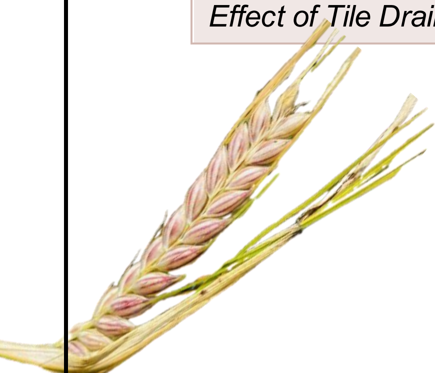



PESAI

2023 PESAI ANNUAL REPORT



2023 Public / Industry Partners

- Agassiz Soil & Crop Improvement Association, Beausejour
- Nutrien Ag Solutions Arborg & Rosebank MB
- Manitoba Crop Alliance
- Manitoba Crop Variety Evaluation Team
- Manitoba Pulse & Soybean Growers Association
- Manitoba Agriculture
- Parkland Crop Diversification Foundation (PCDF)
- Seed Manitoba
- Department of Biosystems Engineering, University of Manitoba
- Saskatchewan Crop Development Centre
- Manitoba Flax Growers Association
- Westman Agricultural Diversification Organization Inc. (WADO)
- Ducks Unlimited
- BASF
- Foster Ag Services Arborg
- Paterson Grain Arborg
- Brian Kurbis Farms (Near Dencross)
- Western Ag Lab
- Department of Plant Sciences, University of Manitoba
- Department of Soil Sciences, University of Manitoba
- SeCan
- Manitoba Forage & Grassland Association
- Syngenta

PESAI: Who we are?

Prairies East Sustainable Agriculture Initiative Inc. (PESAI) is a not-for-profit organization (incorporated in December 2005) serving the Interlake & Eastern Prairie region of Manitoba. It is one of the four Manitoba Diversification Centres (DCs), including Parkland Crop Diversification Foundation (PCDF) – Parkland Region, Westman Agriculture Diversification Organization (WADO) – Southwest Region and Manitoba Crop Diversification Centre (MCDC) – Central Region (Fig.1).

PESAI

This initiative is a collaborative partnership between the agricultural communities of Interlake / Eastern Manitoba and Manitoba Agriculture. PESAI's objective is to support applied production research, crop diversification and value-added opportunities in the Eastern and Interlake areas. PESAI receives majority of its funds from the Agricultural Sustainability Initiative and Canadian Agricultural Partnership programs. Additional funding comes from the MCVET committee and other Industry partners for the contract plot work that PESAI is able to provide to these organizations.

Headquartered in Arborg, PESAI also does research work at Beausejour site. PESAI focuses on applied field research, innovation, diversification, value-added, advanced technology, market development and sustainability initiatives that directly benefit local area producers. The research results are communicated by various extension programs such as plot demonstrations; crop tours, seminars & workshops, annual reports & DC's website.

2023-24 Board of Directors

An elected Board comprised of agricultural producers and entrepreneurs from the Eastern Prairie region directs PESAI activities (Table 1). Staff from Manitoba Agriculture / PESAI help to carry out PESAI activities (Table 2).

Table 1. PESAI Board of Directors during 2023-24 year.

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

Table 2. PESAI / Manitoba Ag Staff during 2023-24.

Position	Name	Organization
Applied Research Specialist	*Dr Nirmal Hari*	*Manitoba Agriculture*
Applied Research Technician	*James Lindal*	*Manitoba Agriculture*
Applied Research Technician	*Brett Sigurdson*	*PESAI*
Summer Research Assistant	*Keely Emms-Finnson*	*PESAI*
Technician	*Shaun Kendrick*	*PESAI*
Summer Research Assistant	*Emily Mazur*	*PESAI*

Extension Events during 2023

Why PESAI does extension?

1) To communicate with producers / Ag industry about PESAI research projects & partnership / job opportunities.
2) To encourage participants for PESAI membership

www.mbdiversificationcentres.ca

Twitter @ PESAIresearch

prairies.east@gmail.com

Here is the list of extension / outreach activities PESAI did during 2023-24:

- 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. A total of four projects were submitted and the following two projects were granted funding –
  1) Testing fall rye and oat mixtures for production (Brian Kurbis) - $4500
  2) Testing Eco Tea for enhancing crop production (Foster Ag Services) - $875

- PESAI's 2023-24 Annual Report was compiled and uploaded on Diversification Centre (DC)'s website (www.mbdiversificationcentres.ca).

- Individual project reports were also uploaded on DC's website. A total of 19 project reports are available on DC's website.

- During 2023-24, DC's website received 25,145 views, which were 14% greater than views in previous fiscal year. The start of monthly DC's Newsletter made a significant difference, as it alone received 2,656 views in the fiscal year. PESAI is contributing to this newsletter every month.

- PESAI tweeted 22 times about its research and extension / job activities during 2023-24. These tweets made 10,406 impressions. PESAI tweets can be accessed using twitter handle @PESAIresearch.

- A soybean research tour was organized at PESAI plot site in Beausejour on September 7, 2023 where 25 people attended. Soybean variety selection and soybean agronomic issues were discussed during the tour.

- A sunflower research tour was organized at PESAI plot site in Beausejour on September 6, 2023 where 25 people attended. Sunflower variety selection and desiccation & harvesting challenges were discussed during the tour.

- PESAI manned a booth entitled "Manitoba's Diversification Centres" at Ag Days (Jan 2024) and Crop Connect Conference (Feb 2024), with its counter-parts 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 25, 2023 at Arborg site. More than 45 participants attended the tour and they interacted with speakers on tile drainage, GHG emissions and other talks. The tour was covered by Manitoba Cooperator.

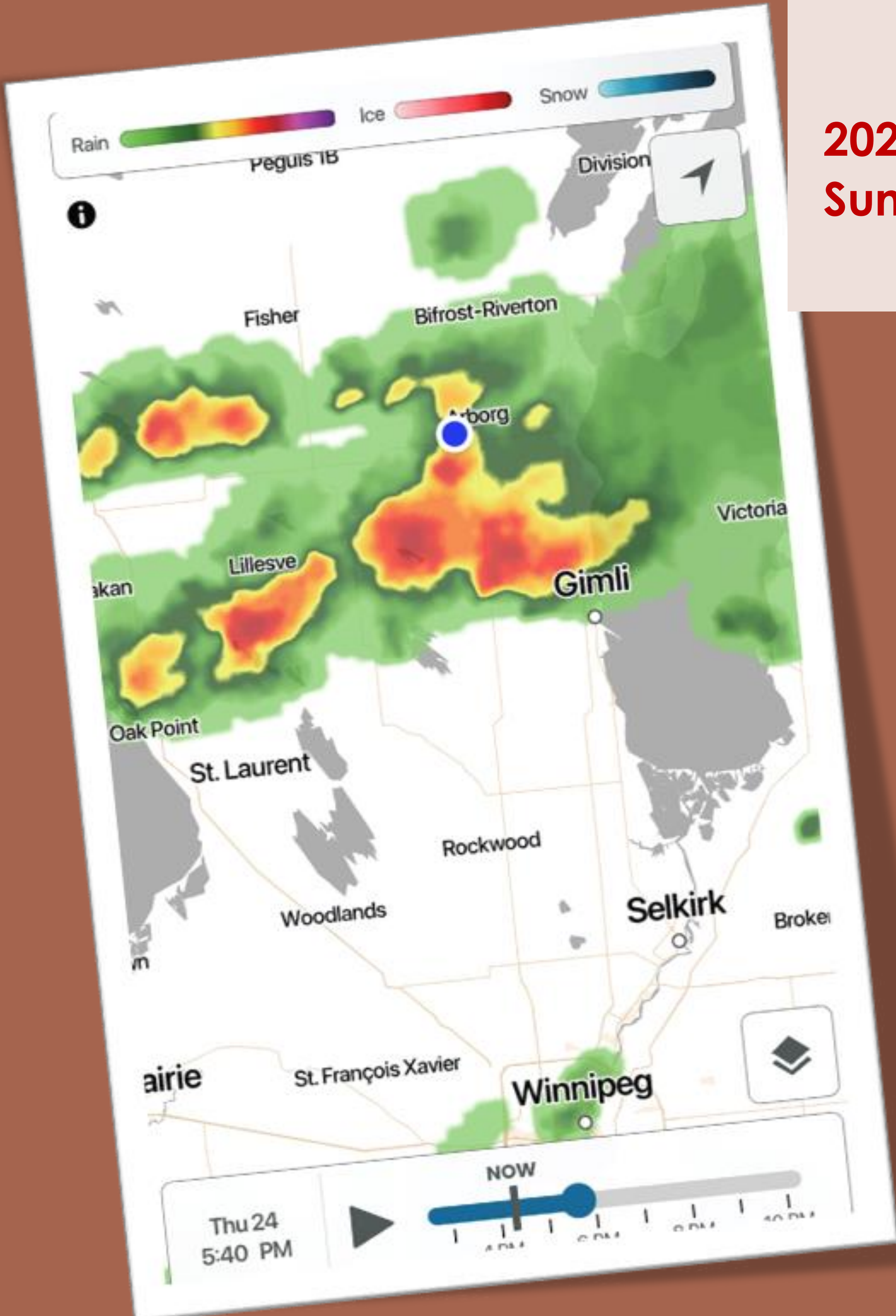
Table 1. List of the speakers and the topics covered at PESAI Crop tour.

Sub-surface irrigation strategies through tile drainage	*Komlan Koudahe, U of M*
Soybean herbicide timing	*Brodie Erb, U of M*
Incorporating legume cover crops in spring cereals	*Anne Kirk, Manitoba Ag*
Linking GHG emissions with N fertilizers	*Manasah Mkhbela, Manitoba Ag* *Brad Sperling, U of M*
Flax Seed treatments	*Morgan Cott, Manitoba Crop Alliance*

- PESAI's Annual General Meeting was held on April 3, 2023 at Half Pint Brewery in Winnipeg. Nirmal Hari presented on "Small Farming Systems in Northern India – Sustainability & Challenges" at the AGM. A total of 22 people attended the AGM.
- PESAI has set up its booth at Brokenhead River Ag Conference (Feb 7, 2024) and South Interlake Grain Day events (January 4, 2024).
- Nirmal Hari presented about "PESAI Research Program" at South Interlake Grain Day at Clandeboye (Jan 4, 2024).
- PESAI presented about its current research program and future directions during Ag Summit on Feb 7, 2024.
- PESAI members were sent 2023 MCVET evaluation results in December 2023.

PESAI sent its staff to attend the following conferences for the professional development:

  - *Manitoba Agronomists Conference – Winnipeg (Dec 2023)*
  - *Crop Connect Conference – Winnipeg (Feb 2024)*



2023 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 2023 growing season (May 1 - Sept 30), the Arborg site received 63% of the normal precipitation. The Arborg site received below average precipitation for the months of May (34%), June (37%), July (83%) and August (67%). September was the only month with slightly above average precipitation (102%). The dry spring affected crop germination especially in the winter cereals and small seeded crops like quinoa & teff.

Growing Degree-Days

During the 2023 growing season (May 1 - Sept 30), Arborg site received 117% of normal growing degree-days. The months of May and June had well above average growing degree days (146% & 131%, respectively) while July saw below average growing degree days (86%) with August at near normal growing degree days (102%). September had above average growing degree days (157%).

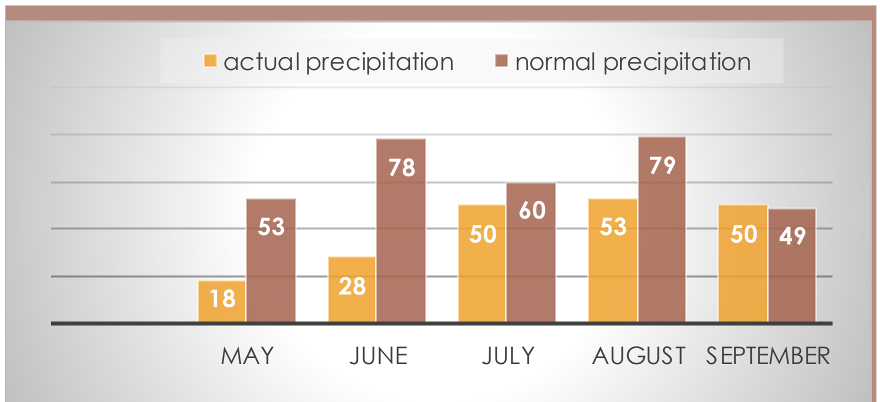


Figure 1. Monthly rainfall (mm) during 2023 crop season at Arborg site.

Corn Heat Units

Arborg site received 113% of the normal corn heat units during the growing season. The months of May and June received well above average corn heat units (May 133% and June 122%) while July received below average corn heat units (86%). August received near normal corn heat units (101%) and September received well above normal corn heat units (153%)

Overall, the growing season of 2023 begin with very dry and hot conditions during May & June followed by relatively less precipitation afterwards. Few trials were irrigated during early June to facilitate germination and early growth. Rainfall events were so scarce that the site received half an inch rainfall only four times (on June 20, Aug 21, Sep 4 & Sep 28) during the entire growing season.

Table 1. 2023 Arborg Seasonal Weather Summary.

May 1-Sept 30	Actual	Normal	% Normal
Growing Degree Days	1811	1554	117%
Corn Heat Units	2946	2616	113%
Precipitation (mm)	201	320	63%

Beausejour Site

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

Rainfall

During the 2023 growing season (May 1 - Sept 30), Beausejour received 70% of normal rainfall. Beausejour received 99% of normal rainfall in May. However, the months of June (64%) July (73%), August (54%) & September (67%) received below than normal precipitation.

Growing Degree Days

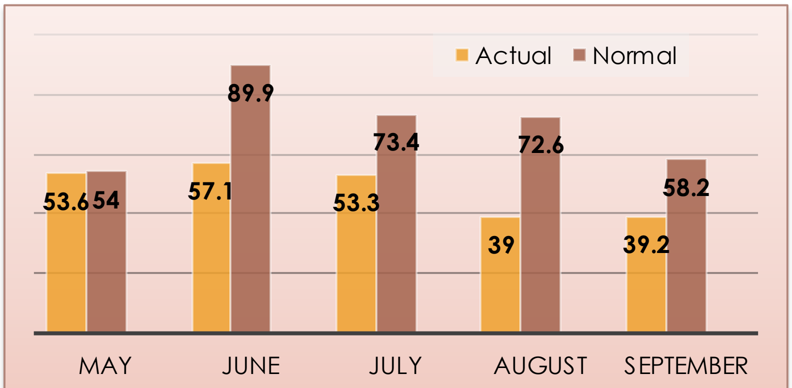


Figure 2. Monthly rainfall (mm) during 2023 season at Beausejour site.

During the 2023 growing season (May 1 - Sept 30), Beausejour received 115% of normal growing degree days. May and June received above normal growing degree days (May 151% & June 130%). July received below normal growing degree days (82%) whereas August had normal degree days (99.7%). September was again above normal with 147% growing degree days.

Corn Heat Units (CHU)

During the 2023 growing season (May 1 - Sept 30), Beausejour received 114% of normal corn heat units. Similar to growing degree days, May and June received above normal corn heat units (May 139% and June 126%) whereas July had below normal CHU (85%). August was slightly above normal with 103% while September was well above normal with 143% of normal corn heat units.

In Overall, Beausejour site received normal rainfall in May but below normal rainfall for the rest of the season. This site received above normal temperatures in the spring & fall but below normal temperatures in the month of July. Beausejour had a severe rain storm during late July which resulted in slight foliage damage in soybean plots. This storm caused significant losses to the tarp shed in the town.

Table 2. 2023 Beausejour Seasonal Weather Summary.

May 1-Sept 30	Actual	Normal	%Normal
Growing Degree Days	1855	1619	115%
Corn Heat Units	2990	2629	114%
Precipitation (mm)	242	348	70%

Comparing rainfall and temperature data from two types of weather stations

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 compared data on average daily temperature and precipitation from Automatic weather stations (AWS) & Manitoba Ag Weather stations (MAWS) to find out any correlation.

PESAI sites in Arborg and Beausejour had automatic weather stations installed around MCVET cereal plots. Arborg's AWS was stationed almost 700 m away from Manitoba Ag weather station, whereas in Beausejour both AWS & MAWS were separated by almost 7 miles.

Pearson correlation coefficient (r) was used to assess the strength of association between the measurements from both types 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. The data was analyzed using Minitab 18 software. We also calculated daily differences for average daily temperature and precipitation values using data from both sites.

Results

Arborg site

The average daily temperature (during May 10 – October 25) was measured slightly higher by AWS (16.2°C) than by MAWS (15.8°C), however, the differences were insignificant. A highly positive correlation coefficient (r = 0.984, p<0.0001) depicted agreement between both type of weather stations for temperature measurement. Daily differences for temperature were less than 1°C for most days with only six days when the differences were more than 2°C. The highest difference was 4.6°C on October 25.

Precipitation measurements (in mm, during May 10 – June 20) were quite similar by both types of weather stations with highly positive correlation coefficient (r = 0.980, p<0.0001). AWS stopped measuring precipitation after June 20 so the results are only for May 10 – June 20 period. There were 12 days during this period when at least one weather station recorded precipitation. The daily differences for precipitation were less than 1 mm except for only two days when the differences were close to 2 mm. During the period of study, Arborg site received significantly less precipitation than 30-year normal values with the highest daily precipitation (15.6 mm) on June 20.

