 2024
Legume biomass sampling	October 3, 2024	n/a	n/a	n/a

Table 3. *Seeding rate by crop type.*

Crop Type (Variety)	Seeding Rate
Winter wheat (AAC Wildfire)	323 pl/m^2
Alfalfa (Stellar II)	12 lb/ac
Red clover (single cut, common)	10 lb/ac
White clover (Bombus)	6 lb/ac
Sweet clover (common)	10 lb/ac
Perennial ryegrass (Melpetra)	12 lb/ac

Table 4. *Seasonal precipitation and growing degree days (Sep 1 to Nov 15, 2023).*

	Arborg	Carberry	Melita	Roblin
Precipitation (mm)	116	64	100	69
% of Normal precipitation	136	84	126	77
Growing degree days (GDD)	379	388	362	358
% of Normal GDD	178	179	143	205

Table 5. *Monthly and growing season (April 1 - October 31, 2024) precipitation and growing degree days for Arborg, Carberry, Melita, and Roblin.*

	Apr	May	June	July	Aug	Sept	Oct	Apr – Oct
	Arborg							
Precipitation (mm)	33	74	120	62	39	7	10	347
% of Normal precipitation	116	139	154	104	49	15	34	92
Growing degree days	36	177	320	468	416	359	80	1860
% of Normal GDD	201	86	95	108	108	189	360	117
	Carberry							
Precipitation (mm)	65	121	163	21	30	48	8	459
% of Normal precipitation	181	251	233	32	44	99	41	126
Growing degree days	57	181	318	461	384	369	102	1876
% of Normal GDD[1]	464	98	95	108	99	194	400	120
	Melita							
Precipitation (mm)	29	91	109	64	27	10	4	337
% of Normal precipitation	101	169	108	93	35	30	15	85
Growing degree days	69	203	307	466	372	345	110	1874
% of Normal GDD[1]	286	99	87	103	90	163	270	110
	Roblin							
Precipitation (mm)	20	78	116	45	75	32	1	369
% of Normal precipitation	86	174	157	63	134	60	5	105
Growing degree days	32	152	242	427	347	319	59	1581
% of Normal GDD[1]	415	89	77	109	98	195	533	112

[1]Based on 30-year averages (Data from Manitoba Agriculture).

Results and Discussion

Cover Crop Establishment

At all locations cover crop establishment was better with spring broadcast compared to fall seeding. Method of planting likely influenced establishment of spring and fall seeded cover crops. Fall seeded cover crops were planted at the same depth as the winter wheat. Deep seeding may have aided emergence if the fall had been dry, but in a year with adequate precipitation likely hindered emergence. All locations had higher than normal precipitation in May and June (Table 5), which would have aided legume establishment in the spring broadcast treatments.

Fall planted alfalfa had the best establishment of the fall planted cover crops at Arborg and Melita (Table 6). In Roblin there was no significant difference in the establishment of any fall seeded cover crops.

Cover crops established better in Arborg than the other locations. This may have been the result of timing of seeding and precipitation, surface residue and soil conditions.

Table 6. Cover crop establishment (pl/m²) measured in the spring and after winter wheat harvest in the fall.
Least significant difference (LSD) values are shown for sites where there is a significant difference (Pr<0.05) between treatments. Means followed by the same letter within a column are not significantly different.

		Arborg			Melita			Roblin	
Cover Crop	**Timing**	**Spring (pl/m^2)**	**Fall (pl/m^2)**		**Spring (pl/m^2)**	**Fall (pl/m^2)**		**Spring (pl/m^2)**	**Fall (pl/m^2)**
Sweet clover	fall	3d	3d		0b	1d		76b	0b
Alfalfa	fall	111c	73c		16b	26c		12b	4b
Red clover	fall	13d	26d		2b	7d		18b	1b
White clover	fall	5d	7d		0b	1d		2b	1b
Sweet clover	spring	298b	149a		77a	67a		98a	18b
Alfalfa	spring	487a	160a		72a	43b		45b	20b
Red clover	spring	344b	120b		60a	8d		103a	44b
White clover	spring	527a	127ab		63a	13cd		155a	94a
Perennial ryegrass	fall	52cd	63c		0b	10d		5b	2b
LSD		*95*	*33*		*21*	*14*		*77*	*24*

Cover Crop Biomass

Cover crop biomass was collected in the fall, after winter wheat harvest. Due to poor cover crop growth at Melita, Carberry and Roblin, biomass was collected at the Arborg location only.

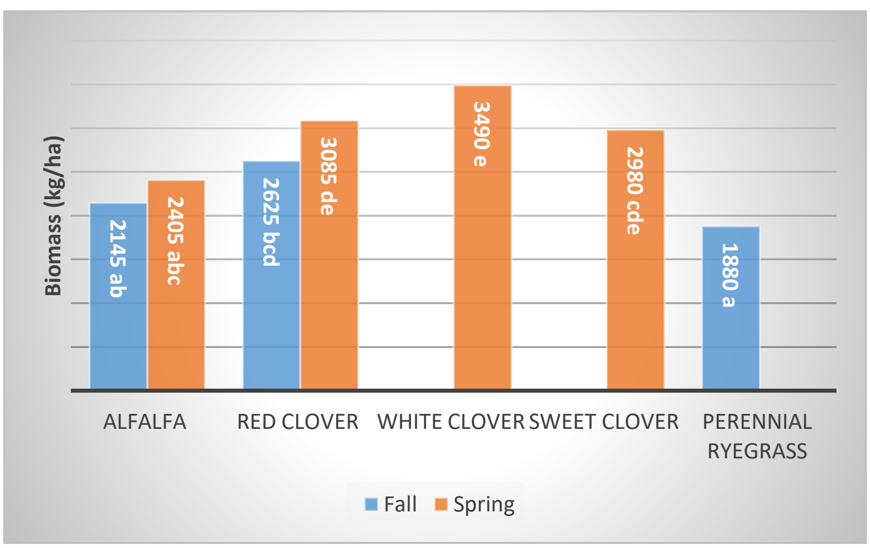


Figure 1. 2024 Fall cover crop biomass (kg/ha) at Arborg. *Treatments with the same letter above the bars are not significantly different.*

Wheat Yield and Protein

Cover crops did not affect winter wheat grain yield. There were no significant differences in wheat yield across all treatments or protein trends between legume and non-legume treatments (Table 7).

Table 7. Winter wheat yield (bu/ac) and protein (%) content at different sites.

		Arborg		**Melita**		**Roblin**	
Cover Crop	**Timing**	**Yield (bu/ac)**	**Protein (%)**	**Yield (bu/ac)**	**Protein (%)**	**Yield (bu/ac)**	**Protein (%)**
No cover crop	n/a	66	9.6	92	11.5	87	11.6
No cover crop	n/a	64	9.4	94	10.6	84	11.4
No cover crop	n/a	66	9.3	97	10.9	85	11.6
Sweet clover	fall	68	10.1	90	11.1	86	11.5
Alfalfa	fall	63	9.0	99	11.6	86	11.6
Red clover	fall	62	9.5	101	11.0	87	11.7
White clover	fall	61	9.0	96	10.3	90	11.7
Sweet clover	spring	62	10.0	92	10.5	90	11.7
Alfalfa	spring	63	9.5	96	10.9	85	11.8
Red clover	spring	66	9.9	103	10.7	85	11.3
White clover	spring	60	9.2	98	11.3	82	11.1
Per. Ryegrass	fall	67	9.2	94	10.7	84	11.4
Mean		*64*	*9.5*	*96*	*10.9*	*86*	*11.5*
Significant difference		*NO*	*n/a*	*NO*	*n/a*	*NO*	*n/a*

<u>Fall Soil Fertility</u>

Nitrate N varied across treatments, but there was no trend towards high N levels in legume treatments or in treatments with higher legume biomass (Table 8). Soil samples were not collected at the Melita location.

Table 8. Nitrate nitrogen (lb/acre) measured in the in the top 0-24" of soil in late fall 2024.

		Nitrate N (lb/acre)	
Cover crop	Timing	Roblin	Arborg
No cover crop	n/a	24	4
No cover crop	n/a	20	4
No cover crop	n/a	16	4
Sweet clover	Fall	8	4
Alfalfa	Fall	28	8
Red clover	Fall	28	8
White clover	Fall	24	4
Sweet clover	Spring	20	4
Alfalfa	Spring	12	8
Red clover	Spring	24	4
White clover	Spring	16	4
Perennial ryegrass	Fall	20	4

Summary

Fall seeded cover crops did not establish well at Carbery, Melita, and Roblin (Carberry data not shown). Poor establishment may have been related to planting time and depth. Spring seeded cover crops had better establishment, which was in part related to the wet spring conditions at all locations. Wheat yield was not impacted by cover crops.

Cover crop biomass production was poor at Carberry, Melita, and Roblin, this may have been due to the winter wheat out competing the cover crops. Cover crop biomass production was excellent at Arborg, except for fall seeded white clover and sweet clover.

Soil nitrate N levels at Arborg did not reflect the high biomass production but may be evident in year two of the project. This is an interim project report, year 2 of the experiment will be conducted at Arborg only in 2025.

Linseed Flax Variety Evaluation

Collaborators

Dr. Bunyamin Taran, Crop Diversification Centre, University of Saskatchewan

Objectives

Comparing seed yield, oil and protein content and meal yield of newly registered flax cultivars and experimental varieties against established flax varieties.

Results

Yield results from the 2024 Linseed Flax Trial in Arborg are presented in Table 1. The trial consisted of 9 varieties: five experimental (FP entries), two newly registered (SVPG entries) and two check varieties, CDC Glas and AAC Bright. Only CDC Kernen yielded greater than check flax variety, AAC Bright. All other flax entries were similar to check varieties in terms of seed yield.

Entry FP 2612 had the tallest plants, whereas first year entries, FP 2615 & FP 2616 had relatively shorter plants. AAC Bright had the highest oil content, whereas FP 2616 had the second highest ranking in per cent oil content. Flax entries also differed in protein content with FP 2608 being the lowest in protein as well as meal yield (see table below).

Table 1. Linseed Flax Variety Evaluation Trial Results from Arborg site.

ENTRY	Yield ('00 kg/ha)	Yield Bu/Acre	Yield Ranking	Height (cm)	Oil Content (%)	Protein Content of Seed (%)	Protein Content of Meal (%)	Meal Yield (kg/ha)
Checks								
CDC Glas	26.4	21.4	2	69.0	45.3	22.7	41.5	1085
AAC Bright	24.0	19.4	9	69.6	48.9	22.0	43.2	1027
SVPT Entries								
CDC Kernen	27.1	21.9	1	72.9	45.9	22.1	40.7	1098
CDC Esme	26.3	21.3	3	69.0	45.5	22.3	40.9	1078
3rd Year Entries								
FP2608	25.8	20.9	4	69.7	45.4	21.1	38.9	989
FP2609	25.7	20.8	5	70.2	45.7	21.6	40.0	1019
2nd Year Entry								
FP2612	25.7	20.8	6	73.1	44.9	22.6	41.1	1049
1st Year Entries								
FP2615	25.3	20.5	7	66.2	45.4	22.4	41.1	1038
FP2616	24.5	19.9	8	65.8	46.4	21.9	40.9	996
Mean	25.6	20.8		69.5	45.9	22.1	40.9	1042
C.V. %	5.8	5.8		3.3	0.9	2.5	1.9	5.9
LSD	2.60	2.60		3.93	0.69	0.95	1.37	106.1

Project Findings

The entries differed in their yield performance and quality parameters at Arborg site. A complete project report will be compiled by Dr. Bunyamin Taran (bunyamin.taran@usask.ca).

Background / References / Additional Resources

The cultivation of linseed is particularly attractive to growers both for seed / oil and straw / fibre. The factors such as environmental variables, phenological traits, plant density significantly affected the productivity of linseed (Fila *et al* 2018).

The current coop trial was conducted at Melita, Roblin, Carberry and Arborg sites in Manitoba. Other trial sites are in Alberta and Saskatchewan that cover various soil zones and are not discussed in this report.

References

Fila, G., Bagatta, M., Maestrini, C., Potenza, E., & Matteo, R. (2018). Linseed as a dual-purpose crop: evaluation of cultivar suitability and analysis of yield determinants. The Journal of Agricultural Science, 156(2), 162-176. https://doi.org/10.1017/S0021859618000114

Materials & Methods **(for Arborg site)**

Experimental Design – Randomized complete block design
Plot size: 8.22m^2
Treatments: 9 flax entries (Table 1)
Data collected – Grain yield, plant height, days to maturity, stem dry down and determinate growth habit were reported to Dr. Bunyamin Taran's team. Seed subsamples were sent to CDC Saskatoon for oil and protein analysis.

Agronomic information

Stubble: soybean stubble
Soil type: heavy clay
Soil fertility: N-P: 9-28 (lbs/acre); Applied with the seed: N-P: 60-20 (lbs/acre)
Pesticides applied –
Glyphosate 540 @ 1 litre /acre on May 8th (pre-seed)
Basagran Forte @ 0.91L/acre on June 14
Seeding date: May 21, 2024
Harvesting date: Sep 3, 2024

Fungicide Efficacy Testing for *Mycosphaerella* Blight in Peas

Project duration: 2022-2024

Collaborators: Scott Chalmers (WADO) Melita, James Frey (PCDF) Roblin, Nirmal Hari (PESAI) Arborg, AAFC (Portage la Prairie), Dr Baljeet Singh (Assiniboine College) Brandon, MPSG

Background

- Ascochyta / *Mycosphaerella* blight complex is among the most widespread and economically damaging foliar diseases of the pea crop (*Pisum sativum*) in Manitoba. Infections are caused by the fungi *Ascochyta pinodes* (leaf infection), *Ascochyta pinodella* (foot rot infection), and *Ascochyta pisi* (pod infection) on peas.

- In all 14 fields surveyed in 2020 by Manitoba Pulse and Soybean Growers (MPSG), *Mycosphaerella* blight was present (100% prevalence and severity scale of 3.4 (0-9 scale), whereas white mould was noted in only 14% of the fields with a severity scale of 0.4%. In 2021, in 41 pea fields surveyed by MPSG, *Mycosphaerella* blight prevalence was 100% and the average severity was 3.5 (0-9 scale). White mould was not found in any fields in 2021, most likely due to extremely dry conditions in the province. In 2022, MPSG conducted a foliar and stem disease survey in 48 pea fields at R4 stage in Manitoba. *Mycosphaerella* blight was the most common foliar disease, found in 100% of fields.

- Infection begins at the bottom third of the plant and progresses upward. Fungicides are generally applied during the early flowering stages of pea growth to protect plants against disease.

- This study presents the results of small-plot field trials conducted at Roblin, Portage la Prairie, Melita, and Arborg from 2022-24 of fungicide efficacy testing under the product evaluation and testing program.

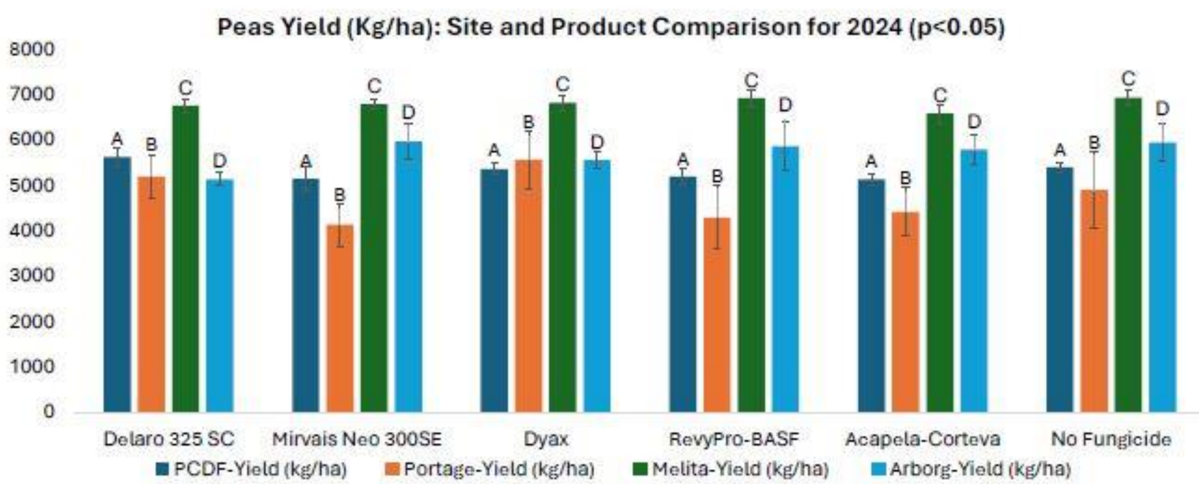
Objectives and Trial details (Arborg site)

The following fungicide treatments were compared with untreated control for Mycosphaerella blight suppression and their effect on grain yield of peas.

- *Treatment 1: Delaro 325 SC – Bayer (356 ml /acre)*
- *Treatment 2: Miravis Neo 300 SE- Syngenta (505 ml /acre)*
- *Treatment 3: Dyax – BASF (160 ml /acre)*
- *Treatment 4: RevyPro- BASF (400 ml /acre)*
- *Treatment 5: Acapela – Corteva (240 ml /acre)*

Seeding / Harvesting dates: May 10 / August 19
Seeding rate: 75 plants / m^2
Variety: AAC Chrome
Row to row spacing: 9 inches
Weed control: Basagran Forte @ 0.91L/acre on June 14
Fungicides were sprayed on July 8 at early flowering stage.

Results



Weather data at all sites were collected from nearby MB Agriculture weather stations from May to August for the years 2022-24. The data show average low temperatures, low relative humidity, and low precipitation at all the sites. The dry growing season and low relative humidity resulted in low disease pressures at test sites. Fungicides did not have any effect on pea yield at any site during 2024 (see Figure). Similar results were found during 2022 & 2023 testing.

Multi-Year Annual Crop–Living Mulch System for the Canadian Prairies

Jessica Frey and Joanne Thiessen Martens, U of M

INTRODUCTION

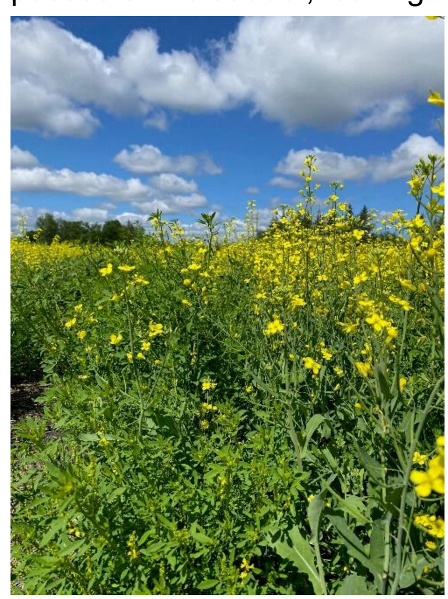
In the Canadian prairie growing season of 90-110 frost-free days, cover cropping with nitrogen-fixing legumes requires innovative strategies to allow sufficient time for cover crop establishment. Seeding the cover crop and cash crop at the same time in Year 1, maintaining the cover crop after harvest, and then seeding a second cash crop into the overwintered cover crop in Year 2 is referred to as a "living mulch".

Establishment of a living mulch allows a well-established perennial-legume living mulch to continue its nitrogen fixation both between cash crops and throughout the subsequent growing season. In year 1, this study sought to compare 1) the establishment of four legume cover crops and 2) the performance of wheat grown together in the establishment year. In year 2 it compared 1) canola performance when seeded into the established living mulch and 2) the impact of the established mulch on system nitrogen dynamics.

MATERIALS AND METHODS

Field trials investigating a spring wheat – cover crop establishment were seeded in May 2023 and 2024 in six site-years at four locations. Four legumes, including white clover, red clover, sweet clover, alfalfa, and one non-legume perennial ryegrass control, were seeded with wheat in the same row and at the same depth as wheat during 2023. Three wheat-only controls were established at the same time to allow for different fertility treatments in the following living mulch canola phase (year 2 in 2024) but were not manipulated in the wheat phase (in 2023).

Seeding rates were calculated to accommodate the low range of recommended wheat seeding rates and the high range of recommended seeding rates for the cover crops. Fertilizer was applied to meet a target yield of 70 lb/ac. Seeding depth was ¾" and legumes were inoculated prior to seeding. Each plot consisted of three passes of the seeder, leaving the two side passes for destructive sampling and the middle pass for yield.



In the living mulch canola phase (in 2024), Clearfield canola was seeded to a target plant population of 10 pl/ft^2 midrow into the established cover crops at the two best-performing 2023 sites. The three canola only control plots were fertilized to three levels (0, 50% and 100%). Spring regrowth was measured prior to canola herbicide application (Ares) by biomassing 4 meters of row from each plot.

Soil nitrate samples were taken at this time, and four pairs of in-situ Plant Root Simulator (PRS) probes were also buried in all cover crop plots and in the 50% added N canola-only control, on the opposite side of the row from the side banded N, and nested up against the clover plants. Canola plants were counted 3 to 4 weeks after seeding. After three weeks, the probes were switched and sent away for analysis. At the switch, plants were again biomassed and soil samples were taken for nitrate. This cycle was repeated twice at three-week intervals for a total of three burial periods. Soil moisture was also recorded on the same day.

Synopsis of Objectives and their Results

Objective 1: *To compare establishment and biomass of five cover crops.*
Statistical analysis revealed that across all six site-years, alfalfa consistently emerged best, and that whereas white clover emerged well in Carberry 2 (2024), Melita (2023), Roblin1 (2023) and Roblin2 (2024), it did not emerge well in Arborg (2023) or Carberry1 (2023). Likewise, the differences in years between Roblin1 and Roblin2 and Carberry1 and Carberry2, were likely due to greater rainfall in the early part of the second seeding (2024).

At Carberry1 perennial ryegrass, red clover and white clover did not survive and in Melita, the cover crops died from herbicide application. At the other four site-years, cover crop biomass was highly variable at each site, but alfalfa performed the best at all sites. In most cases the decreased competition after harvest boosted growth of the cover crops. As judged by plant counts and spring biomass, alfalfa survived the winter better than the other legumes.

Objective 2: *To compare establishment and performance of wheat with five cover crops.*
Statistical analysis for Objective 2 shows that the wheat cash crop was not affected by the presence of the cover crop during establishment phase. This trend is shown across the measurements of emergence plant counts, wheat biomass at soft dough stage, wheat yield and wheat protein.

Objective 3: *To compare establishment of canola into living mulch in 2024.*
Analysis for this objective is not complete however it can be reported that while canola emerged at all sites, the proposed cover crop management strategy of the Liberty system herbicide was insufficient to stunt growth, and the canola could not compete.

Objective 4: *To characterize the potential N benefit of four perennial legume species as living mulch systems.*

Table 1: Nitrogen Measurements during the test.

Agvise Soil NO_3	6 probes / plot / sampling period	3 sampling dates
PRS NO_3 and NH_4	8 probes / plot / sampling period	3 sampling dates
Plant Biomass N	4 meters / plot / sampling period	3 sampling dates

PRS probes were placed on the opposite side of the row to the placement of the N sideband, but adjacent to cover crop, with a target burial period of 21 days. PRS probes are different than Agvise soil samples in that they measure movement and update of different forms of N over a certain period.

Table 2: ANOVA results for soil N measurements at Roblin (RB) and Carberry (CB) sites.

		Response Variables							
		NO3		NH4		Agvise NO3		Moisture	
Factor	**Treatment**	RB	CB	RB	CB	RB	CB	RB	CB
Cover Crop	50% Control	117.0 ± 25.0 a	93.0 ± 11.7 a	1.5 ± 0.5	1.7 ± 0.4	14.1 ± 1.5	13.3 ± 1.1 A	19.5 ± 0.6	25.7 ± 0.7 ab
	Alfalfa	72.3 ± 15.4 ab	50.4 ± 6.3 b	1.8 ± 0.6	1.3 ± 0.3	13.4 ± 1.4	11.3 ± 1.1 A	21.6 ± 0.6	27.4 ± 0.7 a
	PRG	28.6 ± 6.1 c		1.8 ± 0.6		10.9 ± 1.2		20.6 ± 0.6	
	Red Clover	29.0 ± 6.2 c		1.1 ± 0.4		9.9 ± 1.1		21.1 ± 0.6	
	Sweet Clover	48.3 ± 10.3 bc	63.2 ± 7.9 b	1.1 ± 0.3	1.8 ± 0.4	13.0 ± 1.4	14.7 ± 1.1 A	20.8 ± 0.6	24.4 ± 0.7 b
	White Clover	35.2 ± 7.5 bc		1.8 ± 0.6		12.0 ± 1.3		21.0 ± 0.6	
Day									
	25	137.5 ± 20.6 a	372.7 ± 46.8 a	1.6 ± 0.4	3.5 ± 0.3 a	22.0 ± 2.4 A	17.2 ± 1.1 A	27.4 ± 0.5 a	25.6 ± 0.5
	48	68.0 ± 10.2 b	67.9 ± 8.5 b	1.0 ± 0.2	1.2 ± 0.4 b	14.3 ± 1.18 B	11.9 ± 1.1 B	21.8 ± 0.5 b	26.1 ± 0.5
	67	11.3 ± 1.7 c	11.7 ± 1.5 c	2.0 ± 0.4	0.9 ± 0.3 b	10.7 ± 0.74 C	10.2 ± 1.1 B	13.1 ± 0.5 c	na
	Source of Variation	**p-values**		**p-value**		**p-values**		**p-values**	
	Cover Crop	<0.0001	<0.0001	0.7634	0.5962	0.0829	0.1038	0.0657	0.0326
	Day	<0.0001	<0.0001	0.0852	0.0005	<0.0001	0.0003	<0.0001	0.5165
	Day x Cover crop	0.4214	0.4868	0.1143	0.9295	0.0801	0.303	0.1462	0.7401

ANOVA results for the three soil N measurements all reflect the same trend, which is that as the season went by, soil nitrate and soil ammonium decreased in measurements. Alfalfa resulted in least decrease, when compared to the canola only control, whereas perennial ryegrass and red clover decreasing the most.