Beausejour site

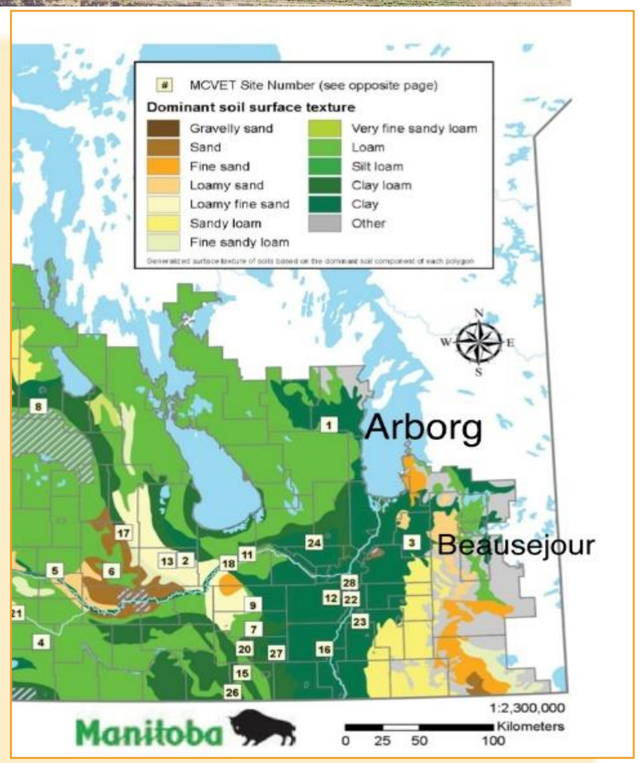
At this site, weather data were compared for 87 consecutive days during June 14 – September 8. Daily average temperature measurements were similar from both types of weather stations with a highly significant correlation ($r = 0.984$, $p<0.0001$). There was only one day during the entire study period when the temperature differences were more than 2°C between both type of weather stations.

Precipitation measurements, however, vary a lot between AWS & MAWS. AWS recorded a total of 203.3 mm precipitation during the entire 87-day period while MAWS had only 74.5mm. There were six days when the precipitation differences were more than 5 mm with the highest daily difference (24.9mm) on August 24. Ironically, there was a significant positive correlation ($r = 0.684$, $p<0.0001$) between both type of weather stations in estimating precipitation.

Conclusions

1) Both type of weather stations were quite consistent in measuring average daily temperature at both sites.
2) However, precipitation estimates seem to be quite unrelatable as the distance between two weather stations increased (Beausejour site). AWS at the Beausejour trial site reported almost three times of precipitation than by MAWS located 7 miles away.
3) Arborg precipitation values were quite comparable from both type of weather stations, but very low precipitation (a total of about 30 mm) during the study period and closer proximity (0.7 km) of AWS & MAWS might be the reasons for the lack of differences.
4) This emphasizes the need for more localized weather stations to be installed for correlating weather parameters with research plots.

Manitoba Crop Variety Evaluation Trials



PESAI has 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 in order 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 2023 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 all MCVET trials were accepted for publishing in SEED MANITOBA. Winter wheat plots at Beausejour site, however, got killed due to winter kill. Please visit SEED MANITOBA's website for MCVET testing results from Arborg & Beausejour sites.

Table 1. Agronomic details of 2023 MCVET trials conducted at Arborg & Beausejour 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	Canola	11-28	12-May	70-15	Aug 21	72
Oats	Canola	11-28	12-May	70-15	Aug 28	39
Barley	Canola	11-28	12-May	70-15	Aug 21	69
Winter Wheat	Canola	21-24	19-Sep	30-20 (at seeding) 100-0 (broadcasting in spring)	03-Aug	21
Fall Rye	Canola	21-24	19-Sep	30-20 (at seeding) 100-0 Broadcasting in spring	03-Aug	21
Peas	Wheat	25-18	12- May	0-15	Aug 28	54
Conv. Soybeans	Wheat	19-18	16-May	0-15	Sep 27	78
HT Soybeans	Wheat	19-18	16-May	0-15	Sep 17	135
Silage Corn	Soybeans	85-49	15-May	135-15	Sep 22	108
Flax	Wheat	25-18	15-May	25-15	Sep 26	36
Annual Forages	Canola	15-66	16-May	40-15	Aug 3 - 24	42
BEAUSEJOUR						
Winter Wheat	Fallow	60-10	14-Sep	30-20	Winter kill	21
Fall Rye	Fallow	60-10	14-Sep	30-20 (at seeding) 100-0 (broadcasting in spring	04-Aug	21
Spring Wheat	Fallow	35-17	23-May	55-15	Aug 30	39
Oats	Fallow	35-17	23-May	55-15	Aug 30	30
Barley	Fallow	35-17	23-May	55-15	Aug 30	51
Conv. Soybeans	Fallow	35-17	23-May	0-15	16-Oct	78
HT Soybeans	Fallow	35-17	23-May	0-15	16-Oct	135
Grain Corn	Soybeans	39-19	May 16	100-15	Oct 19	90
Sunflowers	Wheat	39-17	May 16	90-15	Oct 11	69

Testing MCVET Annual Forages in Interlake

Project Duration

2021-2023

Objectives

To test different crop types (& varieties) of annual forages for yield and feed quality

Collaborators

- MCVET
- Shawn Cabak, Manitoba Agriculture

Results

The year 2023 was a dry year at Arborg site and the site received very low precipitation between May 15 – June 15 period. The plots were irrigated (about 0.5 inch) once around June 10 to facilitate early growth of forage plots. Millets & spring triticale had significantly low forage yield (Table 1), whereas CDC Renegade variety of Barley & forage sorghum produced higher yield. The mixtures of peas & barley also produced good forage yield with the added advantage of more crude protein (CP) content in the forage. Most forage species or mixtures had relative feed value (RFV) greater than 100 except from the plots of CDC Arborg (oats), foxtail millet, sorghum Sudan grass & forage sorghum.

Table 1. Relative performance of different annual forages (or mixtures) at Arborg site in 2023.

Crop	Variety	Forage Yield	CP (%)	TDN (%)	RFV
Oats	CDC Haymaker	5.3	8.1	62.4	100
Oats	CDC Arborg	5.8	10.2	61.4	98
Oats	CDC Endure	4.9	10.2	61.5	102
Oats	OT6036	5.1	9.5	64.5	109
Oat Average			**9.5**	**62.5**	**103**
Barley	AB Advantage	6.1	9.3	70.6	138
Barley	AB Tofield	5.9	7.7	74.4	162
Barley	CDC Renegade	7.0	7.5	70.9	150
Barley Average			**8.2**	**72.0**	**150**
Peas/Barley	CDC Lewochko - AB Advantage	6.1	13.6	68.6	109
Peas/Oats	CDC Lewochko - CDC Arborg	5.8	9.9	67.0	116
Pea/cereal Average			**11.8**	**67.8**	**113**
Spring Triticale	Pronghorn[2]	3.2	11.4	67.1	122
Proso Millet	Crown[2]	2.7	10.4	66.0	108
Foxtail Millet	Siberian[2]	2.8	8.4	61.6	98
Millet Average			**9.4**	**63.8**	**103**
Sorghum Sudangrass	common[2]	6.0	7.1	60.5	91
Forage Sorghum	common[2]	6.8	9.7	63.9	97
Sorghum Average			**8.4**	**62.2**	**94**
Grand Mean (tonnes/acre)		5.3			
CV %		13.7			
LSD (0.05)		1.2			
Sig Diff		yes			
Seeding Date		16-May			
Harvest Date		July 26 to Aug 24			

1 Dry matter yields measured under a one-cut system.
2 Due to lack of availability, common seed was used.

Dry matter forage yield in tones /acre; CP – Crude protein; TDN – Total digestible nutrients

Project Findings

Forage species differed in dry matter forage yield when tested at Arborg site during 2023. Proso and foxtail millets had the lowest forage yield whereas sorghum and one variety of barley produced higher forage yield.

Weather is a predominant factor in determining forage yield and 2023 Arborg weather did affect the performance of crop species tested at the site. The Arborg site received below average precipitation for the months of May (34%), June (37%), July (83%) and August (67%).

Dry weather during the months of May & June halted the growth of plots although the irrigation given on June 10 helped plots somewhat for the crop growth. Most forage plots were harvested by early August except sorghum & sorghum Sudan grass plots. These plots benefitted from August 1st rain (about 21mm) to grow for three more weeks.

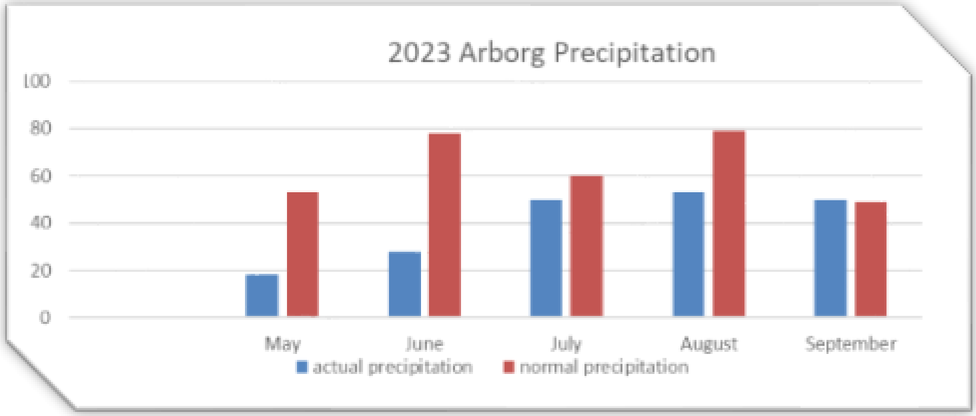


Figure 1. Monthly average precipitation (mm) at Arborg site during 2023.

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.

Table 2. Performance of annual forage species (or mixtures) at Arborg site during 2021-23.

Crop Type	**Variety (s)**	***Dry Matter Forage Yield (tonnes / acre)*** 2021	2022	2023
Oats	CDC Haymaker	4.0 cde	3.9 de	5.3 b
	CDC Arborg	3.3 b	3.8 cde	5.8 b
Barley	AB Advantage	3.7 bcd	3.2 bc	6.1 b
Peas / Barley	CDC Jasper (21), CDC Lewochko (22/23) / AB Advantage	4.6 e	3.5 cd	6.1 b
Peas / Oats	CDC Jasper (21), CDC Lewochko (22/23) / CDC Arborg	3.1 ab	4.4 e	5.8 b
Spring Triticale	Common (2021) Pronghorn (22/23)	2.3 a	4.0 de	3.2 a
Foxtail millet	Golden German (21/22) Siberian (23)	4.3 de	1.5 a	2.8 a
Red Proso millet	Cerise (21) Crown (22/23)	3.7 bcd	1.0 a	2.7 a
Sorghum-Sudangrass	Common	3.4 bc	2.8 b	6.0 b
Seeding / Harvesting dates		May 19 July 27	May 24 July 29-Aug 25	May 16 July 26-Aug 24
Precipitation* (% of normal)		55	189	56

**Precipitation values during May 15 – Aug 15*

Table 2 presents the summary of annual forage testing during 2021-2023 at Arborg site. The years 2021 & 2023 were dry and both years received about 55% of the normal rainfall during May 15 – August 15 period. On contrary, 2022 was a wet year and received almost 3.5 times more rainfall than 2021 & 2023 during the same period.

CDC Haymaker oats produced higher forage yield across all the three years, whereas CDC Arborg oats had relatively good yields only during 2022 & 2023. Pea / barley mixtures were the top performers in 2021 & 2023 but not in 2022. On the other hand, pea / oats mixtures produced higher forage yield during 2022 & 2023 but not in 2021.

Spring triticale, foxtail millet & sorghum Sudan grass produced relatively higher yield only in 1 / 3 years.

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-Sudan, 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, 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 canola stubble in heavy clay soil. Plots were organized in a randomized complete block design (with 3 replications) in which 14 forage species (or blends) were tested (Table 1). Plots were seeded on May 16th with R-Tech double disc plot seeder.

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 (lbs/acre) was applied at a rate of N:40 – P:15. Nitrogen was mid row banded and the phosphorus was applied in the seed row. 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 July 26 – Aug 24. Sorghum and sorghum-Sudan grass plots were harvested on Aug 24 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 / Sorghum:** 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.

Testing MCVET Sunflower varieties in Eastman region

Project Duration
2023

Objectives
To evaluate the yield potential of sunflower varieties (oilseeds & non-oils) in Eastman region.

Collaborators
Daryl Rex, Manitoba Crop Alliance

Results

Sunflower variety trials were conducted at Elm Creek, Carberry, Rossendale, Melita and Beausejour sites during 2023. At Beausejour site, the tested sunflower varieties differed in their yield potential both for oil and non-oil types (see Tables 1 & 2).

In oilseed sunflowers, the yield varied from 2619 – 4046 lbs / acre (at 15.5 % moisture). Among all oilseed varieties tested, NSC-SF92 recorded the highest yield followed by variety N4H161CL. Differences also existed among varieties for plant height and days to maturity. The plants of variety N4H161CL were significantly shorter whereas variety NSC-SF92 had tallest plants in the test. The variety NSC-SF92 also took greater number of days to mature whereas N4H161CL was the early maturing variety and it took only 111 days to reach physiological maturity.

Table 1. Performance of sunflower varieties (oil type) at Beausejour site during 2023.

Hybrid	Herbicide/ Disease Tolerance	Oil Type	Company	Yield (lb/ac)	Moisture (%)	Maturity[1] (days to R9)	Height (inches)	Test Wt[2] (lb/bu)	Oil (%)
CP432E	ExSun	NS	WinField United / CROPLAN	2989	13.0	117	58	31.6	48.0
CP455E	ExSun	HO	WinField United / CROPLAN	3182	14.3	124	56	31.3	46.7
N4H302 E	ExSun	HO	Nuseed	2907	13.9	123	52	27.9	46.4
P63HE60	ExSun/DM	HO	Pioneer Hi-Bred	2941	13.8	120	60	31.7	47.0
P63ME80	ExSun/DM	NS	Pioneer Hi-Bred	2619	13.9	123	56	29.5	50.4
P63HE501	ExSun	HO	Pioneer Hi-Bred	3047	13.4	118	55	30.1	44.9
Talon	ExSun/DM	NS	Nuseed	3273	12.7	117	55	28.3	46.6
N4HM354	CL	NS	Nuseed	3288	15.9	123	49	31.1	48.3
N4H161 CL	CL	HO	Nuseed	3566	15.9	111	40	33.7	44.6
Experimental lines being tested/proposed for registration in Canada									
N4H202 E	ExSun	NS	Nuseed	3182	12.4	121	48	27.2	49.2
N4L215 E	ExSum	NS	Nuseed	2675	12.6	123	48	27.7	49.0
AC2301	IMI Plus	HO	RAGT SEMENCES	2828	13.2	123	64	27.3	46.8
NSC-SF83	--	NS	NorthStar Genetics	2622	14.9	125	59	31.6	44.1
NSC-SF92	--	NS	NorthStar Genetics	4046	16.2	126	65	31.5	45.1
P63HE920	ExSun	HO	Pioneer Hi-Bred	2693	14.9	124	59	34.1	46.6
Site Average				3065	14	121	55	-	-
CV%				10.87	7.46	0.93	8.15	-	-
Sign Diff				Yes	Yes	Yes	Yes	-	-
LSD (0.05)				556	1.8	2	7	-	-
Planting Date				May 16, 2023					
Desiccation Date									
Harvest Date				October 10, 2023					

1 Physiological maturity for sunflowers is R9, where the bracts on the head are almost completely brown.
2 Test weights are reported in lbs per Avery (Canadian) bushel.
Refer to the MCA website at www.mbcropalliance.ca for more details.

In non-oil type sunflower variety test, the yield varied from 2268 – 3208 lbs / acre. The variety NDKM16761 had the lowest yield, whereas the variety Panther DMR along with four experimental lines were the top performers. These non-oil type varieties had significant differences for plant height and days to maturity.

Project Findings

Sunflower varieties differed in their yield potential at Beausejour site during 2023. For more information, please contact Manitoba Crop Alliance.

Table 2. Performance of non-oil type sunflower varieties at Beausejour during 2023.

Hybrid	Genetic Trait	Company	Yield (lb/ac)	Moisture (%)	Maturity[1] (days to R9)	Height (inches)	Lodging[2] (1-9)	2023 Seeding Sizing (%)[3]			Test Wgt[4] (lb/bu A)
								>22/64	>20/64	<20/64	
6946 DMR	DM	Nuseed	2698	11.3	117	55	2.5	12	41	46	25.5
Panther DMR	DM	Nuseed	3151	11.9	117	52	1.0	41	41	18	24.3
Experimental lines being tested/proposed for registration in Canada											
EX 359239	ExSun	MCA	3078	11.6	118	60	1.0	89	6	6	24.8
EX 20306	ExSun	MCA	3118	10.8	114	52	1.0	83	11	6	24.0
EX 200239	ExSun	MCA	3208	11.2	117	60	1.0	82	13	5	24.9
NJKM65823	IMI	Nuseed	2677	12.2	119	53	3.2	56	28	15	23.0
NDKM15700	IMI	Nuseed	2937	10.3	113	52	1.2	66	25	9	21.2
NDKM16761	IMI	Nuseed	2268	10.6	114	52	1.3	48	35	18	21.5
Site Average			2892	11.2	116	55	1.5	-	-	-	23.6
CV %			7.00	2.76	1.46	5.85	24.33	-	-	-	3.12
Sign Diff			Yes	Yes	Yes	Yes	Yes	-	-	-	Yes
LSD (0.05)			355	0.5	3	6	0.6	-	-	-	1.3
Planting Date			May 16, 2023								
Desiccation Date			September 22, 2023								
Harvest Date			October 11, 2023								

1 Physiological maturity for sunflowers is R9, where the bracts on the head are almost completely brown.
2 Lodging score is 1=0%; 3=30% lodged
3 Totals may not add to 100% due to rounding
4 Test weights are reported in lbs per Avery (Canadian) bushel.

Background / References / Additional resources

Sunflowers are grown on roughly 75,000 acres in Manitoba. Almost all the sunflowers produced in Canada are grown in Manitoba (Manitoba Crop Alliance, 2023). Sunflowers require a generous, frost-free growing season. They are typically planted in mid-May and harvested in October. Sunflowers are categorized as oil or non-oil (confection). Large, non-oil sunflower seeds are sold for human consumption as a snack or baking ingredient and smaller seeds are marketed as birdseed. Oil sunflower seeds are crushed to produce sunflower oil, which is also marketed largely for human consumption. Sunflower meal is a byproduct of sunflower crushing that is sold as a high-protein ingredient in livestock feed. These trials were conducted to see production potential of different sunflower varieties / lines in the Eastman region.