The conclusion can be drawn that in the absence of competition from a well-established canola crop, the legumes made use of the available soil nitrogen rather than fixing their own. The data for plant N uptake are not yet available and so it is not possible to quantify how much was conserved in plant material. However, cover cropping in general assumes the storage of nutrients in the cover crop and is even termed to be scavenging nutrients, especially if the intended use of the cover crop is as a green manure. This storage of nutrients in plant form preserves them from other forms of loss, such as overland water flow or water movement below the plant rooting zone, and it then makes those nutrients available at a later point in time when the plant material is slowly broken down by soil bacteria. Moisture, likewise decreased over the course of the season, but it did not have a statistically significant effect on the different forms of soil N.

CONCLUSIONS

Although the data analysis is not complete at this time, there are some preliminary conclusions that can be drawn.

First, it is possible to establish a cover crop at the same time as growing a profitable wheat crop and the wheat performance is unaffected when compared to a wheat only control.

Second, cover crop establishment varies by site and by the cover crop, with alfalfa performing the best across sites with respect to consistent biomass, winter survival and spring regrowth.

Third, while cover crop management was not the focus of this study, more research is needed to determine the best management strategy for seeding into a living mulch.

Fourth, legumes, in the absence of competition from a thriving cash crop, use available soil nitrogen, as has been shown in previous research (Islam et al., 2012; Osterholz et al., 2023). Nutrient benefit to the soil would come in the form of reincorporating of the cover crop into the soil, where it would then release the sequestered nutrients that it had taken up.

REFERENCES

1) Islam, M., Ali, S., Mohsan, S., Khalid, R., Fayyaz-ul-Hassan, Mahmood, A., & Afzal, S. (2012). Relative Efficiency of Two Sulfur Sources Regarding Nitrogen Fixation and Yield of Chickpea. *Communications in Soil Science and Plant Analysis*, *43*(5), 811–820. https://doi.org/10.1080/00103624.2012.648358

2) Osterholz, W., Ruark, M., Renz, M., & Grabber, J. (2023). Interseeded alfalfa N2 fixation and transfer to maize are reduced by N fertilizer. *Nutrient Cycling in Agroecosystems*, *126*(1), 67–79. https://doi.org/10.1007/s10705-023-10276-y

Optimizing Nitrogen Fertility in Winter Wheat Varieties

Project Duration*:* 2022-2024 (Reporting 2024)

Collaborators*:* Ducks Unlimited Canada (Ken Gross, Alex Griffiths, Elmer Kaskiw), Manitoba Agriculture (John Heard), Western Ag & Professional Agronomy (Edgar Hammermeister)

Objectives

- Update the winter wheat fertility recommendations in the Manitoba Soil Fertility Guide.
- To compare spring broadcast only application to fall and split applications of nitrogen for yield & protein.
- To see if there are varietal differences in nitrogen use efficiency between Wildfire & Vortex varieties.

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 and split application, during planting in fall and at tillering or stem elongation in spring (Anderson, 2008; Schulz et al., 2015).

Fertility management, in particular nitrogen and phosphorus fertility, remains an integral part of the overall management package aimed at achieving higher yields in winter wheat (Halvorson et al. 1987). Recommended fertilizer management, particularly nitrogen management, differs widely in winter wheat production, but the crop's nitrogen demand is correlated to yield potential and availability of moisture in dryland production systems (Beres et al., 2018). Compared to spring wheat, winter wheat presents more challenges in development as a result of its higher nitrogen demand during the long vegetative phase, hence the reason why it requires 25 to 50% more N than spring wheat in the Prairies (Fowler et al., 1989). There is still a knowledge gap on the rates and timing of nitrogen fertilizer application, particularly in Western Canada, that result in improved yield without compromising grain quality and economic returns. This study aims to understand varietal demand to nitrogen as well as whether fall/spring split applications of nitrogen are more effective than single spring applications.

Materials & Methods

This study was established at Melita, Roblin, Carberry and Arborg sites. The trial consisted of two varieties and 7 nitrogen 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 treatments

1. Check – No fertility except starter phosphorus
2. 60 kg/ha (54 lbs/ac) nitrogen, split 50:50
3. 90 kg/ha (80 lbs/ac) nitrogen, split 50:50
4. 120 kg/ha (107 lbs/ac) nitrogen, split 50:50
5. 150 kg/ha (134 lbs/ac) nitrogen, split 50:50

6. 180 kg/ha (161 lbs/ac) nitrogen, split 50:50
7. 120 kg/ha (107 lbs/ac) nitrogen all applied in spring

The soil test results, and the applied fertilizer amounts are listed for each site in Table 9.1. All 5 split applications had 50% of the rate applied in the fall, and 50% of the rate applied the following spring. Specific 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. Plant target density was 325 plants/m^2 and 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 120 kg/ha (107 lbs/ac) is the current producer fertility practice when growing winter wheat representing treatment 7. Each site where this trial was carried out used slightly different agronomic practices and had different field conditions which are outlined in the following Tables 9.1. through 9.3.

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 general linear model (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 9.1. Fall soil test results by site & fertilizer treatments for winter wheat during 2023/2024.

Fall Soil Test and Fertilizer Application (Actual lbs/ac)				
		Soil Supply	Applied*	Total
Melita	N	78	130	208
	P	16	30	46
	K	74	22	96
	S	93	16	109
	Zn	0.49	1	1
Roblin	N	44	124	168
	P	18	15	33
	K	175	10	185
	S	62	5	67
	Zn	3.39	0	3
Arborg	N	13	136	149
	P	5	59	64
	K	156	10	166
	S	52	0	52
	Zn	0	0	0
Carberry	N	12	130	142
	P	24	35	59
	K	67	20	87
	S	25	0	25
	Zn	0.67	0	1

*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 9.2. Description of site fields in the 2024 Ducks Unlimited Winter Wheat Fertility Trial in Melita, Roblin, Arborg, and Carberry.

Location	Melita	Roblin	Arborg	Carberry
Cooperator	WADO	PCDF	PESAI	MCDC
Legal	SW 11-4-26W1	NE 20-25-28W1	RL37-22-2E	SE/SW 8-11-14W1
Rotation	Wheat, Canola	Millet, Oat/Barley	Canola, Wheat	Soybean, Canola
Soil Series	Waskada Loam	Erickson Clay Loam	Fyala (Heavy Clay)	Ramada Clay Loam
Soil Test	Yes	Yes	Yes	Yes
Field Prep	Heavy Harrow	None	None	Heavy Harrow
Stubble	Canola	Oat, Barley	Canola	Canola
Burn off	Yes	Yes	No	Yes

Table 9.3. Agronomic practices and description of sites in the 2024 Ducks Unlimited Winter Wheat Fertility Trial in Melita, Roblin, Arborg, and Carberry.

Location	Melita	Roblin	Arborg	Carberry
(Date/Rate per acre/Products)	Glyphosate (0.67L/ac) + Heat (34mL/ac) 06-Sep-23	Glyphosate (0.64L/ac 27-Sep-23	No Burnoff	Glyphosate (0.67L/ac) + Heat (29mL/ac) 13-Sep-23
Moisture at Seeding	Good	Poor	Good	Good
Seed Date	06-Sep-23	27-Sep-23	19-Sep-23	19-Sep-23
Seed depth (in)	0.5	0.75	0.5	1
Seeder	Air Drill	Disc Drill	Disc Drill	Disc Drill
Seeding Errors	None	None	None	None
Topdressing Date	15-Apr-24	25-Apr-24	30-Apr-24	29-Apr-24
Herbicides: (Date, Rate/ ac, Name)	Achieve (0.2L/ac) + Mextrol (0.5L/ac) 02-May-24	None	Refine SG (12g/ac) 10-May-24	Fitness (120mL/ac) / Buctril M (0.4L/ac) + Axial (0.5L/ac) 18-Jun / 24-Jun-24
Fungicides	Prosaro (325mL/ac) 27-Jun-24	None	None	None
Insecticides	None	None	None	None
Desiccation	Glyphosate (0.67L/ac) 02-Aug-24	Reglone (0.69L/ac) + LI700 (0.25%) + Glyphosate (0.67L/ac) 15-Aug-24	None	Glyphosate (0.67L/ac) + Heat (29mL/ac) 23-Aug-24
Harvest Date	06-Aug-24	21-Aug-24	12-Aug-24	29-Aug-24
Total Precip. (Seeding to Harvest)	424mm	450mm	443mm	504mm

Results & Discussion

The 2024 trial was successfully completed at all the Diversification Centers and agronomic characteristics that were evaluated included test weight, protein, and yield. In Melita, variety had a significant effect ($p < 0.001$) on test weight while in Arborg, the combined effects of variety and fertility significantly influenced (p = 0.031) test weight. In Melita, Vortex had a greater test weight (83.7 kg/hL) than Wildfire (82.9 kg/hL). This trend was consistent amongst the other sites, but the difference was not significant. Test weight was not found to be significantly influenced by variety or fertility at either the Roblin or Carberry sites (Table 9.4).

The significant interaction of variety and fertility at Arborg suggests that the effect of fertility was dependent on which variety was used. In fact, when nitrogen rates were 90 kg/ha and below, Wildfire had greater test weights than Vortex and as nitrogen rates increased to 120 kg N/ha and above, Vortex had higher test weights. This trend appeared to be specific to Arborg. While test weight has been found to be significant in some situations, it was not particularly affected by the treatments in the 2023-2024 growing season.

In Melita, protein was found to be significant different (p < 0.001) between the varieties (Table 9.5). Vortex had a higher protein (11.8%) than Wildfire (10.9%). Fertility was also found to have a significant effect (p < 0.001) on protein in Melita; 150 kg N/ha split applied produced the highest protein (12.3%) but it was not significantly higher than the split application of 180 kg N/ha (12.1%). The check treatment with no additional nitrogen applied had the lowest protein (10.4%) in Melita.

In Roblin, protein was found to be significant (p < 0.001) between varieties; Vortex being higher (9.7%) than Wildfire (9.1%). Fertility treatment was also found to be significant (p < 0.001) in Roblin. The 180 kg/ha nitrogen split application produced the highest protein (10.6%) while 90 kg/ha nitrogen split application produced the lowest protein (8.5%) in Roblin, but it was not significantly lower than the check treatment with no additional nitrogen applied (8.9%).

In Arborg, protein was only found to be significantly affected (p = 0.025) by fertility. The 180 kg N/ha split application produced the highest protein grain (10.9%), and it was significantly greater than the proteins achieved by split applications of 60 kg N/ha (9.5%) and 90 kg N/ha (9.6%).

Variety and fertility were found to significantly influence protein in Carberry (p < 0.001). Again, Vortex produced the higher protein (11.1%), and Wildfire had lower protein grain (10.3%). The fertility treatment that produced the highest protein grain was the split application of 180 kg N/ha (11.7%), but it was not significantly different from the protein than that of split applied 150 kg N/ha (11.2%) or 120 kg N/ha applied in the spring (11.1%).

In Melita, grain yield was found to be significantly different (p = 0.010) between varieties; Wildfire was the higher yielding variety (6283 kg /ha) compared to Vortex (5919 kg/ha) (Table 9.6). Fertility was also found to have a significant effect (p < 0.001) on yield. When nitrogen was split applied at the 150 kg N/ha rate the highest yield (6607 kg/ha) was achieved, though it was not significantly different from the yield of 180 kg N/ha and 120 kg N/ha split applications or spring applied 120 kg N/ha nitrogen (6541 kg/ha, 6464 kg/ha, and 6198 kg/ha respectively). The lowest yield (4943 kg/ha) was observed for check treatment where no additional nitrogen was applied.

Grain yield was significantly affected by variety (p = 0.034) and fertility treatment (p < 0.001) in Roblin. Vortex produced the highest yield (4866 kg/ha) and Wildfire the lowest (4500 kg/ha). The 180 kg N/ha split applied had the greatest yield (5865 kg/ha) and was statistically the same as both 120 kg N/ha treatments and 150 kgN/ha split applied. The check treatment with no additional nitrogen applied had the lowest yield (2400 kg/ha).

In Arborg, only fertility treatment had a significant effect (p < 0.001) on yield. The split application of 180 kg N/ha achieved the highest yield (6371 kg/ha), though it was not significantly higher than the yields produced by 150 kg N/ha split applied (6264 kg/ha) or 120 kg N/ha applied in the spring (6028 kg/ha).

In Carberry, yield was not affected by variety or fertility enough to result in a significant p-value. However, trends were similar to the other three sites. Vortex had a greater yield than Wildfire by just over 200 kg/ha. The greatest yields were observed for the split applications of 120 kg N/ha (5982 kg/ha) and 150 kg N/ha (6231 kg/ha) treatments.

Table 9.4. Test weight results from 2024 in Melita, Roblin, Arborg, and Carberry.