References

Manitoba Crop Alliance (2023) Crop Profiles: Sunflowers. https://mbcropalliance.ca/market-development-access/crop-profiles/sunflower/

Materials and Methods

Experimental Design – Randomized block design with three replications
Treatments – 23 sunflower varieties (see Tables 1 & 2)
Plot size – 18m²
Plant population – 17,000 plants/acre for Confections; 21,000 plants/acre for Oilseeds
Data collected – plant stand, plant height, days to flowering (R5.1), days to maturity, disease ratings, yield

Agronomic information

Stubble, soil type – Corn, Heavy clay
Fertilizer applied – N 90 lbs/ acre, P 15 lbs/acre

Pesticides applied (grams or liters per acre) –

24-May	*Glyphosate 540 (Round Up)*	*1000 ml*
23-Jun	*Assure*	*300 ml*
21-Jul	*Lance*	*175 grams*
21-Jul	*Headline*	*165 ml*
4-Aug	*Matador*	*34 ml*

Seeding/Harvesting date – May 16 / Oct 10

Testing MCVET Silage corn varieties in Interlake region

Project Duration
2023

Objectives
To evaluate the yield potential of silage corn varieties in Interlake region.

Collaborators
Daryl Rex, Manitoba Crop Alliance

Results

Variety trials for silage corn were conducted at Elm Creek, St. Pierre and Arborg sites during 2023. At Arborg site, the tested silage corn varieties differed in their yield potential (see Table 1). The yield varied from 11.3 – 18.0 Mt/acre (at 65% moisture). Among all varieties tested, NK8204-V recorded the highest yield, while variety MS 6960R had the lowest yield. Moisture content at harvest also varied (range: 43.6 – 64.3%) among corn varieties. Similarly, corn varieties also differed in 50% silking period and the variety 924S took highest number of days (81) to reach this stage. The detailed results on quality analysis are presented in the Table 1.

Project Findings

Silage corn varieties differed in their yield potential at Arborg site. For more information, please contact Manitoba Crop Alliance.

Background / References / Additional resources

Now with the short-season corn varieties available, producers have more options to grow silage corn in Manitoba especially in the Interlake region. Manitoba Crop Alliance coordinates varietal evaluation of potential new silage corn varieties in the province. These varietal trials were done at different sites in the province and Arborg was one of the evaluation sites. This trial was conducted to see production potential of different silage corn varieties in the Interlake region.

Materials and Methods

Experimental Design – Randomized block design with three replications
Treatments – 36 silage corn varieties (see Table 1)
Plot size – 18m^2
Plant population – 32,000 plants/acre
Data collected – plant stand, 50% silking, yield

Agronomic information

Stubble, soil type – Soybeans, Heavy clay
Fertilizer applied – N 135 lbs/ acre, P 15 lbs/acre
Pesticides applied – Dicamba @ 161 ml/acre (June 1), Lontrel @ 200 ml (June 21)
Seeding/Harvesting date – May 15 / Sep 22

Table 1. Performance of silage corn varieties at Arborg site during 2023.

CHU[1] Rating	Hybrid	Trait[2]	Arborg[6] 65% Yield (Mt/ac)	Moisture[3] (%)	50% Silk (days)	TDN (%)	ADF (%)	NDF (%)	Milk/Acre[4] (lbs/ac)	Beef/Acre[5] (lbs/ac)
1925	TH6370 VT2P	6	14.9	43.6	70	73.3	23.7	44.2	18187	1399
2000	MS 6960R	4	11.3	49.8	71	65.8	30.8	53.6	14191	954
2025	CX23072A/VT2P	6	13.6	60.3	76	74.7	22.4	41.8	16667	1305
2075	DKC21-36RIB	6	11.9	47.6	71	74.6	22.5	41.9	14338	1139
2075	EXP072-23	6	13.0	54.5	71	73.1	23.9	44.3	15667	1216
2100	CP1440VT2P/RIB	6	15.6	57.2	72	79.3	18.1	35.4	19328	1587
2100	CSX22077A/RR	4	15.0	56.6	73	72.8	24.2	44.2	18474	1400
2100	DKC24-06RIB	6	13.9	52.8	72	75.3	21.8	41.3	16951	1341
2100	PV 60273RIB	6	15.6	50.2	71	78.0	19.3	38.3	19083	1564
2100	Rustler	14	12.7	52.8	73	73.5	23.5	43.6	15404	1200
2150	913S	4	15.7	57.6	75	71.4	25.5	45.6	19143	1434
2150	MZ 1340DBR	6	13.4	49.9	71	77.7	19.6	37.9	16629	1337
2200	AS1018G2 EDF	6	17.6	48.5	71	75.8	21.4	41.2	21702	1712
2200	DLF 2320RR	4	13.2	53.2	72	73.0	24.0	43.5	16309	1232
2200	MS 7420R	4	13.5	48.5	71	67.3	29.3	51.7	16352	1164
2200	PV 61177SRR	4	14.3	57.6	73	75.5	21.7	40.6	17255	1382
2200	Riel	14	16.5	58.3	71	71.7	25.3	45.9	20531	1516
2225	TH6278 VT2P	6	15.2	56.4	72	78.4	19.0	36.7	18484	1529
2250	HZ 1685	19	14.4	59.6	75	73.2	23.8	43.6	17219	1350
2250	MS 8022R	4	17.1	59.0	72	75.0	22.2	41.8	21253	1648
2275	924S	4	15.9	64.3	81	75.4	21.8	41.4	18659	1542
2275	DLF 2333RR	4	16.0	58.1	71	75.0	22.1	41.2	19431	1536
2300	TH6180 VT2P	6	16.2	55.4	71	75.1	22.1	40.5	19825	1558
2300	X22080A/VT2P	6	12.6	61.2	79	72.2	24.8	44.3	15297	1162
2325	928S	4	15.4	64.3	80	69.1	27.7	50.3	17635	1369
2325	DLF 2495RR	4	17.6	60.8	73	73.9	23.1	42.5	22016	1669
2350	AS1028G2 EDF	6	17.4	54.6	76	73.4	23.6	43.3	21676	1635
2350	HZ 1831	19	13.8	60.1	75	75.2	21.9	43.0	16524	1328
2350	HZ 675	19	13.6	61.3	76	71.5	25.4	46.5	16326	1243
2350	NK7837-V	27	15.2	54.8	75	78.2	19.2	37.9	18594	1523
2400	A4705HMRR	4	14.8	60.7	70	72.6	24.4	44.1	18194	1382
2400	NK8005-V	27	16.5	56.2	74	76.7	20.5	38.5	20183	1624
2450	HZ 2220	19	15.0	61.3	76	72.2	24.7	45.2	18433	1394
2525	EXP8223-AA	28	12.4	42.2	70	76.5	20.8	39.7	15015	1216
2525	X22084A/VT2P	6	14.6	60.7	74	75.3	21.9	41.0	17655	1407
2550	NK8204-V	27	18.0	59.7	76	74.5	22.6	41.5	22103	1720
		Mean	14.8	55.8	73					
		CV %	11.72	4.85	1.97					
		LSD (0.05)	2.4	3.7	2					
		Sig diff	Yes	Yes	Yes					
		Planting Date			May 15					
		Harvest Date			Sept 22					

Establishing an Annual Crop-Living Mulch System at Four Manitoban Locations

Project Duration
2023-2024

Objectives

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

Collaborators

1) Jessica Frey, Parkland Crop Diversification Foundation
2) Joanne Thiessen Martens, Dept of Soil Sciences, U of M
2) Manitoba Crop Alliance
3) Prairies East Sustainable Agriculture Initiative
5) Manitoba Crop Diversification Centre
6) Westman Agricultural Diversification Organization

Background

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

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

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

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

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

Materials and Methods

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

Table 1: Description of the treatments.

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

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

Table 2: Site Profiles during 2023.

	Arborg	**Carberry**	**Melita**	**Roblin**
Soil Sample Date	08-May	28-Apr	28-Apr	27-Apr
Stubble	Canola	Canola	Canola	Millet
Soil Preparation	Direct seed	Direct seed	Direct seed	Direct seed
Seeding Date	15-May	12-May	10-May	12-May
Moisture at Seeding	dry	good	Very good	poor
Added N	All sites background N topped up to 140 lb/ac			
Added P	All sites applied P to match 70 bu/ac target yield			
Pre-emergence spray	May 31 Pardner @ 0.4 L	May 8 Glyphosate @ 0.8L + Heat @ 60ml	May 10 Roundup @ 0.67L + Aim @ 20ml	Glyphosate @ 0.64 L
Mid-season spray	Jul 14 Pardner @ 0.4L	Jun 19 Basagran Forte @ 0.8 L + UAN @ 1.6L	Jun 1 Koril @ 0.5L (3 leaf)	Jun 21 Axial @ 0.5L + Basagran Forte @ 0.7L
Anthesis	12-Jul	06-Jul	27-Jun (heading)	28-Jun
Soft Dough	first week August	20-Jul	17-Jul	03-Aug
Reseed	NA	30-Aug	05-Sep	NA

Table 3: Seasonal Weather Data from various sites (January 1 to December 21 2023).

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

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

Table 4: Seeding rate by crop type.

Crop type (variety)	Seeding rate
Wheat (Landmark)	250 plants/m^2
Alfalfa (Stellar II)	12 lb/ac
Red Clover (Single Cut)	10 lb/ac
Sweet Clover (Yellow Blossom)	10 lb/ac
White clover (Bombus)	6 lb/ac
Perennial Ryegrass (Soraya)	12 lb/ac

Results and Discussion

Plant establishment

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

Table 5: Wheat Establishment (plants/m^2) at different sites during 2023 (target plant stand - 250 plants/m^2).

Treatment	Arborg	Carberry	Melita	Roblin
Seeding Date	May 15	May 12	May 10	May 12
Date of plant count	May 30	May 30	May 23	May 29
Wheat-only Control	351	255	234	122a
Sweet Clover	368	225	224	80ab
Alfalfa	401	276	248	56b
Red Clover	374	266	254	81ab
White Clover	410	264	251	76ab
Perennial Ryegrass	377	280	253	72ab
SEM	27	2	21	12
p-value	0.7	0.4	0.9	0.03

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

Table 6: Mulch Establishment (plants/m²) at different sites during 2023.

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

Summer Wheat Biomass

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

Table 7: Wheat Biomass (Kg/ha) at soft dough at different sites during 2023.

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

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

Table 8: Summer Mulch Biomass (kg/ha) at different sites during 2023.

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

Anomalies

The following anomalies occurred at the participating sites:

- At Melita, all mulch crops were killed due to a spraying error of Bromoxynil. These plots were reseeded after the wheat harvest, with the aim of continuing the trial in Year 2.
- At Carberry, red clover, white clover, and perennial ryegrass was reseeded at the end of summer, due to negligible emergence for those crops.
- At Arborg, red clover and white clover produced very low amounts of biomass, but based on the plant counts, the crops were not reseeded. The plants are expected to produce sufficient biomass in Year 2.

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

Wheat Yield and Protein

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

Table 9: Wheat Yield (bu/ac) and Protein content (%) at different sites during 2023.

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

Post-harvest Mulch Performance

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

Table 10: Post-harvest mulch performance (kg/ha) at different sites during 2023.*

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

** R = Reseeded after wheat harvest*

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

Discussion

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

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

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

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

Summary

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

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

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Optimizing Nitrogen Fertility in Winter Wheat Varieties

Project Duration

2023-2024

Objectives

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

Collaborators

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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). The ideal fertility management package would help counteract the escalating cost of winter wheat production per unit area, which is the main goal of winter wheat producers. 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.

Methods and Materials

This study was established at Melita, Roblin, Carberry and Arborg, Manitoba. The trial design consisted of two varieties and seven 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^{-1} (53.5 lbs ac^{-1}) nitrogen, split 50:50
3. 90 Kg ha^{-1} (80.3 lbs ac^{-1}) nitrogen, split 50:50
4. 120 Kg ha^{-1} (107.1 lbs ac^{-1}) nitrogen, split 50:50
5. 150 Kg ha^{-1} (133.8 lbs ac^{-1}) nitrogen, split 50:50
6. 180 Kg ha^{-1} (160.6 lbs ac^{-1}) nitrogen, split 50:50
7. 120 Kg ha^{-1} (107.1 lbs ac^{-1}) nitrogen all applied in spring

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

Each site where this trial was grown used slightly different agronomic practices and had different field conditions which are outlined in the following Tables 2 and 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 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 1. Fall soil test results by site & fertilizer treatments for winter wheat in the 2022/2023 season.

Fall Soil Test and Fertilizer Application (Actual lbs/ac)					
		Soil Supply	Applied*	Total	Product Type
Melita	N	31	120	151	Urea, 40 rock
	P	32	30	62	40rock
	K	72	20	92	Potash
	S	112	0	112	
	Zn	0.48	1	1.48	Zinc sulfate
Roblin	N	32	120	152	Urea, MAP
	P	61	15	76	MAP
	K	94	0	94	
	S	17	0	17	
	Zn	0.69	0	0.69	
Carberry	N	23	120	143	Urea, MAP
	P	17	35	52	MAP
	K	32	50	82	Potash
	S	21	0	21	
	Zn	0.78	0	0.78	
Arborg	N	23	120	143	Urea, MAP
	P	23	30	53	MAP
	K	41	30	71	Potash
	S	14	0	14	
	Zn	0.17	0	0.17	

*Note: Applied nitrogen value is the soil test recommended value for treatments 4 & 7 as a baseline and took into account nitrogen sources from phophorous products.

Table 2. Description of site fields during 2023.

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

Table 3. Agronomic practices and description of sites in the 2023 Ducks Unlimited Winter Wheat Fertility Trial in Melita, Roblin, Carberry and Arborg.

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

Results and Discussion

Arborg

In Arborg, the variety used was found to have a significant ($P < 0.001$) effect on winter wheat yield in 2023 (Table 4). Wildfire winter wheat produced the highest yield at that site (3159 kg ha^{-1}) and was significantly different from the yield of Vortex winter wheat (2701 kg ha^{-1}). Protein content was also found to be significant ($P = 0.001$) between varieties at Arborg; Vortex had higher protein (15.0%) than Wildfire (14.3%). The variety used also had a significant ($P = 0.042$) effect on the test weight of the winter wheat. The variety Vortex had a higher test weight (67.0 kg hL^{-1}) than Wildfire (65.6 kg hL^{-1}) at Arborg. Plant population was also found to be significant ($P = 0.002$) between the two varieties grown. Fertility treatment was not found to have a significant effect on yield, protein, test weight, or plant population at the Arborg site. The effects of both variety and fertility treatment together were found to have a significant ($P = 0.040$) effect on winter wheat yield at the Arborg site as well. Interestingly, the treatment that had the highest yield overall (3593kg ha^{-1}) was Wildfire grown with no extra fertility treatment (treatment 1,1). While the highest, the yield of that treatment was not significantly different from the yield of Wildfire grown with the fertility treatments of 120 and 180 kg ac^{-1} of nitrogen split between spring and fall, and 120 kg ac^{-1} of nitrogen applied in the spring. The treatment with the lowest yield (2245 kg ha^{-1}) was shown to be Vortex grown with 120 kg ac^{-1} of nitrogen with a split application; this yield was not significant from four other treatments in the trial. While significant ($P = 0.036$), the plant population did not vary as much between treatments; it is important to consider the plant population when evaluating yield differences between treatments.

Carberry

In Carberry, the winter wheat variety Wildfire produced higher yields (5803 kg ha^{-1}) than Vortex winter wheat (5426 kg ha^{-1}), though the difference was not significant ($P = 0.196$) (Table 4). Vortex winter wheat also had a higher protein content (13.5%) than Wildfire (11.8%); these values were significant ($P < 0.001$). Plant population was found to be significant ($P = 0.003$) between the two varieties. Test weight of the grain was not found to be significantly different ($P = 0.093$) between the two varieties at Carberry in 2023. When evaluating fertility, yield and test weight again were not found to be significant. Protein content was found to be significant ($P < 0.001$) between fertility treatments. The split application of 180 kg ac^{-1} of nitrogen was shown to have the highest protein content (13.7%), though it was not significantly different from the split applications of 120 and 150 kg ac^{-1} nitrogen or the spring application of 120 kg ac^{-1} nitrogen. The plots were only start phosphorous was applied (checks) along with the low rate of split nitrogen (60 kg ac^{-1}) both produced the lowest protein content (11.7%) of the trial at Carberry. The protein content of those treatments was not significantly different from the protein content of the split application of 90 kg ac^{-1} nitrogen (12.1%). Plant population was found to be significant ($P = 0.009$) between fertility treatments in Carberry; this is important to consider when evaluating yield. At the Carberry site, none of the evaluated characteristics were found to be significant when looking at the effects of both variety and fertility. Though not significant, Wildfire with a split nitrogen application of 60 kg ac^{-1} had the highest yield (6186 kg ha^{-1}), while Wildfire with no nitrogen application (check) had the lowest yield (4573 kg ha^{-1}) in the trial.

Melita

In Melita, the variety used was found to have a significant (P = 0.004) effect on winter wheat yield in 2023 (Table 4). Wildfire winter wheat produced the highest yield at that site (4783 kg ha^{-1}) and was significantly different from the yield of Vortex winter wheat (4370 kg ha^{-1}). Protein content was also significantly (P = 0.001) affected by variety choice at Melita. Vortex winter wheat had a protein content of 12.7%, which was significantly higher than that of Wildfire winter wheat (12.3%). Variety choice did not influence test weight or plant population. The fertility treatment used was found to have a significant (P = 0.001) effect on yield of winter wheat and only at Melita in 2023 compared to all other sites. The treatment of a split nitrogen application of 120 kg ac^{-1} was shown to have the highest yield (5086 kg ha^{-1}), which was not significantly different from the split nitrogen applications of 90, 150, and 180 kg ac^{-1}. The check fertility treatment had the lowest yield (3826 kg ha^{-1}) which was not significantly different from the yields of split nitrogen applications of 60, 150, or 180 kg ac^{-1} or 120 kg ac^{-1} of nitrogen applied in the spring. Fertility had a significant (P < 0.001) effect on protein content at Melita. Winter wheat grown with 120 kg ac^{-1} nitrogen applied in the spring had the highest protein content (13.3%) which was not significantly different from the protein content when 150 and 180 kg ac^{-1} of nitrogen was split between the fall and spring. In Melita, fertility was also found to have a significant (P = 0.005) effect on test weight in 2023. The plots that had no nitrogen applied (checks) were found to have the highest grain test weight (80.9kg hL^{-1}) which was not significantly higher than the test weights of the treatments including split nitrogen applications of 60, 90, 120, and 150 kg ac^{-1}. Together, variety choice and fertility treatment were not found to have any significant effects. While not significant, Wildfire grown with a split nitrogen application of 120 kg ac^{-1} had the highest yield (5230 kg ha^{-1}) while the Vortex grown with no additional nitrogen had the lowest yield (3539 kg ha^{-1}). Interestingly, the higher protein contents were seen in the spring nitrogen application of 120 kg ac^{-1} for both Vortex (13.5%) and Wildfire (13.1) varieties at the Melita site in 2023.

Roblin

In Roblin, the variety used was found to not have a significant effect on winter wheat yield in 2023 (Table 4). Variety choice was found to have a significant (P < 0.001) effect on protein content. The protein content of Vortex winter wheat (12.9%) was significantly different from that of Wildfire (11.8%). The fertility treatment was also found to only have a significant (P < 0.001) effect on protein content. The application of 120 kg ac^{-1} nitrogen was shown to produce the highest protein content (13.3%), though not significant from three other fertility treatments included in the trial. While not found to be significant, the split application of 150 kg ac^{-1} of nitrogen produced the highest yield (5631 kg ha^{-1}) at Roblin. When the effects of variety and fertility were evaluated together, no significance was found in any factor. While not significant, the variety Vortex grown with a split application of 120 kg ac^{-1} of nitrogen had the highest yield (6166 kg ha^{-1}) of the treatments grown at Roblin. The variety Wildfire grown with a split application of 180kg ac^{-1} of nitrogen produced the lowest yield (4786 kg ha^{-1}) of the treatments grown at Roblin in 2023. Wildfire grown without additional nitrogen had the lowest protein content (10.1%), while Vortex with a spring application of 120 kg ac^{-1} nitrogen produced the highest protein content (13.9%). The trend was similar for the grain test weight. At the Roblin site, the plant counts were more inconsistent than at the other sites; this could indicate issues with the plant stand and vigor, such as high weed pressure.

When the data from all four sites was combined, variety choice was shown to have significant ($P = 0.016$) effect on yield (Table 5). Across all sites, the variety Wildfire had the highest yield (4772 kg ha^{-1}). Variety choice was also found to have a significant ($P < 0.001$) effect on protein content across all trial sites. The variety Vortex produced the higher protein content (13.5%), while Wildfire produced the lower protein content (12.6%). Across all four sites, fertility treatment was only found to have a significant ($P < 0.001$) effect on protein content of the grain. Two treatments produced the highest protein content (13.7%); split application of 180 kg ac^{-1} nitrogen and spring application of 120 kg ac^{-1} nitrogen. Across all four sites, when variety and fertility were evaluated together, no factors were found to be significant. Though not significant, the variety Wildfire grown with a split application of 150 kg ac^{-1} nitrogen produced the highest yield (4986 kg ha^{-1}). The variety Vortex grown without additional nitrogen produced the lowest yield (4114 kg ha^{-1}) over all trial sites.

When comparing the overall yield, protein, test weight, and plant population for each site to each other, all four factors were found to be significant (Table 6). The Carberry trial site yielded the highest (5614 kg ha^{-1}) overall, though it was not significantly different from the overall yield at Roblin (5379 kg ha^{-1}) and Melita (4576 kg ha^{-1}). Three of the four sites responded to nitrogen in terms of protein content, all three of which responded significantly and consistently to all fertilizer applied in spring (trt 7) compared to split application treatments. The Arborg trial site had the highest overall protein content (14.7%), which was significantly ($P < 0.001$) higher than the other sites. The Melita trial site produced the highest overall test weight (80.1 kg hL^{-1}) though not significantly different from the test weights at the Roblin site (76.8 kg hL^{-1}). The Carberry trial site had significantly ($P = 0.003$) higher plant counts (334 ppms) from the rest of the sites and above target rates indicating that data collection was skewed. All four sites were seeded with the same target plant population at seeding time; there may have been some discrepancies in counting plants between the sites. The main reason for significant differences found between the four sites is the seasonal growing conditions in each site. These conditions will all influence the crop differently.

The weather differed slightly at each site across the province. In the fall, Arborg received 125% of normal rainfall and Carberry received their normal average amount, while the Melita and Roblin sites only received around half of the normal rain fall for the area in that time frame (Table 7). All four sites received significantly higher growing degree days than they normally get in that time frame. In the spring until harvest, all four sites received only 50-61% of normal rainfall (Table 8). The four sites also received 111-114% of normal growing degree days for their area at that time of year. The crops at all sites may have been subjected to stressful conditions with low precipitation amounts, and higher than normal heat.

Table 4. Results including yield, protein, and test weight from the 2022-2023 test in Arborg, Carberry, Melita, and Roblin.

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

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

Table 5. Combined results on yield, protein, test weight, and plant counts from 2022-23 testing.

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

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

Table 6. Results including yield, protein, test weight, & plant counts from each site in 2023.

		Yield (kg ha^{-1})	Protein (%)	Test Wt. (kg hL^{-1})	Plants (ppms)^
Site	Arborg	2942b	14.7a	66.3b	261ab
	Carberry	5614a	12.7b	70.2b	334a
	Melita	4576ab	12.5b	80.1a	213b
	Roblin	5379a	12.4b	76.8a	136b
P-Value	Site	<0.001	<0.001	<0.001	0.003

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

Table 7. Seasonal precipitation and growing degree days from the fall seed date to November 15th, 2022, in Arborg, Carberry, Melita, and Roblin Sites.

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

Table 8. Seasonal precipitation and growing degree days from April 1st, 2023, to the harvest date in Arborg, Carberry, Melita, and Roblin.

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

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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

Berseem clover did not emerge due to very dry conditions during the months of May & June at Arborg site. However, oats and Italian grass did emerge and their plant establishment was higher in plots where both species were grown as mono crops (Fig 1). When their seeding rate was reduced to 75% of the recommended, it resulted in lower plant establishment as compared to their mono crop plots. Further lowering of the seeding rate (50% or 33% or 25% of the recommended) greatly reduced plant establishment both for oats & Italian grass.

This test recorded significant differences for forage yield among different forage treatments (Table 1). Plots having oats mixed at any of the seeding rate did produce higher forage yield than Italian ryegrass plots or mixed plots of Italian ryegrass & berseem clover. The plots of oats mono crop (100 % seeding rate) had similar yield as of plots where oats were mixed only at 25% of the recommended seeding rate with berseem clover. As berseem clover did not establish, these yields are primarily from oats. It appears that oats were able to grow more profoundly even at reduced seeding rates to produce similar forage yield as of pure oat stands. Italian ryegrass was not competitive with oats for forage production.

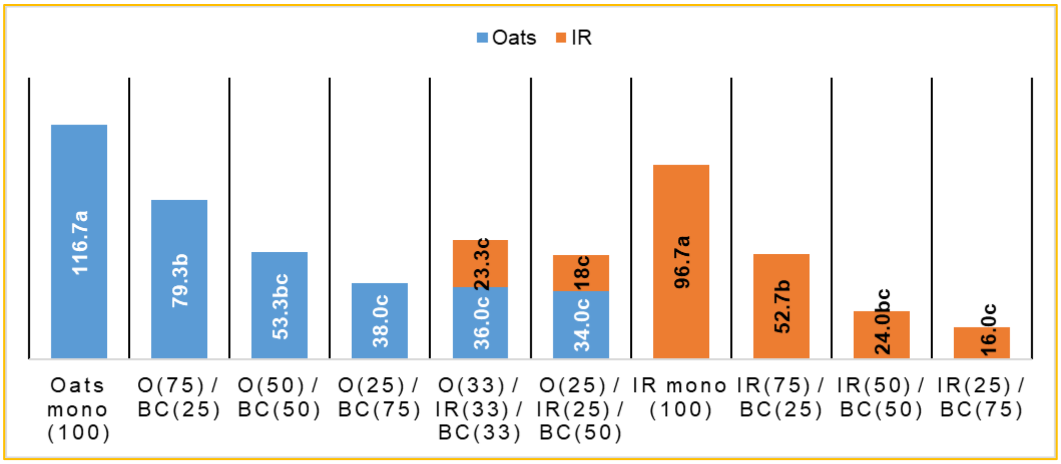

Fig 1. Plant establishment (no of plants / m^2) of different forage species / mixtures at Arborg site.

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

Cropping treatment	Dry Matter Forage Yield (tones/acre)
Oats mono (100)	4.762 a
O (50) – BC (50)	4.603 a
O (25) - IR (25) - BC (50)	4.521 a
O (33) - IR (33) - BC (33)	4.338 a
O (25) – BC (75)	4.224 a
O (75) – BC (25)	4.126 a
Italian Ryegrass mono (100)	1.342 b
IR (75) – BC (25)	1.102 b
IR (50) – BC (50)	0.940 b
IR (25) – BC (75)	0.672 b
P	<0.0001
Significant Difference	YES

Project Findings

Lack of moisture after seeding proved to be detrimental to many plots in the test. Berseem clover did not emerge due to dry conditions. Reduced seeding rate had significant effects on plant establishment both for oats and Italian ryegrass and it resulted in lowering plant populations. In the current test, Italian ryegrass did not grow well and it produced much lower yield than in plots where oats were mixed. It is reported that this grass does not withstand hot, dry weather or severe winters (USDA 2022). Italian ryegrass yields were lower than oats even in a wet year in Manitoba (PESAI Annual Report, 2022).

On the other hand, oats produced good forage yield even at reduced seeding rate. During 2022, we found Italian ryegrass – berseem clover mixed cropping as a good option for second cut forage production as both crops can tolerate mild frost events. We did not take forage yield during second cut in 2023 as berseem clover did not establish.

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.

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.

Italian ryegrass used in the study have the following characteristics:

Italian ryegrass - Italian ryegrass is a biennial originating from northern Italy. It is leafy and tillers readily, which makes it suitable for pasture and green manure. This crop does not usually set seed, and will not overwinter in western Canada (McCartney *et al.* 2008).

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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 – 8.22m^2
Data collected – plant stand, forage yield
Agronomic information
Stubble, soil type: wheat, Heavy clay
Fertilizer applied: N - 40 lb /acre; P - 15 lb/acre (at seeding)
Seeding date: May 17, 2023
Harvesting date: Aug 3, 2023

Testing Cover Crops, Intercrops & Perennials for soil health benefits & crop productivity

Project Duration

April 2023 – March 2027

Objectives

Comparing return on investment and soil health of a traditional monoculture grain cropping system with cropping systems where cover crops, intercrops & perennials are part of the crop rotation.

Collaborators

Manitoba Forage & Grassland Association (MFGA)

Results

During 2023, wheat was seeded in all treatment plots. Alfalfa (in PFS) and perennial ryegrass (in IC) were under seeded after wheat emergence. The competition from these under seeded crops did not have any effect on head counts and grain yield of wheat (Table 1).

Table 1. Effect of different cropping treatments on head counts & yield of wheat during 2023.

Cropping Treatment	Head counts / m^2	Grain Yield (bushels / acre)
Conventional Annual Mono-cropping (C)	442	69.8
Minimum-Till Annual Mono-cropping (MT)	465	73.2
Annual Mono-cropping with Fall Cover Crops (CC)	424.7	72.9
Annual cropping with Intercrops (IC)	413.3	75.5
Perennial Forage Seed Cropping (PFS)	433.7	77.2
P	**0.889**	**0.543**
Significant difference	**NO**	**NO**

Project Findings

The year 2023 is the year of establishment for this project. Wheat was seeded in all the treatment plots. Perennial ryegrass was under seeded to establish as intercrop in wheat (in IC treatment). However, it did not germinate well due to very dry conditions during May & June months. Two replication plots have a plant population of 75 plants / m^2 where as other two replications have only 6 plants / m^2. This is well below desired plant populations (400 – 600 plants /m^2) as described by Alberta Agriculture (2020).

Alfalfa under seeded (at the rate of 2 lbs/acre) in PFS treatment plots did establish well and the plant populations were about 20 plants / m^2 in the fall. Previous research from Manitoba demonstrated that a plant establishment of 5.5 plants / m^2 had produced good seed yield (Manitoba Agriculture).

Cover crop mixture was seeded (in CC treatment) after taking wheat off in September. However, cover crops did not emerge until last week of September due to dry conditions during early phase of September month.

Background

Grain monocultures may lead to soil exhaustion with greater risk of soil becoming depleted of essential nutrients. Although lost nutrients can be replaced using chemical and organic fertilizers, it is expensive to do so. There is also an environmental cost, increased mechanization has led to greater fossil fuel use and more greenhouse gas emissions.

Soil health is the capacity of a soil to function within ecosystems and land use boundaries to sustain a) biological productivity b) environmental quality c) plant & animal health (Doran *et al*, 1996).

A healthy soil must have the following characteristics (Doran & Zeiss, 2000):

1. High organic matter—this acts as food for many soil organisms.
2. Good soil tilth, or the formation of soft clumps of soil known as aggregates—this soil characteristic allows water from rainfall or irrigation to easily enter the soil. It also provides pockets of air so that soil organisms can breathe and pockets of soil organic matter that soil organisms can feed on.
3. Efficient nutrient- and water-holding capacity—this is similar to soil tilth, but it means that conditions for healthy growth of soil organisms continue over time.
4. Efficient nutrient cycling—this refers to the interaction of soil organisms in a soil food web.
5. A high level of biological activity and diversity—this refers to the type and numbers of organisms within the soil food web.

The goal of soil health maintenance is to ensure long-term stable high productivity and environmental sustainability of cropping systems. Fig. 1 (adapted from Tony *et al*, 2020) illustrates an example of how an optimized cropping system increases soil health, relative to monoculture.

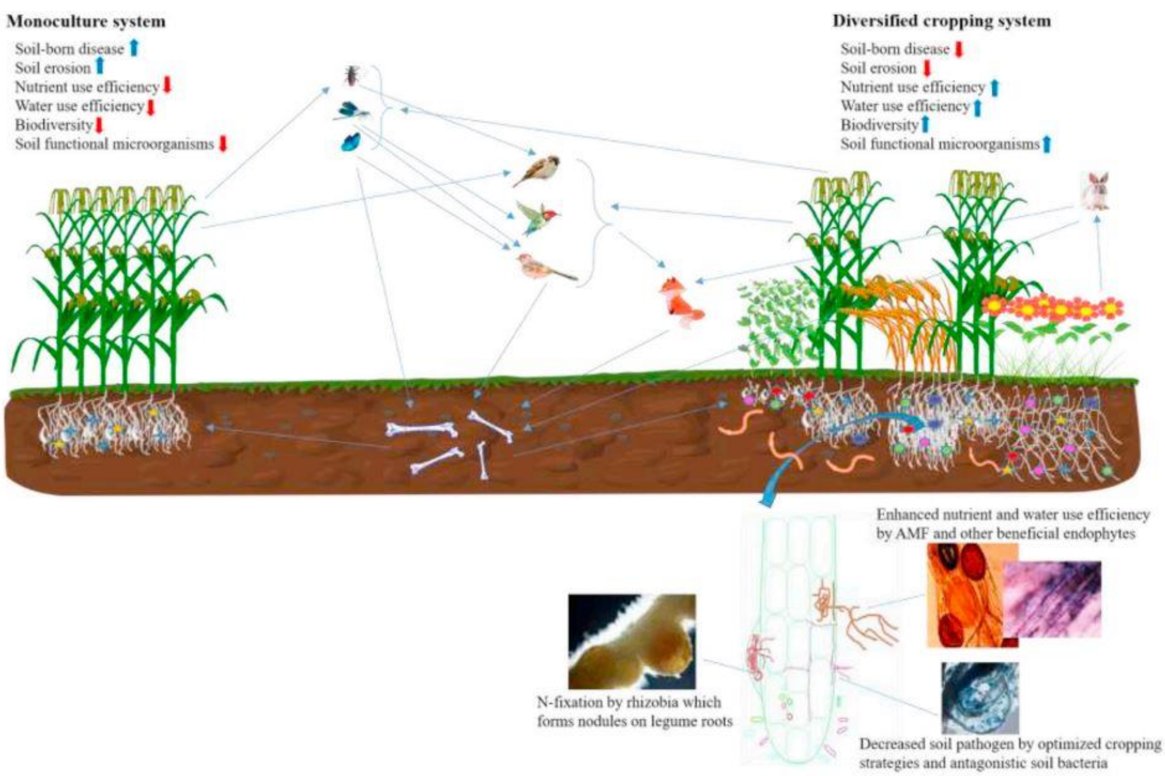

Fig. 1. Soil health comparison in optimized cropping systems and monocultures.

The use of regenerative agriculture practices (e.g. inclusion of intercrops, cover crops and perennials in the cropping systems) have been demonstrated to have positive effects on soil health and productivity of the system. For example, cover crops can feed many types of soil organisms, in addition to building soil carbon and soil organic matter. These crops also contribute to better management of soil nutrients and they aerate the soil and help rain go into the soil. Cover crops are known to reduce soil compaction and improve the structure and strength of the soil.

Similarly, intercropping practices can enhance soil health by inhibiting soil diseases, increasing plant root function, enhancing soil nutrient and spatial use efficiency and promoting bio-functionalities of soil microorganisms. Perennial grain crops could also make a valuable addition to sustainable agriculture, potentially even as an alternative to their annual counterparts. The ability of perennials to grow year after year significantly reduces the number of agricultural inputs required, in terms of both planting and weed control, while reduced tillage improves soil health and on-farm biodiversity.