Treatment		Factor	2024 Ducks Unlimited Winter Wheat TWT (kg/hL)			
			Melita	Roblin	Arborg	Carberry
Variety	Wildfire	1	82.9 b	74.8	73.1	70.8
	Vortex	2	83.7 a	75.8	73.3	71.5
Fertility	Check 0N	1	83.6	77.4	73.2	71.6
	60 Split	2	83.4	73.1	72.8	70.5
	90 Split	3	83.6	74.8	72.6	68.9
	120 Split	4	83.2	74.7	73.6	72.3
	150 Split	5	83.0	75.9	73.3	72.6
	180 Split	6	83.1	75.9	73.5	71.1
	120 Spring	7	83.1	75.3	73.2	71.1
Variety x Fertility		1,1	82.9	77.8	73.8 ab	71.8
		1,2	83.0	74.5	73.1 ab	68.9
		1,3	82.9	74.4	72.7 b	68.5
		1,4	82.9	72.8	73.2 ab	74.7
		1,5	82.5	75.9	72.9 b	72.1
		1,6	83.1	74.3	73.1 ab	71.4
		1,7	82.8	74.1	72.6 b	68.5
		2,1	84.3	77.1	72.6 b	71.5
		2,2	83.7	71.8	72.5 b	72.1
		2,3	84.3	75.1	72.5 b	69.2
		2,4	83.6	76.6	74.0 a	69.8
		2,5	83.5	75.8	73.8 ab	73.0
		2,6	83.0	77.5	73.8 ab	70.8
		2,7	83.3	76.5	73.7 ab	73.7
P-Values	Variety		**< 0.001**	0.164	0.225	0.671
	Fertilty		0.309	0.063	0.133	0.858
	V x F		0.205	0.127	**0.031**	0.655
CV %			0.6	2.2	0.9	6.6

Values followed by the same letter are not significantly different by Fisher's mean separation at 95% confidence.

Treatment		Factor	2024 Ducks Unlimited Winter Wheat Protein (%)			
			Melita	Roblin	Arborg	Carberry
Variety	Wildfire	1	10.9 **b**	9.1 **b**	10.3	10.3 **b**
	Vortex	2	11.8 **a**	9.7 **a**	10.1	11.1 **a**
Fertility	Check 0N	1	10.4 **d**	8.9 **cd**	10.1 **ab**	9.9 **cd**
	60 Split	2	10.3 **d**	8.5 **d**	9.5 **b**	9.7 **d**
	90 Split	3	10.8 **cd**	9.0 **cd**	9.6 **b**	10.6 **b**
	120 Split	4	11.4 **bc**	9.8 **b**	10.3 **ab**	10.6 **b**
	150 Split	5	12.3 **a**	9.7 **b**	10.5 **a**	11.2 **a**
	180 Split	6	12.1 **a**	10.6 **a**	10.9 **a**	11.7 **a**
	120 Spring	7	11.9 **ab**	9.6 **b**	10.6 **a**	11.1 **ab**
Variety x Ferility		1,1	10.0	8.5	10.1	9.2
		1,2	9.6	8.3	9.7	9.5
		1,3	10.3	8.5	9.7	10.0
		1,4	11.0	9.3	10.1	10.5
		1,5	11.7	9.4	10.9	10.6
		1,6	12.1	10.4	11.2	11.1
		1,7	11.3	9.3	10.3	10.9
		2,1	10.9	9.2	10.1	10.6
		2,2	10.9	8.7	9.3	9.9
		2,3	11.3	9.5	9.4	11.2
		2,4	11.7	10.2	10.4	10.7
		2,5	12.8	10.0	10.2	11.8
		2,6	12.1	10.7	10.5	12.3
		2,7	12.6	9.9	10.8	11.3
P-Values	Variety		**< 0.001**	**< 0.001**	0.392	**< 0.001**
	Fertility		**< 0.001**	**< 0.001**	**0.025**	**< 0.001**
	V x F		0.554	0.587	0.701	0.064
	CV %		5.7	3.5	7.3	3.9
Values followed by the same letter are not significantly different by Fisher's mean separation at 95% confidence.						

Table 9.5. Protein results from 2024 in Melita, Roblin, Arborg, and Carberry.

Table 9.6. 2024 yield results in Melita, Roblin, Arborg, and Carberry

Treatment		Factor	2024 Ducks Unlimited Winter Wheat Yield (kg/ha) Melita	Roblin	Arborg	Carberry
Variety	Wildfire	1	6283 a	4500 b	5382	5774
	Vortex	2	5919 b	4866 a	5476	5566
Fertility	Check 0N	1	4943 d	2400 d	3505 c	4784
	60 Split	2	5856 c	3455 c	4806 bc	6073
	90 Split	3	6095 bc	4843 b	5126 b	5751
	120 Split	4	6464 ab	5570 a	5904 b	5982
	150 Split	5	6607 a	5265 ab	6264 ab	6231
	180 Split	6	6541 ab	5865 a	6371 a	5686
	120 Spring	7	6198 abc	5382 ab	6028 ab	5181
Variety x Fertility		1,1	5089	2255 e	3506	4635
		1,2	5953	3637 c	4801	6020
		1,3	6216	4847 b	5029	6043
		1,4	6623	5107 b	5675	6211
		1,5	6825	5425 ab	6228	6148
		1,6	6873	5557 ab	6560	6308
		1,7	6399	4672 b	5877	5051
		2,1	4796	2545 de	3505	4934
		2,2	5759	3273 cd	4811	6126
		2,3	5974	4839 b	5223	5458
		2,4	6304	6033 a	6134	5753
		2,5	6389	5105 b	6299	6314
		2,6	6210	6172 a	6183	5065
		2,7	5998	6092 a	6178	5311
P-Values	Variety		**0.010**	**0.034**	0.329	0.496
	Fertility		**< 0.001**	**< 0.001**	**< 0.001**	0.164
	V x F		0.972	0.060	0.372	0.786
CV %			6.9	11.3	5.6	17.2
Values followed by the same letter are not significantly different by Fisher's mean separation at 95% confidence.						

When the data from all four sites were combined from the 2024 season, fertility had a significant effect on yield and protein ($p < 0.001$), and variety significantly affected ($p < 0.001$) protein (Table 9.7). Results indicate that the split application of 180 kg N/ha produced the greatest yield (6115.9 kg/ha), though it was not significantly higher than the 150 and 120 kg N/ha split applied, or spring applied 120 kg N/ha (6091.6 kg/ha, 5980.0 kg/ha, and 5697.3 kg/ha, respectively). While not significant ($p = 0.623$), the combination of variety and fertility that produced the highest yield was when Vortex was grown with the fertility treatment of 150 kg/ha split nitrogen (6324.4 kg/ha). The variety Vortex produced higher protein (10.7%) across all the sites. As well as the highest yield, the split application of 180 kg N/ha also produced the highest protein grain (11.3%) across all four sites and was significantly higher than the protein produced by all other fertility treatments in the trial. Test weight was not found to be significant between the sites in 2024.

Table 9.7. Results including yield, protein, and test weight from all sites included combined for the 2024 season.

Treatment		Factor	2024 Sites Combined Yield (kg/ha)	2024 Sites Combined Protein (%)	2024 Sites Combined TWT (kg/hL)
Variety	Wildfire	1	5458.7	10.1 **b**	75.4
	Vortex	2	5456.5	10.7 **a**	76.0
Fertility	Check 0N	1	3908.1 **d**	9.8 **de**	76.5
	60 Split	2	5047.5 **c**	9.5 **e**	75.0
	90 Split	3	5453.7 **cb**	10.0 **de**	75.0
	120 Split	4	5980.0 **a**	10.5 **c**	75.9
	150 Split	5	6091.6 **a**	10.9 **b**	76.2
	180 Split	6	6115.9 **a**	11.3 **a**	75.9
	120 Spring	7	5697.3 **ab**	10.8 **bc**	75.7
Variety x Fertility		1,1	3871.3	9.4	76.6
		2,1	5102.9	9.3	74.8
		1,2	5533.8	9.6	74.4
		2,2	5904.1	10.2	75.9
		1,3	6156.5	10.7	75.9
		2,3	6324.4	11.2	75.5
		1,4	5499.7	10.5	75.2
		2,4	3944.9	10.2	76.4
		1,5	4992.1	9.7	75
		2,5	5373.6	10.3	74.1
		1,6	6055.9	10.8	76
		2,6	6026.6	11.2	76.5
		1,7	5907.4	11.4	76.3
		2,7	5894.8	11.2	74.3
P-Values		Site	0.119	0.114	0.112
		Variety	0.807	**< 0.001**	0.133
		Fertility	**< 0.001**	**< 0.001**	0.392
		V x F	0.623	0.791	0.798
		CV %	4.6	2.0	1.7

Table 9.8. Combined results including yield, protein, and test weight from all sites from the 2022, 2023, and 2024 growing seasons.

2022, 2023 & 2024 Site Years Combined					
Treatment		Factor	Yield (kg/ha)	Protein (%)	TWT (kg/hL)
Variety	Wildfire	1	5640	11.4 **b**	73 **b**
	Vortex	2	5423	12.1 **a**	74 **a**
Fertility	Check 0N	1	4511 **d**	11.1 **d**	74
	60 Split	2	5346 **c**	11.1 **d**	73
	90 Split	3	5512 **bc**	11.4 **c**	74
	120 Split	4	5825 **ab**	11.8 **b**	74
	150 Split	5	5933 **a**	12.1 **ab**	74
	180 Split	6	5827 **ab**	12.4 **a**	73
	120 Spring	7	5770 **ab**	12.4 **a**	74
Variety*Fertility		1,1	4660	10.6	74
		1,2	5478	10.8	71
		1,3	5698	11.0	73
		1,4	5872	11.4	73
		1,5	6049	11.8	73
		1,6	5987	12.2	73
		1,7	5740	12.0	73
		2,1	4362	11.6	74
		2,2	5214	11.3	74
		2,3	5326	11.9	74
		2,4	5778	12.2	74
		2,5	5818	12.4	74
		2,6	5668	12.6	74
		2,7	5800	12.8	74
Year	2022		6534	11.9	72
	2023		4591	13.0	73
	2024		5471	10.4	76
Site	Arborg		5457	12.6	70
	Carberry		6046	11.7	70
	Melita		5282	11.5	80
	Roblin		5343	11.2	74
P-Values	Year		0.161	0.159	0.167
	Site		0.138	0.115	0.112
	Variety		0.051	**< 0.001**	**0.014**
	Fertility		**< 0.001**	**< 0.001**	0.582
	V x F		0.954	0.672	0.959
CV%			22.0	8.1	6.2

To gain a broader sense of the results from this research, data was combined from all four sites for the 2022, 2023, and 2024 growing seasons. Statistical results indicated that fertility treatment had an influence on yield and protein while variety had an effect on protein and test weight (Table 9.8).

Winter wheat that received 150 kg N/ha split between fall and spring had the highest yield (5933 kg/ha), though it was not significantly higher than the yield produced by most of the other treatments except when nitrogen rates were reduced to 90 kg/ha and less. The check treatment with no nitrogen applied produced the lowest yield (4510 kg/ha) which was expected and shows that there was a strong yield response to nitrogen fertilization.

Variety and fertility had a significant effect ($p < 0.001$) on protein. Vortex had the highest protein (12.1%) and Wildfire had a marginally lower protein (11.4%). The fertility treatment, 180 kg N/ha split produced the highest grain protein (12.5%), though it was not significantly higher than the protein produced when all nitrogen was spring applied (12.4%) or 150 kg N/ha split applied (12.1%). The check treatment with no additional nitrogen and 60 kg N/ha split applied produced the lowest protein (11.1%).

Variety had a significant effect ($p < 0.001$) on grain test weight whereby Vortex had a slightly greater test weight (74 kg/hL) than Wildfire (73 kg/hL). No statistical differences were observed between fertility treatments for test weight. Results of this trial across three growing seasons and multiple sites were similar as indicated by a non-significant p-value for site and year.

Table 9.9. Seasonal precipitation and growing degree days from the fall seeding date to November 15th, 2023, in Melita, Roblin, Arborg, and Carberry sites.

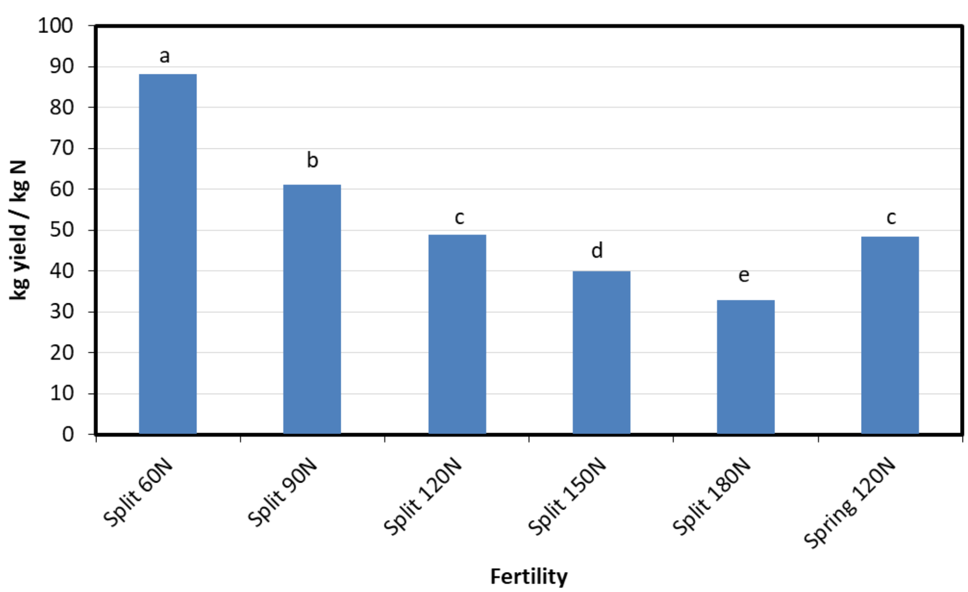
		Normal Precipitation (mm)	Actual Precipitation (mm)	% of Normal Precipitation	Normal GDD	Actual GDD	% of Normal GDD
Site	Arborg	53	83	168	70	205	292
	Carberry	46	46	100	73	201	275
	Melita	71	89	126	200	285	142
	Roblin	40	54	137	23	102	440
Information obtained from: https://web43.gov.mb.ca/climate/SeasonalReport.aspx							

Table 9.10. Seasonal precipitation and growing degree days from April 1st, 2024, to the harvest date in Melita, Roblin, Arborg, and Carberry.