Considering that monocultures can result in soil degradation, reduced biodiversity and increased economic risk, PESAI is testing cover crops, intercrops & perennial cropping systems to see if they benefit soil health & ROI. These treatments are compared with conventional grain mono-cropping system.

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Materials & Methods

Treatments: The following five cropping systems are being compared in this study.

1) *Conventional Annual Mono-cropping (C)*
2) *Minimum-Till Annual Mono-cropping (MT)*
3) *Annual Mono-cropping with Fall Cover Crops (CC)*
4) *Annual cropping with Intercrops (IC)*
5) *Perennial Forage Seed Cropping (PFS)*

More details about year-year plan for individual treatments are presented in Table 2.

Replications: four

Plot size: 255 m^2; The plots were seeded by a Salford air drill with a row spacing of 7.5 inches.

Seeding rates & Variety:

1) *Wheat – 2.25 bushels /acre (AAC Brandon)*
2) *Alfalfa – 2 lbs/acre (Plato)*
3) *Perennial Ryegrass – 8 lbs/acre (Shield)*
4) *Cover Crop mixture: This mixture was prepared by Imperial Seed for fall growth potential. This included Ryegrass (Tetra brand annual – 1.5 lbs/ac), Turnip (Hercules brand – 0.4 lbs/ac), Sunflower (Black oil – 1.25 lbs/ac), Radish (Daikon – 1.75 lbs/ac), Phacelia (Balo brand – 0.25 lbs/ac), Red clover (1 lbs/ac) & Chicory (0.15 lbs/ac). This mixture was seeded at 5.5 lbs/acre seeding rate.*

Oats were added to this mixture at the rate of 50 lbs/acre.

Table 2. Yearly plan about different cropping treatments.

Year	Conventional Annual Mono-cropping	Minimum Till Annual Mono-cropping	Annual Mono-cropping with Fall Cover Crops	Annual Cropping with Intercrops	Perennial Forage Seed Cropping
2023 Crop	*Wheat*	*Wheat*	*Wheat*	*Wheat*	*Wheat*
Winter Cover	*None*	*None*	*Fall Seeded Cover Crop*	*Spring Seeded Perennial Ryegrass*	*Spring Seeded Alfalfa*
Tillage	*Fall Till*	*Harrow*	*Harrow*	*No Till*	*No Till*
2024 Crop	*Canola*	*Canola*	*Canola*	*Perennial Ryegrass Seed*	*Alfalfa seed*
Winter Cover	*None*	*None*	*Fall Seeded Cover Crop*	*Fall Seeded Cover Crop*	*Alfalfa*
Tillage	*Fall Till*	*No Till*	*No Till*	*No Till*	*No Till*
2025 Crop	*RR Soybean*	*RR Soybean*	*RR Soybean*	*Pea + Canola*	*Alfalfa Seed*
Winter Cover	*None*	*None*	*Broadcast Clover Cover*	*Fall Seeded Cover Crop*	*Alfalfa*
Tillage	*Fall Till*	*No Till / Harrow*	*No Till / Harrow*	*No Till / Harrow*	*No Till*
2026 Crop	*Wheat*	*Wheat*	*Wheat*	*Wheat*	*Wheat*

Soil Fertility (N:P - lbs/ac) - 160-22
Fertilizer applied (N:P - lbs/ac) - 25-20
Fall tillage:
All plots were deep tilled in fall 2022 before establishing this research project.
The 2023 tillage details are as follows –

MT – heavy harrowed x 2 times (in fall 2023)
C – Deep tilling (in fall 2023)
CC - heavy harrowed x 2 times in fall 2023

Pesticides applied*: Glyphosate @ 1litre / acre (May 22) as pre-emerge application*
Seeding / harvesting dates:
Wheat – May 19 / Sep 7
Perennial rye grass / alfalfa – May 30
Cover crop mixture – Sep 8

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

Project Duration
2022 & 2023

Objectives
To determine the effects of seeding rate of pea-oats intercrops on grain yield in comparison to their mono crops.

Results

Plant establishment

Both oats and peas exhibited competition when grown together in different seeding rate treatments (Fig 1). Oats had highest plant population/m^2 during both years when grown as mono crop. Oats establishment was significantly reduced when its seeding rate was reduced to half or three-quarters in the intercrop. Their establishment, however, did not suffer when grown with 75% seeding rate of peas (2022). On contrary, pea establishment did not suffer from intercrop competition during 2022 (Fig 1B) except in 75-75 seeding rate treatment. However, peas had significant less establishment in intercrop plots during 2023.

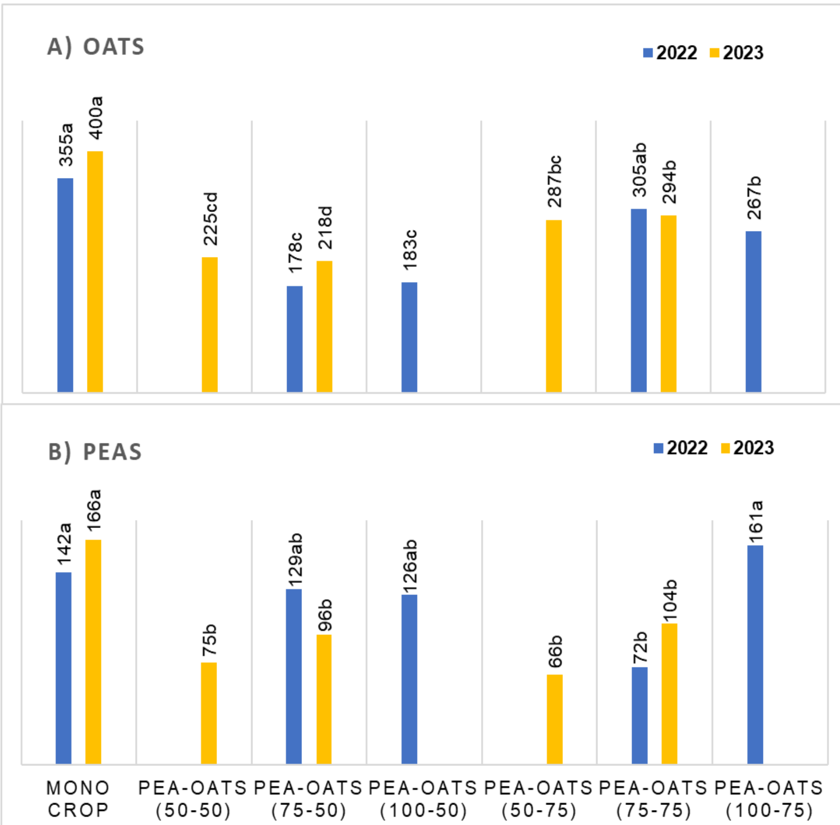

Fig 1. Plant establishment (no of plants/m^2) of a) oats & b) peas in different seeding rate treatments of pea-oats intercrop during 2022 & 2023 crop seasons.

Plant height

When peas and oats were grown together, it did not affect oats height during both years (data not shown). However, pea plants were shorter in all intercrop treatments except in 100-75 & 50-50 seeding rate treatments during 2022 & 2023, respectively (Fig 2).

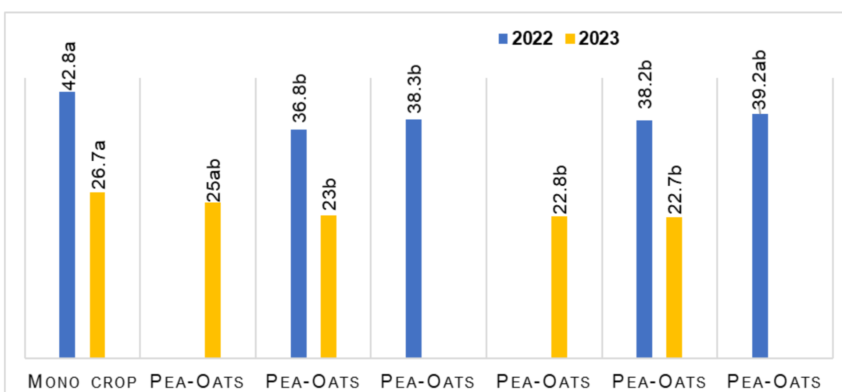

Fig 2. Plant height (inches) of peas as affected by seeding rate treatments during 2022 & 2023.

Grain Yield, Land equivalent ratio (LER) & Revenues

Peas were not competitive with oats and pea yields were significantly reduced in all intercrop treatments during both years (Tables 1 & 2). When peas were added in intercrop even at full seeding rate (100%) in 2022, pea yield was still lower than pea mono crop. Pea yields were better when oats were added up at 50% rather than 75% of the seeding rate during 2023.

Oat mono crop produced highest grain yield during both years and its yield was lower when grown with peas (Tables 1 & 2) except when pea-oats intercrop was grown at 50-75% seeding rate (2023).

Land equivalent ratios (LER) were above 1.00 in all pea-oat intercrop treatments during both years indicating that intercrops produced more than mono crops. The differences were significant only during 2023 though. The seeding rate treatment of 50-50 had the highest LER during 2023.

Pea mono crop had the lowest marginal revenue during both years. Oat mono crop was ranked top in the marginal revenues during 2022, however, it did not compete with intercrop treatments during 2023 (Tables 1 & 2). It looks like peas at 100% seeding rate did not provide additional benefit in the intercrop. In fact, greater marginal revenues were found when peas were added up at 50% of the seeding rate during 2023. Similarly, oats can be added up at 50% of the seeding rate than 75% without losing much on marginal revenues (except in 100% pea treatments which are already ruled out).

Table 1. Grain yield, LER & revenues as affected by different seeding rate treatments of pea-oats intercrop during 2022.

Cropping treatment (% seeding rate*)	***Pea Yield (bushels/acre)***	***Oats Yield (bushels/acre)***	***Land Equivalent Ratio*****	***Gross Revenue ($/ac)***	***Marginal Revenue ($/ac)***	***Ranking***
Peas-Oats (75-50)	*21.4b*	*118.7bc*	*1.19a*	*871.7*	*711.4*	*4*
Peas-Oats (75-75)	*17.6b*	*132.1b*	*1.19a*	*889.3*	*719.1*	*2*
Peas-Oats (100-50)	*22.5b*	*109.1c*	*1.15a*	*838*	*657.8*	*5*
Peas-Oats (100-75)	*22.4b*	*124.6bc*	*1.24a*	*914.2*	*718.2*	*3*
Oats Mono (100)	*-*	*169.4a*	*1.00a*	*847*	*730.4*	*1*
Peas Mono (100)	*43.8a*	*-*	*1.00a*	*569.4*	*426.2*	*6*
Significant Difference	*YES*	*YES*	*NO*			
P	*0.005*	*<0.0001*	*0.069*			

**Normal Seeding rate for Oats & Peas – 250 & 80 plants/m², respectively.*

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

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 2023 Costs of Production: $13.00/bu peas, $5.00/bu oats)

There was no difference in days to maturity among intercrop and mono crops during 2022. However, in 2023, oats mono crop took 2-3 less days to mature, whereas pea mono crop conversely had two more days to mature than in intercrop treatments. Both pea & oats mono crops had significant lower TKW than in intercrop treatments (Table 3).

Table 2. Grain yield, LER & revenues as affected by different seeding rate treatments of pea-oats intercrop during 2023.

Cropping treatment (% seeding rate*)	***Pea Yield (bushels/acre)***	***Oats Yield (bushels/acre)***	***Land Equivalent Ratio*****	***Gross Revenue ($/ac)***	***Marginal Revenue ($/ac)***	***Ranking***
Peas-Oats (75-50)	*18.5b*	*81.2c*	*1.28b*	*646.5*	*495.4*	*3*
Peas-Oats (75-75)	*14.1c*	*90.3bc*	*1.25b*	*634.8*	*475.0*	*4*
Peas-Oats (50-50)	*18.7b*	*91.9b*	*1.43c*	*702.6*	*570.8*	*1*
Peas-Oats (50-75)	*11.6c*	*100.4ab*	*1.26b*	*652.8*	*513.1*	*2*
Oats Mono (100)	*-*	*104.7a*	*1.00a*	*523.5*	*448.3*	*5*
Peas Mono (100)	*36.8a*	*-*	*1.00a*	*478.4*	*345.2*	*6*
Significant Difference	*YES*	*YES*	*YES*			
P	*<0.0001*	*<0.0001*	*<0.0001*			

**Normal Seeding rate for Oats & Peas – 250 & 80 plants/m^2, respectively.*

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

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 2023 Costs of Production: $13.00/bu peas, $5.00/bu oats)

Table 3. Thousand kernel weight (TKW) from different seeding rate treatments of pea-oats intercrop during 2023.

Cropping treatment	***Peas TKW (g)***	***Oats TKW (g)***
Peas-Oats (75-50)	*284.6b*	*45.2b*
Peas-Oats (50-75)	*274.7b*	*45.1b*
Peas-Oats (75-75)	*272.7b*	*46b*
Peas-Oats (50-50)	*268.6b*	*44.9b*
Mono crop	*182.2a*	*40.6a*
Significant Difference	*YES*	*YES*
P	*<0.0001*	*0.001*

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 per hectare 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 a number of practical challenges with respect to crop production, harvest, and grain handling (Struckman *et al.* 2021). In the current study, pea-oat intercrops did not have any lodging. Oats had been reported to support lodge-prone pea varieties throughout the growing season until harvest (Struckman *et al.* 2021).

Peas did not compete well with oats in the current study and they suffered yield reduction in all intercrop treatments. Peas seeded at full seeding rate (2022) did not provide any yield advantage or gain in marginal revenues. Actually, when peas were seeded at reduced seeding rates (75% in 2022 & 50% in 2023), it resulted in better marginal revenues for the intercrop.

Oats at 50% of the recommended seeding rate in the intercrop did well in terms of marginal revenues & LER. In fact, 50-50% seeding rate combination in 2023 was the top producer with significant higher LER values. Similar conclusions were made by Struckman *et al.* (2021), when they recommended that oat seeding rates in an oat-pea 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.

Land equivalent ratios were greater than one in all intercrop treatments. This is promising as it means that growing 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 down side. Struckman et al (2021) cited **c**rop 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

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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.
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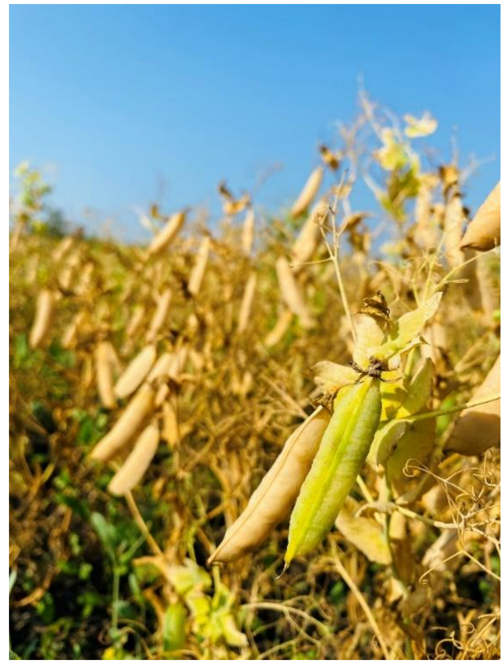
Materials and Methods

Experiment design: Randomized complete block design with three replications.
Treatments: The following mono & intercrop treatments were tested during 2022 & 2023.

Year	*Crop(s)*	*% of standard seeding rate for mono crop*	*Varieties used*
2022	*Peas-Oats*	*75-50*	*AAC Carver - CS Camedon*
2022	*Peas-Oats*	*75-75*	*AAC Carver - CS Camedon*
2022	*Peas-Oats*	*100-50*	*AAC Carver - CS Camedon*
2022	*Peas-Oats*	*100-75*	*AAC Carver - CS Camedon*
2022 & 2023	*Pea mono*	*100*	*AAC Carver*
2022 & 2023	*Oats mono*	*100*	*CS Camedon*
2023	*Peas-Oats*	*75-50*	*AAC Carver - CS Camedon*
2023	*Peas-Oats*	*75-75*	*AAC Carver - CS Camedon*
2023	*Peas-Oats*	*50-50*	*AAC Carver - CS Camedon*
2023	*Peas-Oats*	*75-75*	*AAC Carver - CS Camedon*

In intercrop treatments, both crops were seeded in the same row with row spacing as 9 inches.
Fertilizer use:
2022 - Soil fertility: N-P: 212-36 (lbs/acre); Applied with the seed: N-P: 22-20 (lbs/acre)
2023 - Soil fertility: N-P: 25-19 (lbs/acre); Applied with the seed: N-P: 30-15 (lbs/acre)
***Pesticides sprayed*:**
2022 - Glyphosate @ 0.67L / acre (desiccant) on Aug 25
2023 – Glyphosate @ 0.67 L / acre as pre-emerge spray on May 19
Data collection - Plant establishment, plant height, days to maturity, lodging, grain yield
Seeding / Harvesting dates: May 24 / Sep 6 (2022), May 12 / Aug 29 (2023)
Marginal revenues are based on the following input costs -

Seed cost: Oats -$30 / acre, Pea - $88/acre
Fertilizer – N - $1.085 / lb ($1100 / tonne Urea); P - $0.905 / lb ($1300 / tonne MAP)
Pesticides – glyphosate @ 0.67 L/acre ($4.5/acre)
Seed separation cost - $0.25 / bushel



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

Project Year
2023

Objectives
To evaluate the effect of tile drainage & seeding rate on 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) on tiles, it resulted in less survival than when seeded at 75% of this rate. Tiles or seeding rate did not affect days to maturity for peas. Plants were significantly shorter at harvest when grown on non-tiled land.

Peas yielded almost three times more on tiled land than on non-tiled land. There was no yield difference between recommended and reduced seeding rate (75%) when peas were grown over tiles. Thousand kernel weight was lower for peas grown over non-tiled land (Fig 1).