		Normal Precipitation (mm)	Actual Precipitation (mm)	% of Normal Precipitation	Normal GDD	Actual GDD	% of Normal GDD
Site	Arborg	255	318	125	1155	1154	100
	Carberry	290	402	139	1325	1378	104
	Melita	272	295	108	1123	1115	99
	Roblin	252	324	129	1136	1109	98
Information obtained from: https://web43.gov.mb.ca/climate/SeasonalReport.aspx							

Nitrogen use efficiency (NUE) as a function of yield over amount fertilizer was evaluated over the course of the study from 2022 to 2024. There were no differences between Vortex and Wildfire in NUE ($p = 0.091$) or an interaction effect when looking at variety and fertility together proving that the NUE response was consistent across varieties. Furthermore, while fertility had a significant effect on NUE ($p < 0.001$), both Vortex and Wildfire responded similarly to changes in fertility ($p = 0.823$). Nitrogen use efficiency decreased as nitrogen fertilizer increased which is a typical NUE trend as nitrogen rates increase. When comparing the 100% spring applied nitrogen to the same rate that was split applied, NUE is the same indicating that in this study year, split application of N at this rate did not improve NUE.

Figure 9.1. The relationship between nitrogen treatment and nitrogen use efficiency (NUE = seed yield (kg/ha) / fertilizer N (kg/ha). Letters above bars indicate significant differences between treatments.



References

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

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

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

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

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

Winter Wheat GHG Emissions Evaluation

Project Duration*:* 2023-2024

Collaborators*:* Ducks Unlimited Canada, Manitoba Diversification Centres

Objectives:

1) To determine nitrous oxide emissions from fall, spring and split applications of nitrogen in winter wheat.

2) To determine wheat yield response to fall, spring and split applications of nitrogen.

Materials & Methods

A study on greenhouse gas (GHG) emissions were conducted at all four DC sites during 2023-24. Different nitrogen timing and nitrogen source treatments were compared in winter wheat for nitrous oxide emissions. The following were the treatments:

1. Check (Untreated Control)
2. 100% N requirement as untreated urea banded fall (100FU)
3. 100% N requirement urea treated with Agrotain spring broadcast (100ST)
4. 60% N requirement fall band as untreated urea; 40% N requirement spring broadcast urea treated with Agrotain (60FU40ST)
5. 60% N requirement fall band as untreated urea; 40% N requirement spring stream bar as UAN treated with Agrotain (60FU40STUAN)

Each fertility treatment was replicated four times. Western Ag took the soil samples in the fall and made fertility recommendations for all the sites. Winter wheat variety Wildfire was used for this test. The data on plant establishment, plant height at maturity, lodging and grain yield were recorded. GHG samples were taken every week at regular intervals of 0, 20, 40 and 60 minutes after the chambers were put on. These gas samples were sent to AAFC Brandon for nitrous oxide analysis.

The trial was established at PESAI site (Arborg) in Fyala clay soil with excellent moisture. On September 19th, 2023, winter wheat was seeded into canola stubble at a depth of 0.5-inches. Nitrogen fertilizer was applied as variable treatments shown in the above list. Certain treatments needed to be top dressed; fall top dressing was applied in early November, while spring top dressing was applied on April 30th, 2024. In-crop herbicide was needed to control weeds; Refine SG (12 ml/ac) were applied on May 10. All plots were harvested on August 13th.

Results & Discussion

In 2024, when the data from this winter wheat green house gas emissions evaluation were analyzed, there was multiple significant effects found across the four sites where this trial was grown (Table 10.1).

In Arborg, yield ($p < 0.001$), protein ($p = 0.005$), and test weight ($p = 0.011$) were found to be significantly affected by N fertilizer application (Table 10.1), the greatest yield resulted when 100% of the nitrogen was applied in the fall during seeding (5467 kg/ha). Though higher, that yield was not significantly different from the yield produced by either of the split nitrogen applications, whether UAN (5369 kg/ha) or urea (5268 kg/ha) were broadcasted. The untreated check produced the lowest yield at Arborg (2396 kg/ha).

When 100% of the nitrogen was applied as broadcasted SuperU late in the fall, it resulted in the highest protein at Arborg (11.3%), though it was not significantly higher than when 100% of the nitrogen was applied at seeding (11.0%) or when the nitrogen application was split using urea in the spring (10.8%). The untreated check produced the lowest protein at Arborg (10.0%), though it was not significantly lower than the protein produced when the nitrogen application was split using UAN in the spring (10.4%).

The untreated check produced the lowest test weight at Arborg (71.5 kg/hL) as compared to nitrogen treatments. All other sites had no differences for test weight among nitrogen treatments.

In Carberry, yield was the only factor found to be significantly affected (p = 0.039) by fertilizer application (Table 10.1). the highest yield was produced when all of the nitrogen fertilizer was applied at seeding (3940 kg/ha), though the yield was not significantly different from the yield produced when the nitrogen application was split using UAN in the spring (3643 kg/ha). The lowest yields were observed when all nitrogen was broadcasted in late fall (3037 kg/ha), though not significantly different from the yield produced by the untreated check (3564 kg/ha) or when nitrogen was split using urea in the spring (3516 kg/ha).

In Melita, yield was found to be significantly affected (p < 0.001) by fertilizer treatment (Table 10.1). All nitrogen treatments had higher yield than in untreated check (3681 kg/ha), although the differences among nitrogen treatments were not evident.

Protein was also found to be significantly affected (p < 0.001) by N fertilizer application at Melita. When all the nitrogen was broadcasted as SuperU in the late fall, the highest protein was produced (13.2%). The untreated check produced the lowest protein grain at Melita (10.9%).

In Roblin, yield was found to be significantly influenced (p < 0.001) by fertilizer application (Table 10.1). When nitrogen was applied as a split application broadcasting urea in the spring, the greatest yield was produced (5372 kg/ha), though it was not significantly higher yielding than when nitrogen was applied in a split application using UAN in the spring (5051 kg/ha). The untreated check produced the lowest yield at Roblin (3108 kg/ha).

Protein was found to be significant (P < 0.001) at Roblin. When nitrogen was split applied using UAN in the spring, the highest protein was produced (11.8%), though it was not significantly higher than the protein when all the nitrogen was applied in the fall at seeding (11.3%). The untreated check produced the lowest protein grain at Roblin (9.9%).

2024 Winter Wheat Green House Gas Emissions								
Factor	**Site**	**Untreated Check**	**100% Fall Urea (SB)**	**60% Fall Urea (SB) + 40% Spring Urea (BC)**	**60% Urea Fall (SB) + 40% Spring UAN (BC)**	**100% SuperU Late Fall (BC)**	**P-Value**	**CV%**
Yield (kg/ha)	Arborg	2396**c**	5467**a**	5369**a**	5268**ab**	4892**b**	**< 0.001**	5.7
	Carberry	3564**b**	3940**a**	3516**b**	3643**a**	3037**b**	**0.039**	9.8
	Melita	3681**b**	5691**a**	5416**a**	5545**a**	5380**a**	**< 0.001**	7.8
	Roblin	3108**c**	4585**b**	5372**a**	5051**ab**	4562**b**	**< 0.001**	8.1
Protein (%)	Arborg	10.0**c**	11.0**a**	10.8**ab**	10.4**bc**	11.3**a**	**0.005**	3.6
	Carberry	12.2	12.4	13.1	13.4	13.3	0.320	7.2
	Melita	10.9**c**	12.1**b**	12.3**b**	12.4**b**	13.2**a**	**< 0.001**	3.1
	Roblin	9.9**c**	11.3**ab**	11.0**b**	11.8**a**	10.8**b**	**< 0.001**	3.5
Test Weight (kg/hL)	Arborg	71.5**b**	73.6**a**	73.2**a**	73.5**a**	72.9**a**	**0.011**	1.0
	Carberry	70.0	73.2	66.7	70.8	73.0	0.330	6.6
	Melita	82.9	82.2	81.7	81.4	81.5	0.054	0.8
	Roblin	78.1	77.5	80.4	78.6	78.3	0.150	2.0
*Values that do not share a letter are signficantly different								
SB = Seed Bed Placed, BC = Broadcast								

Table 10.1. Results of the 2024 winter wheat green house gas evaluation at four sites including yield, protein, and test weight.

When the data from all four sites were combined, it was found that both yield and protein were significantly influenced ($p < 0.001$) by fertilizer application, while test weight was not (Table 10.2). When all the nitrogen was applied at seeding, the highest yield was produced (4920.7 kg/ha), though it was not significantly more than the yield produced by either split nitrogen applications. The untreated check produced the lowest yield overall (3187.2 kg/ha).

When all nitrogen was applied as a fall broadcast of SuperU, the highest protein was produced (12.2%), though it was not significantly higher than the protein achieved by the two split nitrogen treatments. The untreated check produced the lowest protein (10.8%).

Table 10.3. Results of all four sites combined for the 2024 winter wheat green house gas evaluation including yield, protein, and test weight.

		2024 Winter Wheat GHG Emissions Sites Combined		
		Yield (kg/ha)	Protein (%)	Test Weight (kg/hL)
Untreated Check		3187.2**c**	10.8**c**	75.6
100% Fall Urea (SB)		4920.7**a**	11.7**b**	76.6
60% Fall Urea (SB) + 40% Spring Urea (BC)		4918.3**a**	11.8**ab**	75.5
60% Urea Fall (SB) + 40% Spring UAN (BC)		4876.8**a**	12.0**ab**	76.1
100% SuperU Late Fall (BC)		4467.9**b**	12.2**a**	76.4
Arborg		4671.5	10.7	72.9
Carberry		3572.5	12.9	70.8
Melita		5119.3	12.2	81.9
Roblin		4533.3	11.0	78.6
P-Values	**Site**	0.119	0.115	0.114
	Treatment	**< 0.001**	**0.001**	0.791
	CV%	5.1	2.3	1.6

The results on GHG emission were still not available at the time of publication for this annual report.

MCA Flax Seed Treatment Evaluation

Project Duration: 2023-2026

Collaborators: MCA (Daryl Rex), the Manitoba Diversification Centres (WADO, PCDF, MCDC, and PESAI)

Objectives

- To evaluate the efficacy of Manitoba-registered flax seed treatments against soil-borne diseases in two flax types (yellow and brown).
- To evaluate the relationship between the seed treatment and germination, emergence, and ultimately yield in brown and yellow flax types.

Background

There has been little testing done recently evaluating the commercially available seed treatments for flax in Manitoba. This project has evaluated commercially available seed treatments and respective label rates in brown and yellow flax for Manitoba farmers in 2023 and 2024 growing seasons across the four Diversification Centre locations. The project was set up as a small plot experiment, randomized complete block design with four replicates. Two flax varieties (one yellow, one brown) were evaluated in this study.

The available seed treatments for flax in Manitoba are Insure Pulse (300 mL to 600 mL/100 Kg of seed), INTEGO Solo Fungicide (13 mL to 19.6 mL/100 Kg of seed), and Vitaflo Brands (525 mL/100 Kg of seed). The following fungicide treatments were tested in the current study:
1) one untreated check,
2) Insure Pulse (300 mL/100 Kg of seed),
3) Insure Pulse (600 mL/100 Kg of seed),
4) Vitaflo Brand product of choice (525 mL/100 Kg of seed).

Each treatment was applied to yellow (AAC Bright) and brown (CDC Rowland) flax types. The trial was established at all four of the Crop Diversification Centers located at Melita, Roblin, Carberry, and Arborg to help evaluate any differences that may be seen due to varying regional conditions.

Trial data collected by the Diversification Centre Specialists and Technicians is analyzed by the MCA. More information on this trial can be found by contacting Manitoba Crop Alliance.

Factor	Treatment	Name
Variety	1	AAC Bright
	2	CDC Rowland
Seed Treatment	1	Untreated
	2	Insure Pulse - Low
	3	Insure Pulse - High
	4	Vitaflo
Variety x Seed Treatment	1,1	AAC Bright x Untreated
	1,2	AAC Bright x Insure Pulse - Low
	1,3	AAC Bright x Insure Pulse - High
	1,4	AAC Bright x Vitaflo
	2,1	CDC Rowland x Untreated
	2,2	CDC Rowland x Insure Pulse - Low
	2,3	CDC Rowland x Insure Pulse - High
	2,4	CDC Rowland x Vitaflo

Table 1. The varieties and fungicide seed treatments used in the Flax Seed Treatment Evaluation Trial during 2024 testing.