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)
Peas on tiles (recommended seeding rate)	10.9a	78.1a	29.2b	62.8b
Peas on tiles (75% of recom. seeding rate)	14.7b	78.2a	28.9b	62.2b
Peas on non-tiled land (recommended seeding rate)	13.1b	77.3a	23.0a	18.8a
Significant Difference	YES	NO	YES	YES
P	0.001	0.454	<0.0001	<0.0001

Project Findings

During the course of this study (May 15 - Aug 18), Arborg site received 56% of the normal rainfall. Site was extremely dry after seeding and got only 12% of the normal rainfall between May 15 - June 15. Usually, peas are susceptible to excess moisture during crop growth but the plants are also sensitive to water stress during flowering and pod fill. Field peas have similar moisture requirements to cereal grains.

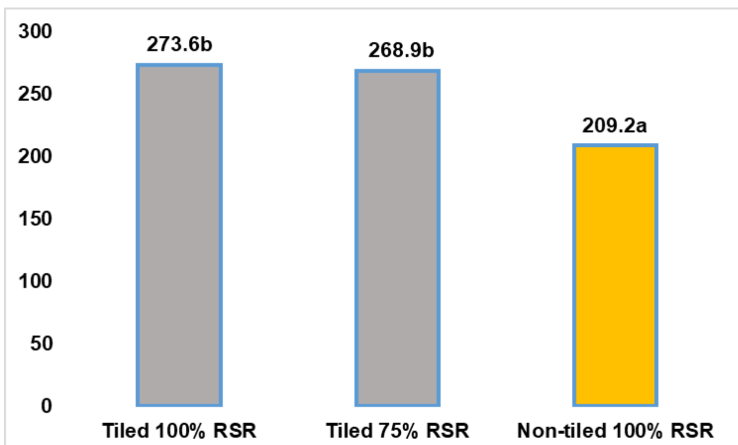


Fig 1. Thousand kernel weight (g) comparisons among peas grown over tiles (100 & 75% of recommended seeding rate - RSR) and on non-tiled land during 2023 at Arborg site.

In the current study, peas were struggling to grow due to lack of moisture at critical crop stages on non-tiled land. These peas were shorter and yielded less than pea plots grown over tiles. Significantly lower TKW also pointed out poor filling of the pods due to lack of moisture. On contrary, sub-surface irrigation was given through tiles during June 12-15 and it did benefit peas grown over tiles in terms of better yield.

It is evident from the current study that tile drainage had a positive influence on the yield. Pea plots grown over tiles produced greater grain yield irrespective of seeding rate. Peas grown even at 75% of the seeding rate yielded as good as with 100% of the recommended seeding rate. 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 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 labour costs (Asante & Ashton, 2021).

PESAI site has plots with 30' wide tiles underneath. 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 (on tiles) to determine its effects on crop growth & yield.

References

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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*

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

> *May 19 – glyphosate @ 0.67L/acre pre-emerge*
> *June 14 – Basagran Forte @ 0.91L/acre*

Data collection

Emergence, plant establishment, days to maturity, plant height, grain yield, TKW
Seeding / Harvesting dates: May 12 & August 18

Testing seed treatments for managing soil borne flax diseases

Project Duration

2023 – 2025

Objectives

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

Collaborators

Manitoba Crop Alliance
WADO – Scott Chalmers – Melita
PCDF – James Frey - Roblin
PESAI – Nirmal Hari - Arborg
MCDC – Haider Abbas – Carberry

Results

Plant establishment

Flax variety CDC Rowland had better plant establishment than yellow seeded variety AAC Bright at 3 out of 4 sites (Table 1.) Seed treatment had significant effect on plant survival at all sites except in Melita. Seed treatments had better plant survival at Roblin & Carberry sites, whereas Vitaflo resulted in lower plant survival at Arborg site.

Table 1. Varietal & seed treatment effects on plant establishment (plants / meter row length) of flax during 2023 tests at four diversification centers.

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

**Estimates based on visual observations.*

Plant height & maturity

Plant height was not affected either by variety or seed treatment at any of the site during 2023 (data not shown). The only exception was Roblin site where variety AAC Bright had taller plants than CDC Rowland.

Similarly, there were no differences in days to maturity at all the sites when either flax varieties or seed treatments were compared (data not shown). The only exception was Carberry site where the use of Insure Pulse (higher rate) and Vitaflo resulted in early maturing flax plots.

Yield

Flax variety CDC Rowland produced more yield than variety AAC Bright at all the test sites. Relatively greater yield was reported from Melita site. Seed treatments did not have any affect on flax yield at 3 out of 4 sites except in Melita, where seed treatment plots had greater yield than in untreated check plots (Table 2).

Table 2. Varietal & seed treatment effects on flax yield (bushels /acre) during 2023 tests at four diversification centers.

	Arborg	Carberry	Melita	Roblin
Factor A (Variety)				
AAC Bright	17.7^{A}	29.9^{A}	45.9^{A}	16.5^{A}
CDC Rowland	21.1^{B}	32.0^{B}	52.7^{B}	22.8^{B}
Prob.	0.0001	0.0084	<0.0001	<0.0001
CV (%)	10.43	9.37	6.18	14.49
Sign.	**Yes**	**Yes**	**Yes**	**Yes**
LSD	**1.5**	**2.2**	**2.2**	**2.1**
Factor B (Seed Treatment)				
Untreated	18.8	31.7	44.5^{A}	19.1
Insure Pulse - Low	20.4	30.7	51.9^{B}	20.3
Insure Pulse - High	20.1	30.7	50.0^{B}	21.1
Vitaflo	18.3	32.8	49.7^{B}	18.2
Prob.	0.1587	0.4293	0.0004	0.2252
CV (%)	10.4	9.4	6.2	14.5
Sign.	No	No	**Yes**	No
LSD	--	--	**3.2**	--

Project Findings

During the first year of testing, seed treatments (Insure Pulse & VItaflo) did not show any effect on flax growth & yield (except at Melita site). In varietal comparisons, flax variety CDC Rowland had better plant survival and yield than AAC Bright. These seed treatments will be tested again during 2024 at all four diversification centers to examine any effect on flax growth & yield.

Background Information

There has been little testing done to evaluate the commercially available seed treatments for flax in Manitoba. This project is aimed to evaluate two seed treatments using labelled rates in both brown and yellow seeded flax varieties.

Materials & Methods

The flax seed treatment trial was established at all four diversification centers in 2023. This trial was laid in two factorial plot design, variety and seed treatment being the two factors. There were four replications.

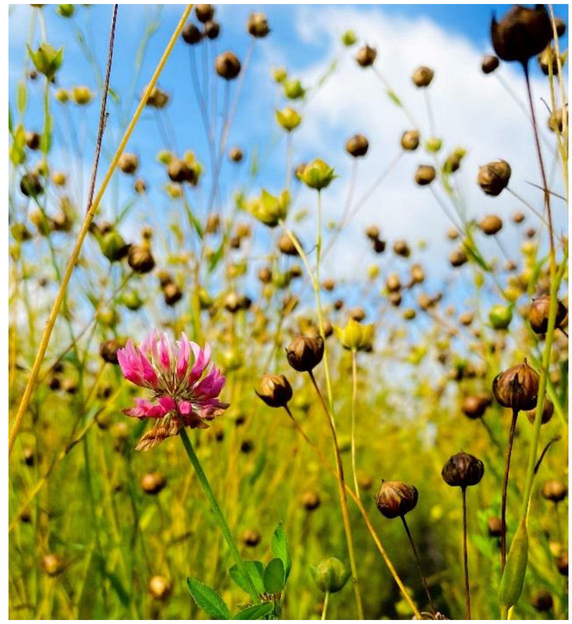
Two varieties were included in the trial. CDC Rowland is a brown seeded type whereas AAC Bright is a yellow seeded variety. Three seed treatments; Vitaflo (525 ml / 100 Kg seed), Insure Pulse (low rate – 300 ml / 100 Kg seed) & Insure Pulse (high rate – 600 ml / 100 Kg seed) were tested along with an untreated check.

Table 3. Trial management details at four sites during 2023.

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

The following data were collected:

- Crop emergence
- Days to maturity
- Plant height at harvest
- Disease presence and severity (*Fusarium* spp. and *Rhizoctonia solani* seed and root rots, plus seedling blight; *Pythium* spp. seed rot and pre-emergence damping off)
- Crop yield



Linseed Flax Variety Evaluation

Project Duration

2023

Objectives

The purpose of the project is to compare yield and other growth parameters of newly registered flax cultivars (SVPG entries) and experimental lines (FP entries) from University of Saskatchewan, Crop Development Centre flax breeding program with check flax varieties.

Collaborators

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

Results

Yield results from different test centres are presented in Table 1. There were 12 test sites across Manitoba, Saskatchewan & Alberta (see Materials & Methods section for details about sites). At Arborg site, experimental line FP 2608 yielded greater than both check flax varieties (AAC Bright & CDC Glas) whereas line FP2614 produced lowest yield in the test. These two lines had also highest and lowest yield, respectively, across all the testing zones during 2023.

AAC Bright had the highest oil content both at Arborg site as well as when data were combined from all test sites (Table 2). CDC Glas had the second ranking in per cent oil content. Flax varieties also differed in protein content and experimental line FP 2614 had the highest protein content both at Arborg site as well as when data were pooled from all the sites (Table 3).

Table 1. Yield ('00 Kg/ha) and rank by testing site and zone during 2023 test.

ENTRY	ZONE 1					ZONE 2						ZONE 3							OVERALL WEST	
	CAR	IND	MLT	AVG	RANK	AVO	SAS	SCO	SWC	AVG	RANK	ARB	GLA	ML	ROB	VEG	AVG	RANK	AVG	RANK
Checks																				
CDC Glas	17.8	21.1	28.7	22.5	9	15.2	25.5	17.9	8.6	16.8	8	11.0	5.8	16.5	15.2	26.1	14.9	9	17.5	9
AAC Bright	17.5	21.2	27.7	22.1	10	15.5	24.8	15.9	8.5	16.2	10	9.6	4.4	19.4	14.3	24.3	14.4	10	16.9	10
SVPT Entries																				
CDC Rowland	18.3	23.4	30.6	24.1	3	17.4	26.7	17.6	8.8	17.6	5	11.0	5.7	18.5	15.9	27.3	15.7	6	18.4	5
CDC Kernen	17.1	22.1	28.5	22.6	8	16.4	26.2	16.7	9.6	17.3	6	12.9	7.1	19.3	17.4	25.6	16.5	2	18.3	6
CDC Esme	18.0	23.2	28.5	23.2	6	17.6	27.0	18.9	9.5	18.3	3	11.6	6.2	18.4	16.4	26.7	15.9	4	18.5	4
2nd Year Entries																				
FP2607	18.7	24.0	29.1	23.9	4	17.3	26.8	18.9	9.7	18.2	4	11.9	6.3	19.1	17.0	26.0	16.0	3	18.7	3
FP2608	19.4	22.7	31.3	24.4	2	18.7	26.5	18.0	10.3	18.4	2	14.2	8.0	20.6	18.1	28.3	17.8	1	19.7	1
FP2609	19.0	23.9	30.9	24.6	1	18.3	26.8	19.5	10.0	18.6	1	11.7	7.0	17.1	15.4	27.5	15.7	5	18.9	2
1st Year Entries																				
FP2611	18.9	22.3	28.3	23.2	7	14.7	25.9	17.5	8.7	16.7	9	12.8	5.5	18.3	13.8	26.0	15.3	7	17.7	8
FP2612	19.1	22.7	29.0	23.6	5	16.7	25.8	16.7	9.3	17.1	7	10.6	5.4	18.5	15.8	25.7	15.2	8	17.9	7
FP2613	15.6	20.0	25.8	20.5	11	15.1	20.8	15.2	7.9	14.8	11	8.3	5.1	15.4	12.6	21.5	12.6	11	15.3	11
FP2614	15.2	13.3	18.3	15.6	12	10.3	12.4	11.2	5.2	9.8	12	4.6	4.0	11.1	9.6	15.9	9.0	12	10.9	12
Mean	17.9	21.7	28.1	22.5		16.1	24.6	17.0	8.8	16.6		10.8	5.9	17.7	15.1	25.1	14.9		17.4	
C.V. %	11.6	4.5	8.5	8.5		10.6	4.6	7.8	12.4	8.1		12.3	12.5	8.8	12.0	10.4	11.6		9.6	
LSD	3.51	1.65	4.05	1.80		2.89	1.92	2.26	1.85	1.09		2.29	1.25	2.65	3.14	4.43	1.26		0.77	
No. of Reps	3	3	3	9		3	3	3	3	12		3	3	3	3	3	15		36	

Project Findings

The entries differed in their yield performance and quality parameters at Arborg site. A complete project report is 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 located 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

Table 2. Oil content (percent) by testing site and zone during 2023 test.

ENTRY	ZONE 1 CAR	IND	MLT	AVG	ZONE 2 AVO	SAS	SCO	SWC	AVG	ZONE 3 ARB	GLA	ML	ROB	VEG	AVG	OVERALL WEST AVG
Checks																
CDC Glas	43.2	45.9	45.7	44.9	43.5	45.0	44.0	43.7	44.1	45.1	45.1	44.5	44.6	43.7	44.6	44.5
AAC Bright	45.4	48.3	47.9	47.2	45.6	46.7	46.0	45.0	45.8	47.3	47.6	46.9	46.3	46.2	46.8	46.6
SVPT Entries																
CDC Rowland	43.1	45.1	45.6	44.6	42.6	44.4	43.1	43.1	43.3	44.5	44.6	43.1	43.9	43.4	43.9	43.9
CDC Kernen	42.1	44.8	44.7	43.9	42.5	44.2	42.7	43.1	43.1	44.1	44.5	43.1	43.1	43.0	43.6	43.5
CDC Esme	43.5	45.6	45.0	44.7	43.0	44.8	43.5	43.6	43.7	44.4	45.2	43.1	44.0	43.9	44.1	44.1
2nd Year Entries																
FP2607	41.9	46.0	45.1	44.3	42.8	45.3	43.8	43.3	43.8	44.8	45.0	43.3	44.2	43.7	44.2	44.1
FP2608	43.0	44.8	45.2	44.3	42.7	44.2	43.7	43.4	43.5	43.6	44.3	43.1	43.5	43.7	43.7	43.8
FP2609	42.5	44.4	44.9	43.9	42.3	44.0	42.8	42.5	42.9	43.4	44.0	42.5	42.9	43.0	43.2	43.3
1st Year Entries																
FP2611	40.9	44.9	44.8	43.5	41.7	44.2	42.6	42.4	42.7	44.3	44.0	42.5	43.1	42.9	43.4	43.2
FP2612	42.6	44.1	44.6	43.8	41.4	43.6	42.3	41.9	42.3	43.3	43.3	42.2	42.7	42.6	42.8	42.9
FP2613	40.9	43.4	44.1	42.8	42.6	42.5	41.5	41.6	42.1	41.5	42.9	41.8	42.3	41.9	42.1	42.3
FP2614	41.8	44.2	44.5	43.5	43.3	43.6	42.8	41.9	42.9	43.1	43.7	42.6	43.3	42.6	43.1	43.1
Mean	42.6	45.1	45.2	44.3	42.8	44.4	43.2	43.0	43.3	44.1	44.5	43.2	43.7	43.4	43.8	43.8
C.V. %	0.7	0.8	0.9	0.8	0.6	1.0	1.0	1.1	0.9	1.1	0.6	1.3	1.1	1.2	1.2	1.0
LSD	0.52	0.59	0.71	0.34	0.45	0.74	0.71	0.82	0.33	0.83	0.47	0.98	0.85	0.88	0.35	0.20
No. of Reps	3	3	3	9	3	3	3	3	12	3	3	3	3	3	15	36

Table 3. Protein content of seed (percent) by testing site and zone during 2023 test.

ENTRY	ZONE 1 CAR	IND	MLT	AVG	ZONE 2 AVO	SAS	SCO	SWC	AVG	ZONE 3 ARB	GLA	ML	ROB	VEG	AVG	OVERALL WEST AVG
Checks																
CDC Glas	25.6	21.5	22.2	23.1	27.0	23.8	25.4	27.1	25.8	22.4	24.7	24.4	23.1	25.8	24.1	24.4
AAC Bright	25.6	21.1	22.6	23.1	27.7	24.1	26.1	27.5	26.4	23.1	24.2	24.1	23.5	25.5	24.1	24.6
SVPT Entries																
CDC Rowland	24.3	22.3	21.7	22.8	29.1	24.2	25.7	27.4	26.6	22.8	26.2	25.5	23.8	26.3	24.9	24.9
CDC Kernen	24.7	21.1	22.3	22.7	28.1	23.5	25.6	26.3	25.9	22.1	25.1	24.4	23.0	26.1	24.2	24.4
CDC Esme	24.0	21.4	22.2	22.5	28.2	24.0	25.9	26.5	26.1	22.8	25.6	25.8	23.5	25.9	24.7	24.6
2nd Year Entries																
FP2607	26.3	20.4	22.0	22.9	27.6	22.9	24.6	27.0	25.5	21.7	25.2	24.6	22.9	26.1	24.1	24.3
FP2608	22.9	21.1	21.7	21.9	27.3	23.7	24.0	25.9	25.2	21.5	25.0	24.3	22.9	25.6	23.9	23.8
FP2609	24.9	22.1	22.1	23.0	28.6	24.1	25.9	27.4	26.5	23.8	26.0	26.0	24.3	26.1	25.2	25.1
1st Year Entries																
FP2611	27.4	22.2	22.3	24.0	29.1	24.3	26.0	27.9	26.8	22.7	26.8	26.0	23.9	26.8	25.2	25.4
FP2612	24.0	22.0	22.4	22.8	28.8	24.5	26.8	28.2	27.1	23.7	26.3	25.8	24.1	26.6	25.3	25.3
FP2613	27.6	21.9	23.0	24.2	26.5	24.0	26.0	26.7	25.8	23.5	24.6	25.4	24.6	25.3	24.7	24.9
FP2614	28.5	24.4	24.2	25.7	27.6	25.3	27.0	27.6	26.9	25.4	25.6	27.0	25.6	26.3	26.0	26.2
Mean	25.5	21.8	22.4	23.2	28.0	24.0	25.7	27.1	26.2	23.0	25.4	25.3	23.8	26.0	24.7	24.8
C.V. %	1.0	2.1	3.1	2.1	1.7	2.9	1.3	1.7	2.0	3.8	1.5	2.6	1.8	2.3	2.7	2.3
LSD	0.41	0.76	1.18	0.46	0.81	1.20	0.58	0.79	0.42	1.47	0.64	1.11	0.72	1.02	0.45	0.26
No. of Reps	3	3	3	9	3	3	3	3	12	3	3	3	3	3	15	36

Materials & Methods (for Arborg site)

Experimental Design – Randomized complete block design
Plot size: 8.22m^2
Treatments: 12 flax entries (Table 1)
Data collected – Grain yield data are presented in this report. Data on plant height, days to maturity, lodging, stem dry down and determinate growth habit were reported to Dr. Bunyamin Taran's team. Subsamples of grain were sent to CDC Saskatoon for oil and protein analysis.

Agronomic info

Stubble, soil type; Wheat, heavy clay
Soil fertility: N-P: 25-19 (lbs/acre); Applied with the seed: N-P: 25-15 (lbs/acre)
Pesticides applied –

Glyphosate 540 @ 1 lit /acre on May 19 (pre-emerge)
Basagran Forte @ 0.91L/acre on June 14

Seeding date: May 15, 2023
harvesting date: Sep 26, 2023

List of Stations and Co-operators - 2023 - Flax Cooperative Trial

Station	Abbreviation	Co-operator
Zone 1 - Black Soil Zone (Longer Growing Season)		
Canada-Manitoba Crop Diversification Centre, Carberry, MB	CAR	H. Abbas
AgQuest Research, Hamiota, MB	HAM	A. Robertson
Westman Agricultural Diversification Organization, Melita, MB	MLT	S. Chalmers
TapRoot-Research Ltd, Rosenort/Brunkild, MB	RO	M. Caron
AAFC, Indian Head Research Farm, Indian Head, SK	IND	E. Schuurmans
SERF, Redvers, SK	RED	L. Shaw
Zone 2 - Brown and Dark Brown Soil Zone		
CDC, University of Saskatchewan, Saskatoon, SK	SAS	B. Tar'an
Palliser Triangle Research Inc, Avonlea, SK	AVO	M. Kurtenbach
AAFC, Scott Research Station, Scott, SK	SCO	C. Gampe
Wheatland Conservation Area Inc, Swift Current, SK	SWT	B. Nybo
Zone 3 - Black and Grey Soil Zones (Shorter Growing Season)		
Parkland Crop Diversification Foundation, Roblin, MB	ROB	J. Frey
Prairies East Sustainability Initiative, Arborg, MB	ARB	N. Hari
AAFC, Melfort Research Farm, Melfort, SK	ML	B. Hrynewich
Discovery Ag, Codette, SK	COD	A. Baxter
AAFC, Scott Research Station, Glaslyn, SK	GLA	C. Gampe
Crop Development and Management, Vegreville, AB	VEG	S. Eldridge
Irrigation		
SIDC, Outlook, Sk	OL1	G. Singh
FarmingSmarter, Lethbridge, AB	LET	M. Gretzinger

Analyzing soil samples using a NIRS soil tester

Objectives

To compare NIRS based tester with soil testing laboratory for soil nutrient analysis.

Background Information

Near infrared reflectance spectroscopy (NIRS) is a rapid and cost-effective soil analysis technique. Recently there is an increased interest in utilizing NIR for the analysis of soil parameters which otherwise require expensive and time-consuming analytical methods. NIRS is being used widely for the analysis of forages and feedstuffs, but its use in soil analysis is relatively new.

Soil is a very heterogenous medium and its complex properties pose a challenge to use NIRS for soil analysis. Contradictory results for given soil properties have been reported and can be attributed to a lack of standardized methodology in relation to: (i) sample preparation, (ii) spectrum acquisition, (iii) spectrum pre-treatment, (iv) soil texture, (v) geological heterogeneity of soil, (vi) reference method, and (vii) calibration method.

For analyzing crops or plants, sample preparation is very important for NIRS predictions and it may account for 60 to 70% of all prediction errors. The preparation of soil samples is also expected to affect the accuracy of NIRS predictions, given the heterogeneous nature of the material. Preparing soil samples includes sampling, blending, subsampling, removing foreign material such as roots and rocks, drying when samples are not analyzed "as is" or "as received," sieving or grinding, and storing. Changes in the moisture content or particle size of soil samples are also known to affect the NIRS spectrum quality.

Materials & Methods

The performance of NIRS based soil analysis is determined by calculating coefficient of determination (r^2) and RPD (Ratio of standard error of performance to standard deviation). RPD is equal to the SEP divided by the standard deviation of the compositional values (determined via wet-chemistry) of the samples in the test set. Simultaneous consideration of these statistics is recommended.

Table 1. Standardized guidelines for the assessment of the accuracy of NIRS predictions of soil attributes

Calibration performance	r^2	RPD
Very reliable	>0.9	>3
Reliable	0.7-0.9	1.75-3
Less reliable	<0.7	<1.75

During 2023, PESAI tested a hand held NIRS tester to analyze soil samples for macro nutrients, organic matter, pH and cation exchange capacity (CEC). This NIRS tester is reported to be calibrated based on more than 1,700 soil samples from North America. We analyzed the same soil samples either using NIRS tester or sending them to a commercial soil testing laboratory. For N, P, K & S, a total of 16 soil samples were compared, whereas for organic matter, pH & CEC, only 10 soil samples were compared.

Results

The results are presented in Table 2. We calculated r^2 to find out any correlation between NIRS testing and laboratory results for different soil parameters. The r^2 values for all tested soil parameters were less than 0.70 suggesting both analyzing methods were not comparable. The r^2 values were significantly correlated only for sulfur determination. Nitrate (lbs/acre) values among different soil samples varied 57-84 for NIRS testing whereas this range was 4-122 from laboratory results.

Table 2. Coefficient of determination between both soil analyzing methods for different soil parameters.

Soil attribute	NO_3	P	K	S	OM	pH	CEC
r^2	0.047	0.239	0.392	0.603	0.026	0.104	0.011
P value	0.416	0.055	0.463	0.000	0.656	0.363	0.767

Testing sunflower varieties in North Interlake

Project Duration
2023

Objectives
To test sunflower oilseed varieties for crop growth & production in Interlake.

Results
Table 1. Performance of four sunflower varieties at Arborg site during 2023.

Variety	Herbicide / Disease tolerance	Plant Height (inches) at R8	Days to Maturity	Yield (lbs/acre)	Moisture (%)
CP432E	*ExSun*	*52.0*	*122*	*1452*	*13.4*
N4H161CL	*CL*	*36.3*	*116*	*2020*	*14.6*
P63HE501	*ExSun*	*59.3*	*124*	*2324*	*18.8*
TALON	*ExSun / DM*	*57.3*	*118*	*2082*	*16.1*

Four sunflower varieties were tested at Arborg site during 2023. The variety N4H161CL had the minimum plant height at R8 and it also took less number of days to mature. When these varieties were compared with MCVET sunflower test at Beausejour site, it was found that these varieties took 5-6 more days to mature in Arborg except the variety Talon. This variety matured in the same number of days as at Beausejour site.

The test varieties yielded 1452 – 2324 lbs / acre with maximum yield in the plots of variety P63HE501 (Table 1). The long-term averages of sunflower yield are reported to be between 501- 1000 lbs / acre in the rural municipality of Bifrost Riverton (MASC 2019). Sunflower plots got significant bird damage during this testing.

Background Information
Oilseed sunflowers are used in the birdfeed and crushing industry for sunflower oil, which is one of the highest quality vegetable oils. Manitoba grows nearly all of Canada's sunflowers, producing 95.6 per cent of Canada's crop in 2023, with the remainder this year grown in Alberta, according to StatCan (Hallick 2023). Traditionally sunflowers will be grown in the southern & eastern region of the province but now the cultivation has also expanded into Interlake.

In the current demonstration, four oilseed varieties were evaluated to see their yield potential in Arborg.

References

1) Glenn Hallick (2023) Manitoba sunflower yields better than anticipated
https://www.agcanada.com/daily/manitoba-sunflower-yields-better-than-anticipated
2) MASC (2019) Average yield – Oil sunflowers (2010-2019)
https://www.masc.mb.ca/masc.nsf/map_average_yield_oilsunflowers_10yr.pdf

Materials and Methods

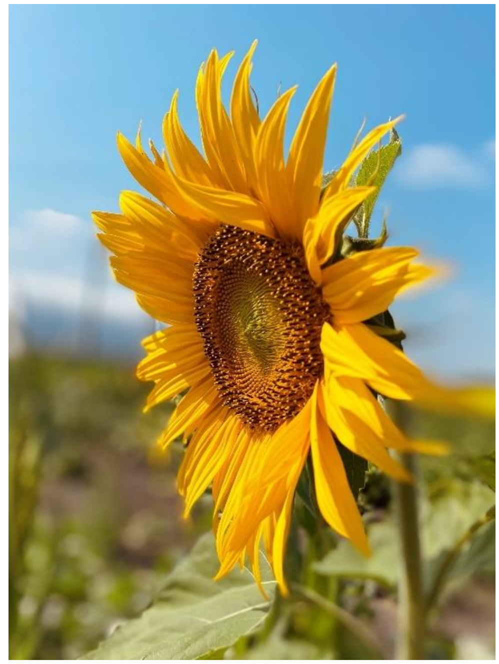
Experimental design: Strip demonstration
Treatments: Four varieties of sunflowers – CP432E, N4H161CL, P63HE501 & Talon
Plot size – 175 m^2
Row spacing – 30 inches
Data collected – Plant height, days to maturity, grain yield

Agronomic information

Stubble, soil type: Fallow, Heavy clay
Fertilizer applied: N - 50 lb /acre; P - 15 lb/acre
Pesticides used:

Glyphosate @ 1 lit/acre (May 27)
Express SG @ 6 g/ acre (June 15 & July 7)
Centurion @ 150 ml / acre (July 7)
Matador @ 34 ml /acre (July 14)

Seeding date: May 15, 2023
Harvesting date: Oct 10, 2023



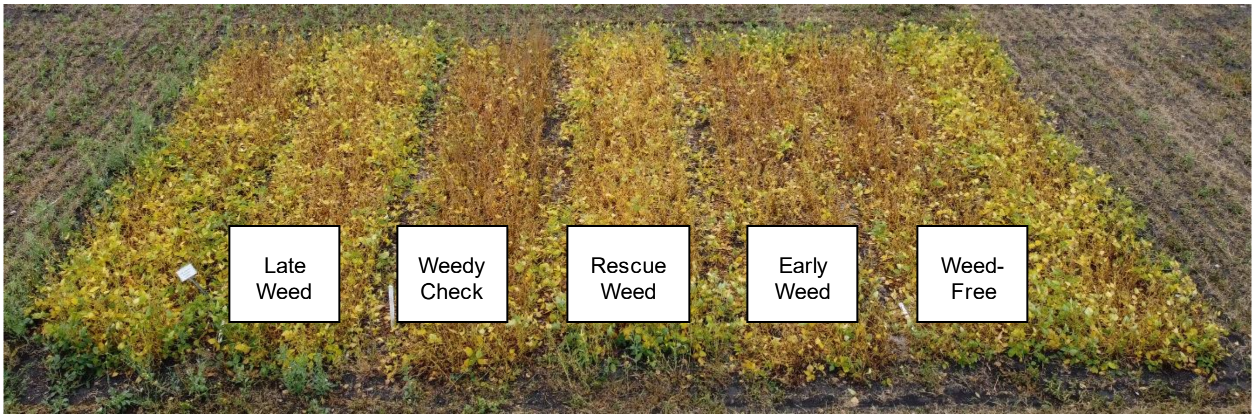


Figure 2. Soybean (at R7) plots at Arborg site on September 5, 2023.

Effect of weed control timing on soybean yield

Project Duration

Carman 2022 - ongoing, Arborg 2023 - ongoing

Objectives

To determine the effect of initial weed control timing on soybean yield.

Collaborators

Soybean and Pulse Agronomy Lab (University of Manitoba),
Prairies East Sustainable Agriculture Initiative Inc. (PESAI)

Results

At Arborg site, soybean yield was not significantly affected by in-crop herbicide timeliness (p = 0.3349). The yield varied from 48 – 56.1 bushels /acre in different treatments (Fig 1). Herbicide timing treatments did not have any effect on plant height, days to maturity, oil and protein content in the grains (Table 1).

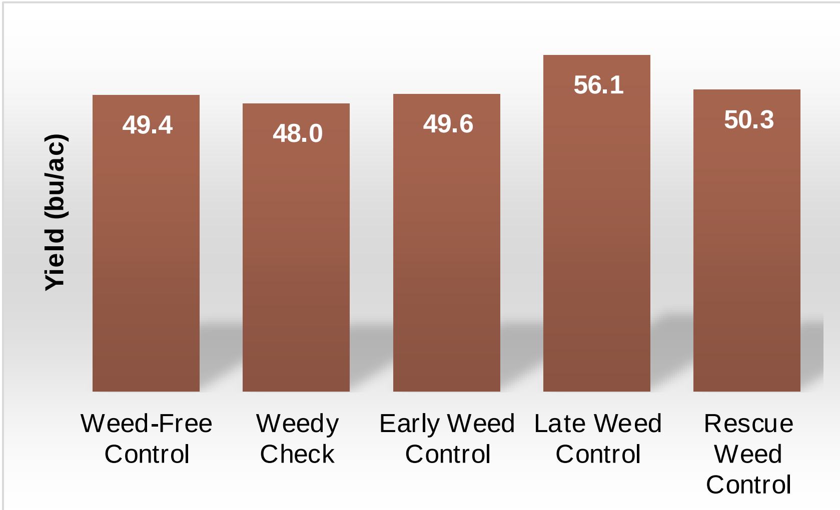


Figure 1. Soybean yield (bu/ac) comparisons among different treatments at Arborg site during 2023.

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

Treatment	Plant Height (cm)	Days to Maturity	Test Weight (kg/hL)	Oil %	Protein %
Weed-Free Control	58.8	119	72.0	22.0	31.1
Weedy Check	55.6	117	72.5	21.5	32.1
Early Weed Control	61.3	119	71.3	21.8	31.3
Late Weed Control	64.4	119	72.4	21.8	31.8
Rescue Weed Control	63.1	117	72.1	21.7	31.7
Significant Difference	No	No	No	No	No
P value	0.4049	0.5732	0.2387	0.2278	0.1245

Project Findings

During 2023, in crop herbicide timing did not have any effect on plant growth, soybean yield & oil / protein content in the grains. Green foxtail, lamb's quarters and wild buckwheat were the common weeds observed which contributed to average weed density of 57 weeds/m^2. Further testing is required especially in environments where weed density and competition may be more detrimental to crop yield.

Background / References / Additional Resources

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 crop can increase crop competitiveness thereby reducing weed biomass and selection pressure from applied herbicides. Additionally, timely herbicide management is important to maximize yield potential.

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

To determine the effect of weed control timing on yield, soybeans were seeded using current best management practices (mid-May seeding date, narrow row spacing, 180-200,000 seeds/ac) and following a pre-seed burn-off (or tillage) in all treatments. In-crop weed control timing was incrementally delayed in different treatments (see Table 2). The experiment design was RCBD with four replicates.

Table 2. 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

Data Collected:

1. Soil test prior to seeding
2. Weed community assessment and soybean growth staging at herbicide timing
3. Soybean plant density at V1
4. Soybean maturity (R8)
5. Soybean canopy height at maturity
6. Grain yield and moisture
7. Seed quality (oil %, protein %)

Agronomic Information:

Stubble, soil type:	wheat, heavy clay
Seeding date:	May 19
Seeding rate:	200,000 seeds/ac
Fertilizer applied:	15 lb/ac P_2O_5 seed-placed
Pesticides applied:	All treatments – May 19, glyphosate (0.67 L/ac) Weed-free control: June 1, dicamba (161 mL/ac) Early weed control: June 8, glyphosate (0.67 L/ac) Late weed control: June 19, glyphosate (0.67 L/ac) Rescue weed control: June 26, glyphosate (0.67 L/ac)
Harvest date:	September 27

Soil water extraction and soybean ET_a under subirrigation through tile drains in heavy clay soil

Project Duration
2023-2024

Objectives

- Measure the impact of subirrigation through tile drainage on soil water extraction at different depths in soybeans.
- Quantify the actual ET_a of soybean under different water management regimes:
1) Mid-way between tiles
2) On top of the tile
3) No tile control

Collaborators

Komlan Koudahe & Ramanathan Sri Ranjan, Department of Biosystems Engineering, U of M

Introduction

- Soybeans are the third largest crop in Manitoba in terms of planted area of 0.65 million ha in 2023 (Manitoba Agriculture 2023).
- Snowmelt infiltration contributes to excess soil moisture in early season (Satchithanantham 2013).
- Prolonged drought affects soybean yields in heavy clay soils.
- Subirrigation through tile drainage, can be an option to provide irrigation water for effective soybean growth.

Materials and Methods

- Field experiment conducted in 2023 at PESAI, Arborg, Manitoba where the tiles were located 4.5 m (15 ft) apart at 0.9 to 1.1 m depth.
- Meter soil water sensors Teros 11/12 (METER Group, Inc., Pullman, WA 99169) measured hourly volumetric water content at 20-, 60-, and 90 cm depths.
- Change in soil moisture represents water removal on a daily time step at different depths.