Materials & Methods (Arborg site)

The flax seed treatment trial was established on Fyala clay soil into soybean stubble. The flax was seeded on May 21 using a double disc drill at 0.5-inch depth. Burn off was sprayed on May 8 before seeding as Round Up (0.67 L/ac). Fertilizer was banded during seeding as 60-20 actual lbs/ac (N-P). In-crop herbicides were applied as Basagran (0.91 L/ac) on June 14th. All plots were desiccated using Roundup Transorb (0.67 L/ac) on August 27th. In Arborg, the plots were harvested on September 3. Data collected throughout the growing season included emergence counts, disease presence and severity ratings, flowering dates, heights, lodging rates, maturity dates, grain yield and moisture.

Results & Discussion

Melita

The results from the 2024 Melita MCA Flax Seed Treatment trial can be found below in Table 2. The variety grown had a significant effect ($p < 0.001$) on the flax plant stand. CDC Rowland had higher plant stands (254 plants/m^2) and AAC Bright had lower plant stands (159 plants/m^2). The seed treatment applied to the flax seed also had a significant influence ($p = 0.001$) on the plant stands. When Insure Pulse was applied to the seed at the high rate, it produced the highest plant stands (244 plants/m^2) between seed treatments, though those stands were not significantly different than when other seed treatments were used. The flax plots that did not receive any seed treatment had the lowest plant stands (136 plants/m^2).

The number of days to flowering was found to be significantly different ($p < 0.001$) between the flax varieties at Melita. CDC Rowland took fewer days to reach flowering (56 days) than AAC Bright (59 days). The height of the flax plants was also found to be significantly different ($p = 0.003$) between the two varieties. AAC Bright plants were taller (72 cm) than CDC Rowland plants (69 cm). Variety, seed treatment, and their interaction were found to have significant effects ($p < 0.001$) on the maturity of the flax in Melita. Between varieties, CDC Rowland matured faster (107 days) than AAC Bright (109 days). When Insure Pulse was used at either the low or high rate, the flax matured the fastest (107 days) between seed treatments, though it was not significantly faster than when Vita Flo was used on the seed (108 days). The untreated flax took the longest to reach maturity (112 days). When the high rate of Insure Pulse was used on CDC Rowland, those flax plots reached maturity faster than all the other seed treatments in the trial (106 days). When AAC Bright was grown without seed treatment, the plants took the longest to mature (115 days).

Table 2. Results from the 2024 MCA Flax Seed Treatment trial at Melita.

Melita 2024 MCA Flax Seed Treatment Results								
Factor	**Treatment**	**Factor**	**Plant Stand**	**Days to Flower**	**Height (cm)**	**Days to Maturity**	**Yield (bu/ac)**	**Moisture (%)**
Variety	**AAC Bright**	**1**	159 **b**	59 **a**	72 **a**	109 **a**	50 **b**	9.1 **a**
	CDC Rowland	**2**	254 **a**	56 **b**	69 **b**	107 **b**	59 **a**	8.6 **b**
Seed Treatment	**Untreated**	**1**	136 **b**	58	68	112 **a**	48 **b**	9.0 **a**
	Insure Pulse - Low	**2**	232 **a**	57	70	107 **b**	57 **a**	8.8 **ab**
	Insure Pulse - High	**3**	244 **a**	57	71	107 **b**	56 **a**	8.6 **b**
	Vita Flo	**4**	214 **a**	57	72	108 **b**	59 **a**	9.0 **a**
Variety x Seed Treatment		**1,1**	78	60	68	115 **a**	39 **d**	9.2
		1,2	185	58	72	108 **bc**	55 **bc**	9.1
		1,3	209	58	73	107 **bc**	52 **c**	8.8
		1,4	163	58	75	108 **b**	56 **bc**	9.1
		2,1	194	56	69	108 **b**	57 **ab**	8.7
		2,2	278	56	69	107 **cd**	58 **ab**	8.6
		2,3	279	56	69	106 **d**	60 **a**	8.5
		2,4	265	55	69	107 **bc**	61 **a**	8.8
P-Value	**Variety**		**<0.001**	**< 0.001**	**0.003**	**< 0.001**	**<0.001**	**< 0.001**
	Seed Treatment		**0.001**	0.087	0.059	**< 0.001**	**<0.001**	**0.018**
	Variety x Seed Treatment		0.861	0.849	0.091	**< 0.001**	**<0.001**	0.602
C.V.%			15.5	1.4	3.4	0.8	5.0	2.4

Again, variety, seed treatment, and their interaction had significant effects ($p < 0.001$) on yield at Melita. CDC Rowland produced the highest yield (59 bu/ac), while AAC Bright produced the lowest yield (50 bu/ac). The seed treatment that produced the highest flax yield was Vita Flo (59 bu/ac), though the yield was not significantly higher than when other seed treatments were used. The untreated flax plots produced the lowest yield (48 bu/ac). When variety and seed treatment were evaluated together, it was found that CDC Rowland treated with Vita Flo produced the highest yield (61 bu/ac), though that yield was not significantly different than any other yield produced by CDC Rowland. When AAC Bright was untreated, it produced the lowest yield in the trial at Melita (39 bu/ac).

The grain moisture at harvest was also found to be significantly different ($p < 0.001$) between varieties grown at Melita. AAC Bright was harvested with the highest moisture (9.1%), while CDC Rowland was harvested with lower seed moisture (8.6%). Lastly, the seed treatment used also had a significant effect ($p = 0.018$) on grain moisture at harvest in Melita. Untreated flax and flax treated with Vita Flo has higher grain moisture at harvest (9.0%); flax treated with the high rate of Insure Pulse had the lowest grain moisture at harvest (8.6%).

Arborg

The results from the 2024 Flax Seed Treatment trial in Arborg can be found below in Table 3. Variety and seed treatment had significant effects ($p < 0.001$) on plant stand at Arborg. CDC Rowland had higher plant stands (321 plants/m^2) while AAC Bright had lower plant stands (214 plants/m^2). When Insure Pulse was used at the high rate, it resulted in the highest plant stands between seed treatments (308 plants/m^2), though the stands were not significantly higher than when Insure Pulse was used at the low rate (302 plants/m^2) or Vita Flow (266 plants/m^2). The untreated plots had the lowest plant stands (193 plants/m^2).

Table 3. Results from the 2024 MCA Flax Seed Treatment trial at Arborg.

Arborg 2024 MCA Flax Seed Treatment Results								
Factor	**Treatment**	**Factor**	**Plant Stand**	**Days to Flower**	**Height (cm)**	**Days to Maturity**	**Yield (bu/ac)**	**Moisture (%)**
Variety	**AAC Bright**	**1**	214 **b**	54 **a**	68	97	36	9.0 **b**
	CDC Rowland	**2**	321 **a**	53 **b**	69	97	39	10.0 **a**
Seed Treatment	**Untreated**	**1**	193 **b**	55 **a**	68	98	35	10.2
	Insure Pulse - Low	**2**	302 **a**	53 **b**	68	97	37	9.7
	Insure Pulse - High	**3**	308 **a**	53 **b**	68	97	39	9.5
	Vita Flo	**4**	266 **a**	53 **b**	70	97	38	9.8
Variety x Seed Treatment		**1,1**	123	56 **a**	69	98	31 **b**	9.9
		1,2	245	54 **b**	66	97	37 **a**	9.0
		1,3	282	53 **b**	68	97	40 **a**	8.7
		1,4	207	54 **b**	69	97	38 **a**	9.3
		2,1	264	53 **b**	67	97	40 **a**	10.5
		2,2	360	53 **b**	70	97	37 **a**	10.4
		2,3	334	53 **b**	67	97	39 **a**	10.2
		2,4	325	52 **b**	70	97	39 **a**	10.3
P-Value	**Variety**		**< 0.001**	**0.002**	0.513	0.171	0.090	**< 0.001**
	Seed Treatment		**< 0.001**	**0.011**	0.455	0.194	0.205	0.111
	Variety x Seed Treatment		0.339	**0.028**	0.130	0.630	**0.048**	0.428
C.V.%			18.4	1.8	4.1	1.0	10.2	5.9

At Arborg, the variety used was found to have a significant effect ($P = 0.002$) on the number of days it took for the flax to reach flowering. CDC Rowland reached flowering earlier (53 days) than AAC Bright (54 days). The seed treatment used had a significant effect ($P = 0.011$) on flowering date at Arborg. The plots that received seed treatment flowered earlier (53 days), while the untreated plots took longer to reach flowering (55 days). The combined effects of variety grown and seed treatment used also had a significant influence ($P = 0.028$) on flowering date Arborg. When CDC Rowland was treated with Vita Flo, the flax took the least number of days to reach flowering (52 days), though it was not found to be significantly different from the days to flowering from any other treatment in the trial except for when AAC Bright was left untreated, which took 56 days to reach flowering.

There were no significant differences found between plant height or maturity of the flax at Arborg. The combined effects of variety with seed treatment had a significant effect (P = 0.048) on yield at Arborg. Both AAC Bright treated with the high rate of Insure Pulse and CDC Rowland with no seed treatment produced the highest yield (40 bu/ac), though the yield was not significantly higher than any other treatment in the trial except when AAC Bright was left untreated, which produced the lowest yield (31 bu/ac). Lastly, the variety grown had a significant effect (P < 0.001) on grain moisture at harvest in Arborg. AAC Bright had a lower grain moisture at harvest time (9.0%), while CDC Rowland had higher grain moisture at harvest (10.0%).

Carberry

The results from the 2024 Flax Seed Treatment trial in Carberry can be found below in Table 4. Plant stands were found to be significantly different (P = 0.001) between the varieties grown at Carberry. CDC Rowland had higher plants stands (248 plants/m^2), while AAC Bright had lower plant stands (154 plants/m^2).

The variety used also had significant effects (P = 0.008) on the number of days it took the flax to reach flowering. CDC Rowland reached flowering earlier (52 days) than AAC Bright (53 days). The days to flowering were also found to be significantly different (P = 0.025) between seed treatments used. When the low rate of Insure Pulse or Vita Flo was used on flax, the plants reached flowering earlier (52 days) than when the high rate of Insure Pulse was used or when the flax was left untreated (53 days).

Table 4. Results from the 2024 MCA Flax Seed Treatment trial at Carberry.

Carberry 2024 MCA Flax Seed Treatment Results									
Factor	**Treatment**	**Factor**	**Plant Stand**	**Days to Flower**	**Height (cm)**	**Days to Maturity**	**Yield (bu/ac)**	**Moisture (%)**
Variety	**AAC Bright**	**1**	154 **b**	53 **a**	71 **a**	111 **b**	32	10.7
	CDC Rowland	**2**	248 **a**	52 **b**	68 **b**	113 **a**	32	10.7
Seed Treatment	**Untreated**	**1**	185	53 **a**	70	114 **a**	31 **b**	10.8
	Insure Pulse - Low	**2**	192	52 **b**	71	114 **a**	31 **b**	10.7
	Insure Pulse - High	**3**	226	53 **a**	67	110 **b**	31 **b**	10.5
	Vita Flo	**4**	203	52 **b**	69	110 **b**	34 **a**	10.8
Variety x Seed Treatment		**1,1**	107	53	70	114 **a**	33 **b**	10.6
		1,2	158	52	74	115 **a**	31 **cd**	10.8
		1,3	200	53	69	105 **d**	30 **de**	10.5
		1,4	153	53	70	109 **c**	35 **a**	10.8
		2,1	263	52	69	114 **a**	29 **e**	11.0
		2,2	225	52	69	112 **b**	32 **c**	10.6
		2,3	253	52	66	115 **a**	32 **b**	10.6
		2,4	253	52	69	110 **c**	34 **a**	10.8
P-Value		**Variety**	**0.001**	**0.008**	**0.029**	**< 0.001**	0.893	0.708
		Seed Treatment	0.215	**0.025**	0.143	**< 0.001**	**< 0.001**	0.569
		Variety x Seed Treatment	0.070	0.429	0.759	**< 0.001**	**< 0.001**	0.535
		C.V.%	21.5	0.7	3.6	0.8	1.5	3.5

The variety grown had a significant effect (P = 0.029) on plant heights at Carberry. The AAC Bright plants were taller (71 cm), while the CDC Rowland plants were shorter (68 cm). The variety grown, seed treatment used, and the combined effects of variety and seed treatment all were found to have significant effects (P < 0.001) on the maturity of the flax at Carberry. Between varieties, AAC Bright matured earlier (111 days), while CDC Rowland too longer to reach maturity (113 days). When the high rate of Insure Pulse or Vita Flo was used, the flax matured earlier (110 days) than the untreated flax or when the low rate of Insure Pulse was used (114 days). When AAC Bright was treated with Vita Flo, it matured the fasted (109 days), though it was not significantly faster than when CDC Rowland was treated with Vita Flo (110 days). When AAC Bright was treated with Insure Pulse at the low rate and CDC Rowland was treated with Insure Pulse at the high rate, the flax took the longest time to reach maturity (115 days). Though the maturity of either flax variety that did not receive seed treatment was not significantly longer (114 days).

The seed treatment used had a significant influence (P < 0.001) on yield at Carberry. When flax was treated with Vita Flo, it produced the highest yield (34 bu/ac), and the remaining treatments produced lower yields (31 bu/ac). The combine effects of variety grown and seed treatment used also significantly affected (P < 0.001) the flax yield at Carberry. The highest yield was produced by AAC Bright treated with Vita Flo (35 bu/ac), though the yield was not significantly different than the yield produced by CDC Rowland treated with Vita Flo (34 bu/ac). The lowest yield was produced when CDC Rowland was left untreated (29 bu/ac), though the yield was not significantly different than the yield produced by AAC Bright treated with the high rate of Insure Pulse (30 bu/ac). The grain moisture of the flax at harvest was not found to be significantly affected at Carberry.

Roblin

The results from the 2024 Flax Seed Treatment Trial at Roblin can be found below in Table 5. The seed treatment used was found to have a significant effect (P = 0.005) on flax plant stands at Roblin. When Insure Pulse was used at the high rate, it resulted in the highest plant stands (163 plants/m^2). When the

Roblin 2024 MCA Flax Seed Treatment Results									
Factor	**Treatment**	**Factor**	**Plant Stand**	**Days to Flower**	**Height (cm)**	**Days to Maturity**	**Yield (bu/ac)**	**Moisture (%)**
Variety	**AAC Bright**	**1**	131	58 **a**	72	107	38 **b**	7.3
	CDC Rowland	**2**	139	57 **b**	72	107	45 **a**	7.6
Seed Treatment	**Untreated**	**1**	114 **b**	58	72	107	39	7.7
	Insure Pulse - Low	**2**	135 **b**	58	71	107	42	7.5
	Insure Pulse - High	**3**	163 **a**	58	71	107	43	7.4
	Vita Flo	**4**	128 **b**	58	74	107	41	7.1
Variety x Seed Treatment		**1,1**	96	58	72	107	35	7.3
		1,2	144	58	71	107	39	7.8
		1,3	162	58	71	107	39	7.0
		1,4	122	58	75	107	38	7.0
		2,1	131	57	73	107	43	8.1
		2,2	126	57	71	107	46	7.2
		2,3	164	57	71	107	47	7.8
		2,4	133	57	73	107	44	7.2
P-Value		**Variety**	0.374	**0.008**	0.731	-	**< 0.001**	0.159
		Seed Treatment	**0.005**	0.412	0.149	-	0.236	0.151
		Variety x Seed Treatment	0.143	0.412	0.602	-	0.933	0.065
		C.V.%	18.0	0.3	3.9	0.0	10.2	7.5

Table 5. Results from the 2024 MCA Flax Seed Treatment trial at Roblin.

flax seed was left untreated, it resulted in the lowest plant stands (114 plants/m^2), though the stands were not significantly lower than when the low rate of Insure Pulse (135 plants/m^2) or Vita Flo was used (128 plants/m^2).

The number of days it took the flax to reach flower was found to be significantly different (P = 0.008) between the flax varieties grown at Roblin. CDC Rowland reached flowering earlier (57 days), while AAC Bright too longer to reach flowering (58 days).

There were no significant influences on plant heights or maturity of the flax at Roblin. The variety grown was the only factor found to have a significant effect (P < 0.001) on flax yield at Roblin. CDC Rowland produced the higher yield flax (54 bu/ac), while AAC Bright produced the lower yielding flax (38 bu/ac). There were no significant effects found on grain moisture at harvest in Roblin.

Effect of Weed Control Timing on Soybean Yield
(Arborg 2023 – continuing)

Objectives
The objective of this trial is to quantify the yield impact of initial weed control timing on soybeans in Manitoba.

Collaborators
- Soybean & Pulse Agronomy Lab (University of Manitoba)
- Prairies East Sustainable Agriculture Initiative Inc. (PESAI)

Results
Weed evaluations prior to initial in-crop herbicide application

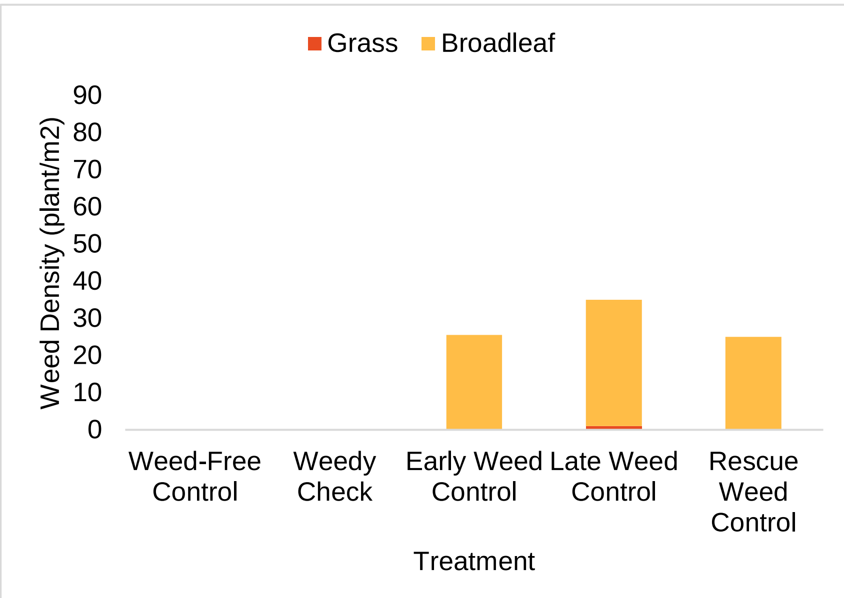


Figure 1. Arborg 2023: *Grassy and broadleaf weed densities for each treatment (weedy check not recorded in 2023) prior to initial in-crop herbicide application. Lamb's quarters and wild buckwheat were the most abundant weeds observed and very few grassy weeds present.*

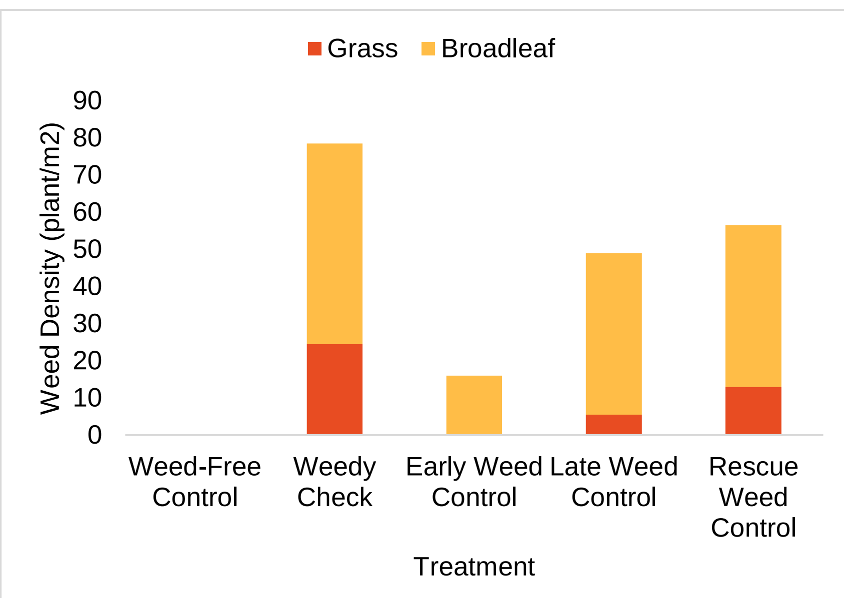


Figure 2. Arborg 2024: *Grassy and broadleaf weed densities for each treatment prior to initial in-crop herbicide application. Lamb's quarters were the most abundant weed surveyed especially earlier in the season. Green foxtail was the most abundant grassy weed and was more prominent later in June.*

Table 1. Effect of in-crop glyphosate timing on soybean plant height, days to maturity, test weight, oil content and protein % at Arborg, 2023.

Treatment	Soybean height (cm)	Days to maturity	Yield (bu/ac)	Soybean oil %	Soybean protein %
Weed-free check	58.8	119	49.4	22.0	31.1
Weedy check	55.6	117	48.0	21.5	32.1
Early weed control	61.3	119	49.6	21.8	31.3
Late weed Control	64.4	119	56.1	21.8	31.8
Rescue weed control	63.1	117	50.3	21.7	31.7
Significant difference	No	No	No	No	No
P value	0.4049	0.5860	0.3349	0.2364	0.1371

Project Findings

To date, limited significant differences have been observed amongst initial in-crop herbicide applications at Arborg 2023 & Arborg 2024. Relatively low natural weed populations amongst other environmental factors may contribute to little difference between treatments. Further testing will continue to capture a wider range of environments where weed density and competition may be more detrimental to crop yield. For more information on the results of this study at the Carman site, please follow this link: https://www.manitobapulse.ca/wp-content/uploads/2023/06/2021-2022-Annual-Report-Soybean-and-Pulse-Agronomy-Lab-MacMillan.pdf.

Background

Early weed interference reduces soybean yield, yet weedy fields are a common occurrence across Manitoba each year. Development of herbicide resistant weeds is increasing and reducing the efficacy of current herbicide programs, but overall, increased attention to timely and effective weed control is warranted. The average critical weed free period (CWFP), which defines the duration of time that soybean must be kept weed free to prevent yield loss, extends from seeding up to V4 (approx. 30 days after emergence) as studied in Ontario (Van Acker, 2001). Intensive studies evaluating various cultural and integrated weed management strategies to shorten the CWFP (Rosset and Gulden, 2019) and reduce selection pressure have recently been conducted in Manitoba (Geddes, 2023). Strategies such as narrow row spacing, high seeding rate and preceding fall rye cover crops can increase crop competitiveness thereby reducing weed biomass and selection pressure from applied herbicides. Additionally, timely herbicide management is important to maximize yield potential.

Table 2. Effect of in-crop glyphosate timing on soybean plant height, days to maturity, test weight, oil content and protein % at Arborg, 2024.

Treatment	Soybean height (cm)	Days to maturity	Yield (bu/ac)	Soybean oil %	Soybean protein %
Weed-Free Check	98.5	125	93.7	21.4	33.2
Weedy Check	91.8	125	86.2	21.0	33.3
Early Weed Control	93.3	125	82.2	21.0	33.2
Late Weed Control	93.0	125	89.8	21.1	33.1
Rescue Weed Control	96.8	125	91.8	21.1	33.1
Significant difference	No	No	No	No	No
P value	0.2546		0.0842	0.1613	0.9351

Figure 3. Soybean plots from Rep 1 at Arborg 2023. Low weed pressure observed throughout the season. Pictures taken on June 29th (A) at soybean stage V4/R1 and September 5th (B) at soybean stage V7.

In North Dakota, delaying herbicide weed control from pre-emerge until VC to V1 or V2-V4 reduces soybean yield by 5% and 8%, respectively, compared to maintaining the crop weed-free (Endres and Ostlie 2011-2014). This type of generalized data on the impact of weed control timing on soybean yield typically resonates well with farmers and agronomists.

References

- Endres G. and M. Ostlie (2011-2014) Timing of Initial Weed Control in Soybean in Carrington, ND. Available online.
- Geddes C. (2023) Supporting soybeans in the war on weeds. Manitoba Pulse & Soybean Growers. Available online.
- Rosset J.D. and R.H. Gulden (2019) Cultural weed management practices shorten the critical weed-free period for soybean grown in the Northern Great Plains. Weed Sci. 68:79-91.
- Van Acker R., C.J. Swanton and S.F. Weise (1993) The Critical Period of Weed Control in Soybean [Glycine max (L.) Merr.]. Weed Sci. 41:194-200.

Materials & Methods

The experiment has been conducted over the past three years at two distinct research sites in Manitoba: Ian N Morrison Research Farm in Carman (2022-2024) and Prairies East Sustainable Agriculture Initiative Inc. in Arborg (2023-2024). To determine the effect of weed control timing on yield, Dekalb DKB005-52 (2022 & 2023) and DKB006-80 (2024) soybeans were seeded using current best management practices (mid-May seeding date, narrow row spacing,180-200,000 seeds/ac). Following a pre-seed burn-off (or tillage) in all treatments, in-crop weed control timing was incrementally delayed based on weed height. A weed-free control treatment was given an additional residual herbicide application at pre-emergence and sprayed in-crop as necessary while the weedy control treatment was not sprayed after the initial pre-seed burn-off (or tillage). The experimental design was an RCBD with 4 or 5 replicates.

Soybeans were seeded at Arborg on 9” spacing using a R-tech double disc seeder at 200,000 seeds per acre. Weed-free control plots received Dicamba in addition to a glyphosate burn-off prior to seeding. Glyphosate was used for in-crop applications at 360 g ae per acre for both years. Dominant weeds at Arborg during the two years of study were lamb’s-quarters, wild buckwheat and green foxtail.

Table 3. Treatment list.

Treatment	Pre-Emerge Residual	Post-Emergent Herbicide	Weed Height at Application	Approximate Soybean Stage
Weed-Free Control	✓	✓	2-4”	V3
Weedy Check	✗	✗	-	-
Early Weed Control	✗	✓	2-4”	VC
Late Weed Control	✗	✓	4-6”	V1
Rescue Weed Control	✗	✓	8+”	V3

Table 4. Agronomic information and important dates

	Arborg 2023	Arborg 2024
Stubble, soil type	Wheat, heavy clay	Wheat, heavy clay
Seeding date	May 19	May 23
Seeding rate	200,000 seeds/ac	200,000 seeds/ac
Fertilizer applied	15 lb/ac P_2O_5 seed-placed	15 lb/ac P_2O_5 seed-placed
Pesticides applied	All: May 19 glyphosate Weed-free: June 1 dicamba Early: June 8 glyphosate Late: June 19 glyphosate Rescue: June 26 glyphosate	All: May 8 glyphosate Weed-free: May 8 dicamba Early: June 18 glyphosate Late: June 26 glyphosate Rescue: July 5 glyphosate
Harvest date	September 27	October 2

Effects of controlled drainage & sub-irrigation on soybeans

Project duration: 2023 and 2024 growing seasons.

Summary

This study investigated soybean (*Glycine max* (L.) Merr.) grain yield and yield components under controlled drainage and subirrigation through the tile drains. 2023 growing season was dry and sub-irrigation was applied through tile drains while 2024 growing season was wet and controlled drainage was used to manage soil water in the rooting depth.

Soybean yield was significantly higher (p = 0.05) in the sub-irrigated plots compared to the rainfed plots in 2023 growing season. Soybean yield was taken from strips on-tile, midway between tiles, and in the non-tile control plots. The on-tile treatment recorded the highest grain yield of 2820.9 kg ha^{-1}, followed by midway between tiles treatment with 2796.7 kg ha^{-1}. The rainfed plots resulted in the lowest grain yield of 2216.9 kg ha^{-1}. In 2024 growing season, soybean on controlled drainage recorded the highest grain yield although results were not significant. Sub-irrigating soybean through tile drains during drought and applying controlled drainage in a wet period were found to increase soybean grain yield.

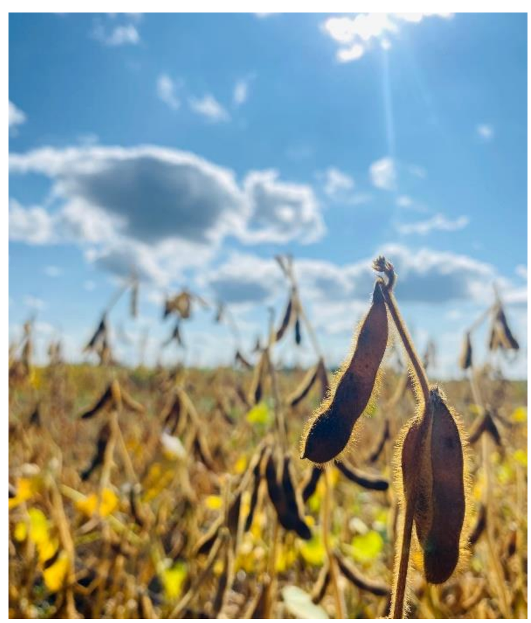
Procedures

The research was carried out at Prairies East Sustainable Agriculture Initiative (PESAI) site in Arborg, Manitoba during the 2023 and 2024 growing seasons. The climate is semi-arid (Bueckert and Clarke, 2013). Soybeans on tile (OT), midway between tile (BT), and no tile (NT) were evaluated. The on-tile treatment represents the experiment plot above the tile drains. Midway between tiles are the plots which were located between the tile drains and the no-tile was the treatment with no tile drains. The experimental field was sub-irrigated in 2023 (few times in the month of June) by applying water through the tile drains spaced at 15 feet while in 2024, controlled drainage was utilized due to wet weather conditions. Soybean variety DKB0008-87 was used with planting density of 180,000 plants per acre. Meter soil water sensors was used to collect soil moisture data at 20, 60, and 90 cm and grain yields were adjusted to 12% grain moisture.

Results

Weather conditions

The seasonal rainfall in 2023 was lower than the long-term average (2013-2022), while in 2024, the seasonal rainfall and the long-term average were the same. The 2023 season was dry while 2024 recorded normal rainfall. Air temperatures in 2023 were high at the beginning of the season and decreased towards the end of the season, while in 2024, the air temperatures were low at the early season and increased toward the development stage.



Soil water content dynamics

In both years, the rainfed or no tile plots showed water content above the field capacity during the vegetative and reproductive phases. The soil under study is heavy clay soil and the lack of subsurface drainage would result in the water content near saturation. The results indicated that during the growth, no tile plots had the highest number of days where the water content was above the field capacity, followed by midway between tiles and on-tile plots.

Grain Yield

Table 1 presents soybean yield and yield components for the drainage and rainfed plots in 2023 and 2024 growing seasons. In 2023 growing season where sub-irrigation through tile drains was applied, soybean yield was significantly higher in the sub-irrigated plots compared to the rainfed plots. On tile plots recorded the highest grain yield of 2820.9 kg ha^{-1}, followed by midway between tiles plots with 2796.7 kg ha^{-1}. The rainfed plots resulted in significant lowest grain yield of 2216.9 kg ha^{-1}. In 2024 growing season, drainage plots had relatively higher grain yield although the results were not significant.

Soybean root growth on rainfed (left) and drainage (right) plots during 2023.

Similarly, above ground biomass collected from the on-tile plots was higher than the rainfed no tile plots in 2023.

In summary, controlled drainage and sub-irrigation were crucial to stabilize soybean yield at this site which is subjected to rainfall irregularity with both drought and excess water conditions. In dry period, sub-irrigation is important to provide necessary moisture to the crop, whereas in wet period, controlled drainage is vital to manage appropriate soil water in the soybean rooting zone.

Table 1: Variation in the soybean yield and yield components between experimental treatments*

Year	Treatments	On tile	Midway between tiles	No tile
2023	Soybean yield (kg/ha)	2820.9a	2796.7a	2216.9b
	Above ground biomass (kg/ha)	6138.1a	5811.9ab	4922.3b
2024	Soybean yield (kg/ha)	3040.0a	2912.6a	2895.3a
	Above ground biomass (kg/ha)	6153.2a	5874.2a	5858.1a

*Values followed by different letters are significantly different at the 5% level ($p = 0.05$).

Reference

Bueckert, R.A. and Clarke, J.M. (2013) Annual crop adaptation to abiotic stress on the Canadian prairies: Six case studies. ***Canadian Journal of Plant Science***, 93(3), 375–385. Available from: https://doi.org/10.4141/cjps2012-184.

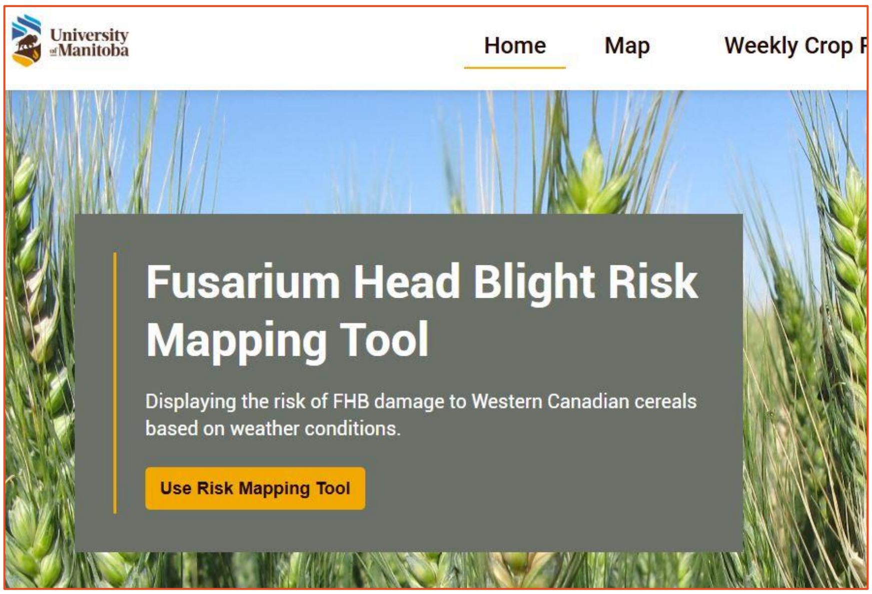
Improving Accuracy, Reliability and Capability of the Fusarium Head Blight (FHB) Risk Forecasting Models for Western Canadian Cereals under a Changing Climate

Project Duration: 2024

Collaborators
Paul Bullock (U of M), Manasah Mkhabela (MB Ag), Timi Ojo (MB Ag), Henrique Carvalho (U of M)

Background

In the spring of 2024, a new FHB risk forecasting online mapping tool (https://prairiefhb.ca/) was launched for the Prairies to enable grain producers to make timely decisions regarding FHB management, such as disease scouting and chemical control. The FHB risk assessment models for winter wheat, spring wheat, durum and barley underwent comprehensive validation and evaluation and initially achieved an accuracy rate of at least 70% or higher. However, it is essential to further enhance the reliability and robustness of these models by incorporating additional data to build a more extensive database of disease levels and weather conditions across different locations and years for the purpose of model testing.



In 2024, 3 varieties of spring wheat and barley, 2 winter wheat varieties, and one durum variety were selected for monitoring at select MCVET locations. These served as research plots for additional data for the FHB risk models. The varieties that were monitored were selected to provide representative FHB response to weather across a range of FHB resistance ratings.

Portable weather stations were installed adjacent to the plot sites to collect hourly weather data, including air temperature, relative humidity, rainfall, and solar radiation. The online mapping tool demonstrates FHB risk using three key indicators: the FHB index (FHBi), deoxynivalenol (DON), and fusarium-damaged kernels (FDK). The FHBi disease response data were collected using non-destructive FHBi ratings performed on 50 heads during the grain filling stage in each replicate of each selected variety. The DON and FDK were determined using commercial lab analysis of approximately 1 kg of the grain samples from each replicate of each selected variety.

List of the selected varieties grown at Beausejour & Arborg sites (in MCVET) for FHB disease rating and lab analysis.

Crop	Variety	FHB Resistance Rating
Spring Wheat	AAC Darby VB	Intermediate
	AAC Dutton	Moderately Resistant
	AAC Perform	Moderately Susceptible
Barley	CDC Austenson	Intermediate
	AAC Stockton	Moderately Resistant
	AAC Lariat	Moderately Susceptible
Winter Wheat	AAC Coldfront	Intermediate
	Emerson	Resistant
Durum	AAC Donlow	Moderately Susceptible

Results

		FDK % (mean)		DON ppm (mean)		FHBi % (mean)	
	Sample size	Beausejour	Arborg	Beausejour	Arborg	Beausejour	Arborg
Spring Wheat	9	0-0.2 (0.12)	0-0.2 (0.06)	0-0.2 (0.07)	0.1-0.4 (0.17)	0-8 (3.42)	0.11-6.63 (2.81)
Winter Wheat	6	0.1-0.3 (0.1)	0.2-1.4 (0.82)	0-0.2 (0.08)	0.2-2 (1.05)	0.4-2 (0.87)	1.6-5.73 (3.14)
Durum	3	0.3-2.8 (1.17)	0.1-0.2 (0.17)	0.5-2.8 (1.63)	0.2-0.3 (0.23)	1.32-7.07 (3.94)	0.72-4.32 (2.6)
Barley	Arborg - 9, Beausejour-6*	0.2-1 (0.53)	0.1-1 (0.37)	0-0.1 (0.3)	0-0.1 (0.09)	0.35-1.95 (1.15)	0.38-2.2 (0.75)

** The third replicate of barley in Beausejour was discarded due to poor stand, hence samples and disease data were only taken from 6 plots (first and second replicates).*

FHBi

The durum wheat in Beausejour had the highest mean FHBi levels of 3.94%, while barley in Arborg had the lowest mean of 0.75% in 2024 growing season. The mean FHBi for spring wheat, winter wheat, durum wheat and barley were 3.42, 0.87, 3.94 and 1.15% in Beausejour, and 2.81, 3.14, 2.6 and 0.75% in Arborg, respectively. Beausejour had higher FHBi levels than Arborg for all crops except winter wheat.

In general, winter wheat in Arborg had higher FDK, DON and FHBi than Beausejour, suggesting a greater FHB risk at this location for winter wheat. Beausejour had higher FHB risk in durum wheat and barley demonstrated by all three indicators. Arborg spring wheat had higher DON, but demonstrated lower FDK and FHBi than Beausejour.

DON (Deoxynivalenol)

DON levels were highest in durum wheat grown in Beausejour, with a mean of 1.63 ppm, while spring wheat in Beausejour showed the lowest mean DON level of 0.07 ppm. In Beausejour, mean DON levels in spring wheat, winter wheat, durum wheat and barley were 0.07, 0.08, 1.63 and 0.3 ppm, respectively. In Arborg, mean DON levels in spring wheat, winter wheat, durum wheat and barley were 0.17, 1.05, 0.23 and 0.09 ppm, respectively.

FDK (Fusarium Damaged Kernels)

The durum wheat grown in Beausejour had the highest FDK levels, with the highest mean of 1.17%. In contrast, spring wheat in Arborg had the lowest FDK level of 0.06%. The mean FDK for spring wheat, winter wheat, durum wheat and barley were 0.12, 0.1, 1.17 and 0.53% in Beausejour, and 0.06, 0.82, 0.17 and 0.37% in Arborg, respectively. Beausejour had higher FDK levels than Arborg across all crops except winter wheat.