General Water Balance Method (Equation 1)

$ET_a = P + I - D - R - \Delta W$ (1)

P: Precipitation (mm), I: Irrigation (mm)

D: Deep percolation (mm) using computer program written in Microsoft Visual Basic

R: Run-off (mm) was determined by the USDA-NRCS model

ΔW: change in stored water within the root zone (mm)

Results

- Highest soil water extraction occurred at 60 cm for midway between tiles, 90 cm for on tile, and 20 cm for no tile (Fig 1).
- Soybean ET_a varied significantly among the treatments and was 189.6, 290.7, and 299.7 mm for no tile, on tile, and midway between tiles, respectively (Fig 2).
- Irrigated treatments recorded the highest seasonal ET_a, representing an ideal condition for increased soybean yield.

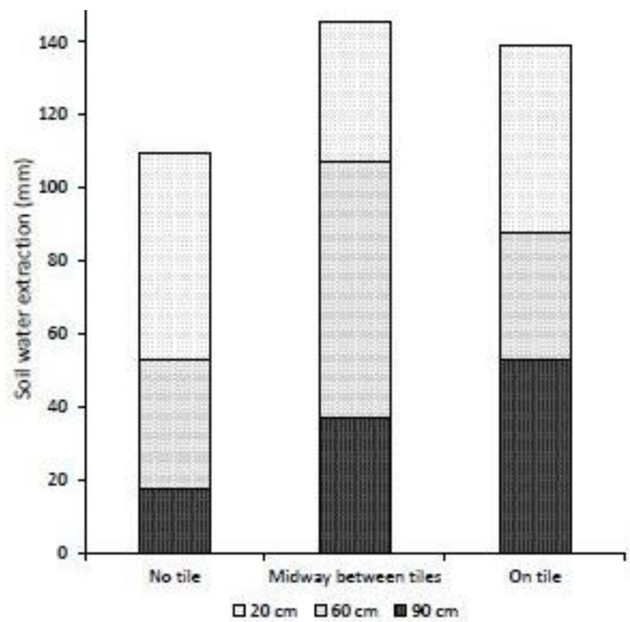


Fig. 1. Soil water extraction at different depths

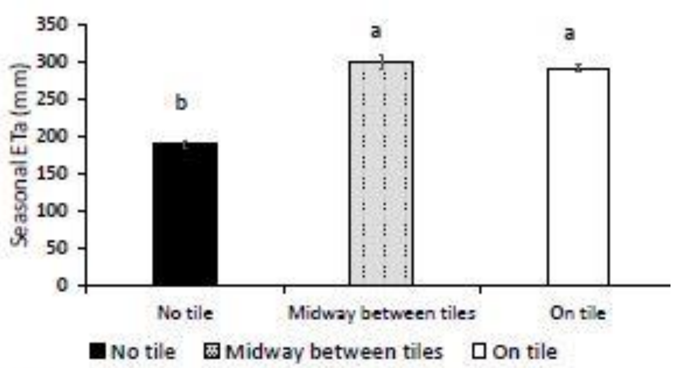


Fig. 2. Soybean seasonal evapotranspiration in different treatments*

*Same letter indicates not significantly different at 5% level

Conclusions

- Soil water extraction was greater in midway between tiles treatment compared to on tile treatment.
- Subirrigation through the tile contributed to more water uptake at the 90 cm depth on top of the tile.
- The ET of the crop created the upward hydraulic gradient.
- The lowest soil water extraction was in the no tile control where no irrigation was done.

References

1) Manitoba Agriculture (2023). Sector profile at glance: Soybeans. (accessed on January 30, 2024).
2) Satchithanantham, S. (2013). Water Management Effects on Potato Production and the Environment. Ph.D. dissertation at the University of Manitoba. 192p

Nitrous oxide emissions as affected by timing & source of nitrogen application in Winter Wheat

Project Duration

2022 - 2024

Objectives

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

Collaborators

Ducks Unlimited
AAFC Brandon
Nirmal Hari (PESAI Arborg)
Haider Abbas (MCDC Carberry)

Results

Plant Height & Grain Yield: There were no plant height differences at both sites among fertility treatments (Table 1). These treatments did not differ for grain yield although all nitrogen applications increased yield in comparison to check plots at Carberry site. Arborg site did not record any yield differences between fertility treatments and check plots.

Table 1. Plant height & yield comparisons among fertility treatments at both sites during 2022-23.

Treatment	Plant height at harvest (inches)		Grain Yield (bushels / acre)	
	Carberry	Arborg	Carberry	Arborg
100% fall- Untreated	30.5a	27.3a	63.7b	38.5
60% Fall Untreated - 40% Spring Treated	28.9a	26.0a	57.1ab	40.8
60% Fall Untreated - 40% Spring Treated UAN	31.5a	25.9a	62.1b	36.7
100%Spring - Treated	29.1a	25.6a	60.4b	40.4
Check	30.1a	25.3a	49.1a	36.0
P Value	0.067	0.379	0.001	0.859
Significant Difference	No	No	Yes	No

Nitrous oxide emissions

Carberry site: Although 100FU treatment resulted in greater nitrous oxide emissions at this site, however, 60FU40ST produced highest emissions during spring / summer measurements (Fig 1). 100ST had relatively lower emissions until mid-June, however, it did exceed 100FU treatment in emissions after this time.

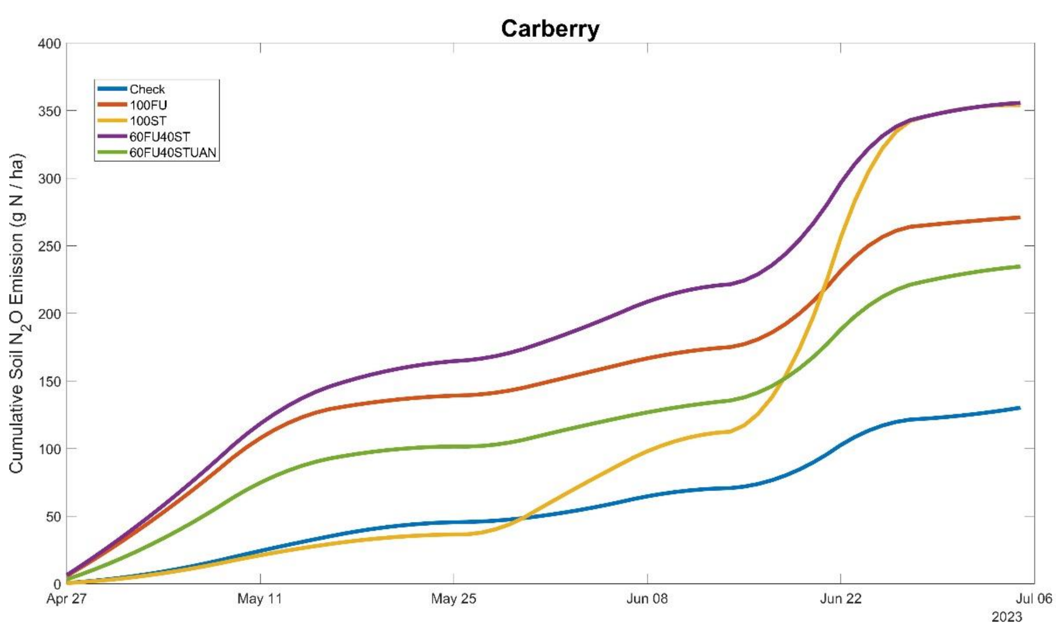


Fig 1. Cumulative soil nitrous oxide emissions at Carberry site during 2022-23.

Arborg site: Nitrous oxide emissions were relatively low in all the treatments during fall measurements. There was a clear trend showing 100FU resulted in significantly higher emissions as compared to 100ST. Ironically, spring N application was broadcast as opposed to banded application in the fall. The split applications (60FU40ST & 60FU40STUAN) had nitrous oxide emissions greater than 100ST but less than 100FU (Fig 2). Overall Arborg site had greater emissions than at Carberry site. Check plots of winter wheat had minimum emissions at both sites.

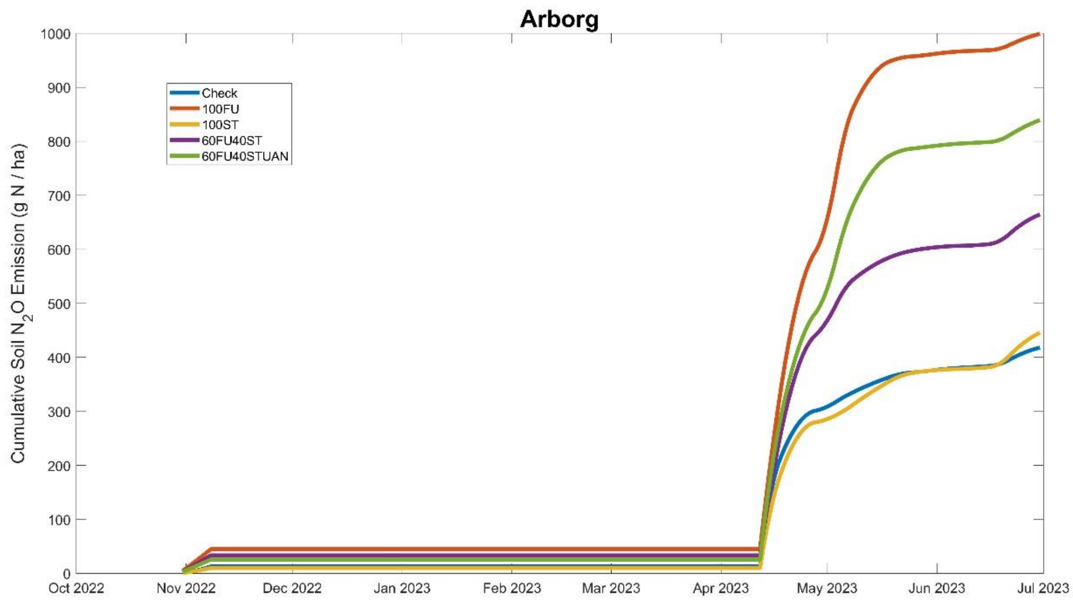


Fig 2. Cumulative soil nitrous oxide emissions at Arborg site during 2022-23.

Project Findings

Arborg site was extremely dry during spring 2023. This might have contributed in poor grain yields and absence of any differences in yield among fertility treatments and check plots. Carberry site, however, had greater grain yield in most fertility treatments than in check winter wheat plots. However, all fertility treatments were similar for grain yield.

Nitrous oxide emissions were higher in 100FU treatment plots as compared to other nitrogen applications at Arborg site. This treatment also resulted in higher emissions next to split application treatment (60FU40ST) at Carberry site. Probably, more data is required to conclude emission patterns due to different timings and sources of nitrogen application in winter wheat. This study is being continued at all four DC sites during 2023-24 to generate more data on nitrous oxide emissions.

Materials and Methods

A study on greenhouse gas emissions were conducted at Arborg & Carberry sites during 2022-23. Different nitrogen timing and source treatments were compared in winter wheat for nitrous oxide emissions during fall and next spring / summer. 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 both 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.

At Carberry site, nitrous oxide sampling was started during spring 2023, whereas sampling was started during fall 2022 at Arborg site. 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 analysis.

Table 2. Agronomic details for the trials at both sites.

	Carberry	Arborg
Rotation (2 year)	Soybean (2021), Canola (2022)	Fallow (2021), Canola (2022)
Soil Type	Ramada Clay Loam	Fyala Heavy clay
Plot size	9.00 m^2	8.22m^2
Burn off	Round up @ 0.67 Lit/A + Heat @29 g/A Sprayed before seeding	No burn off
Pesticides (Date, Rate, Name)	Fitness @ 120 ml/acre (June 14) Buctril M @ 0.4L/acre (June 21) Axial @ 0.5 L/acre (June 21) Prosaro @ 325 ml / acre (June 29)	Curtail @ 0.81L/acre (May 31)
Seed depth (inches)	1"	1”
Seeding Date	Sep 14, 2022	Sep 19, 2022
Harvest Date	Aug 30, 2023	Aug 3, 2023

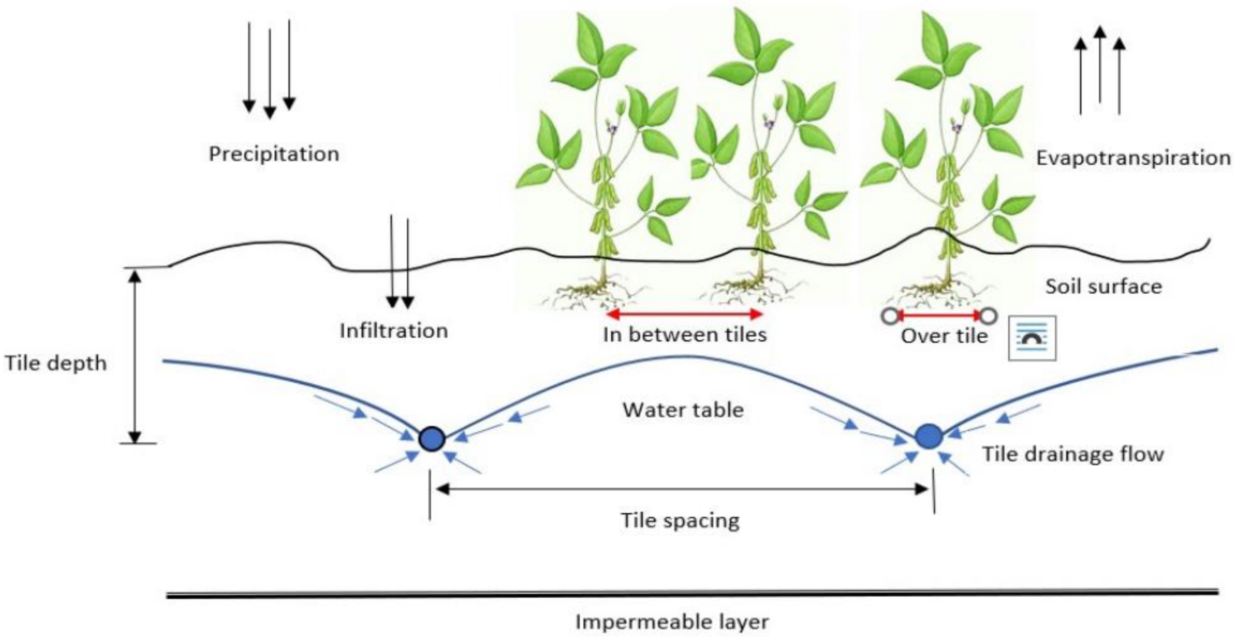


Figure 2. Hydrologic components of the tile drained field (Moursi et al., 2022)

Effect of Tile Drainage on Soybean Yield

Project Duration

2021-2023

Objectives

Evaluation of soybean yield under different water table management using tile drainage in heavy clay soils in the Interlake Region of Manitoba.

Collaborators

Thushyanthy Akileshan & Ramanathan Sri Ranjan, Department of Biosystems Engineering, U of M

Results

- The 2021 growing season was relatively dry with the water table remaining below the tile depth.
- Yield in the tiled plots was 50.2% and in the non-tiled plots was 51.8% of the average provincial yield due to limited water availability.
- Further, one reason for the low yield in 2021 in the tiled plots may have been the removal of water by the tiles early in the season.
- However, the soybean yield was not significantly ($p < 0.05$) different between the two treatments in 2021 (Fig 3).
- 2022 was a wet year resulting in a significantly higher yield ($p < 0.05$) over the tiles compared to mid-spacing of 45' tiles and non-tiled plots (Fig 3).
- 45' tile spacing was too wide to deal with excess water in 2022 in the clay soils of Arborg.

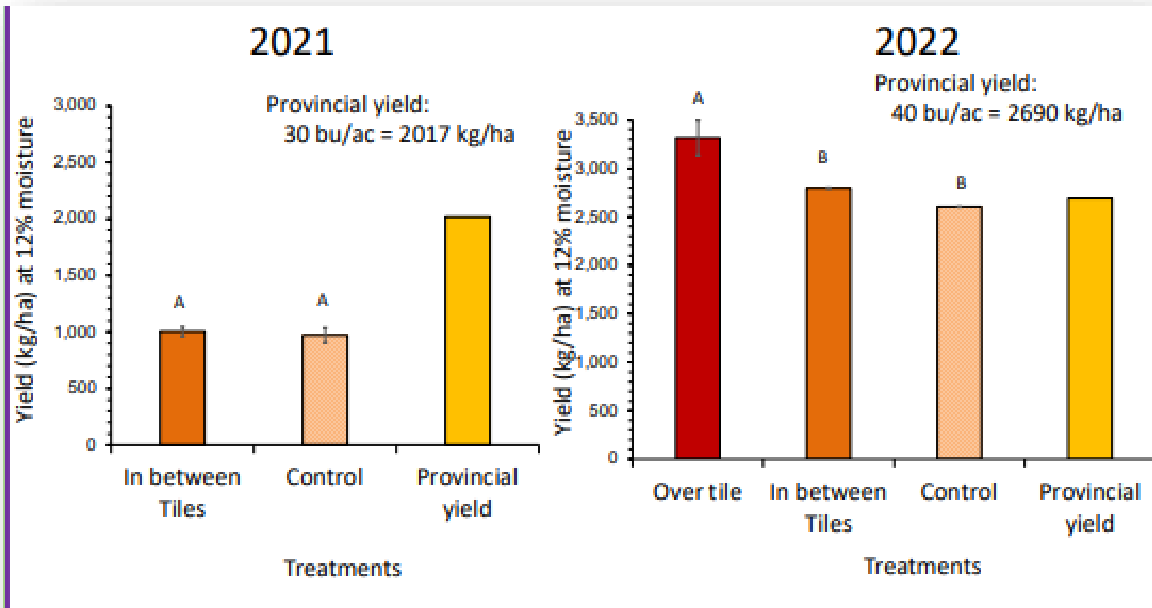


Figure 3. Soybean yield from different treatments

Conclusions

- Proper tile drainage can lead to soybean yield increase.
- Clay soils of Arborg, MB require drain tiles closer than 13.7 m (45') to effectively remove excess water during a wet year like 2022.

Introduction

- Soybean production has been expanding in the Canadian economy over the last decade.
- Canadian Prairies play a vital role in soybean production.
- Managing the water table is very important to increase crop productivity in areas where the water table is shallow.

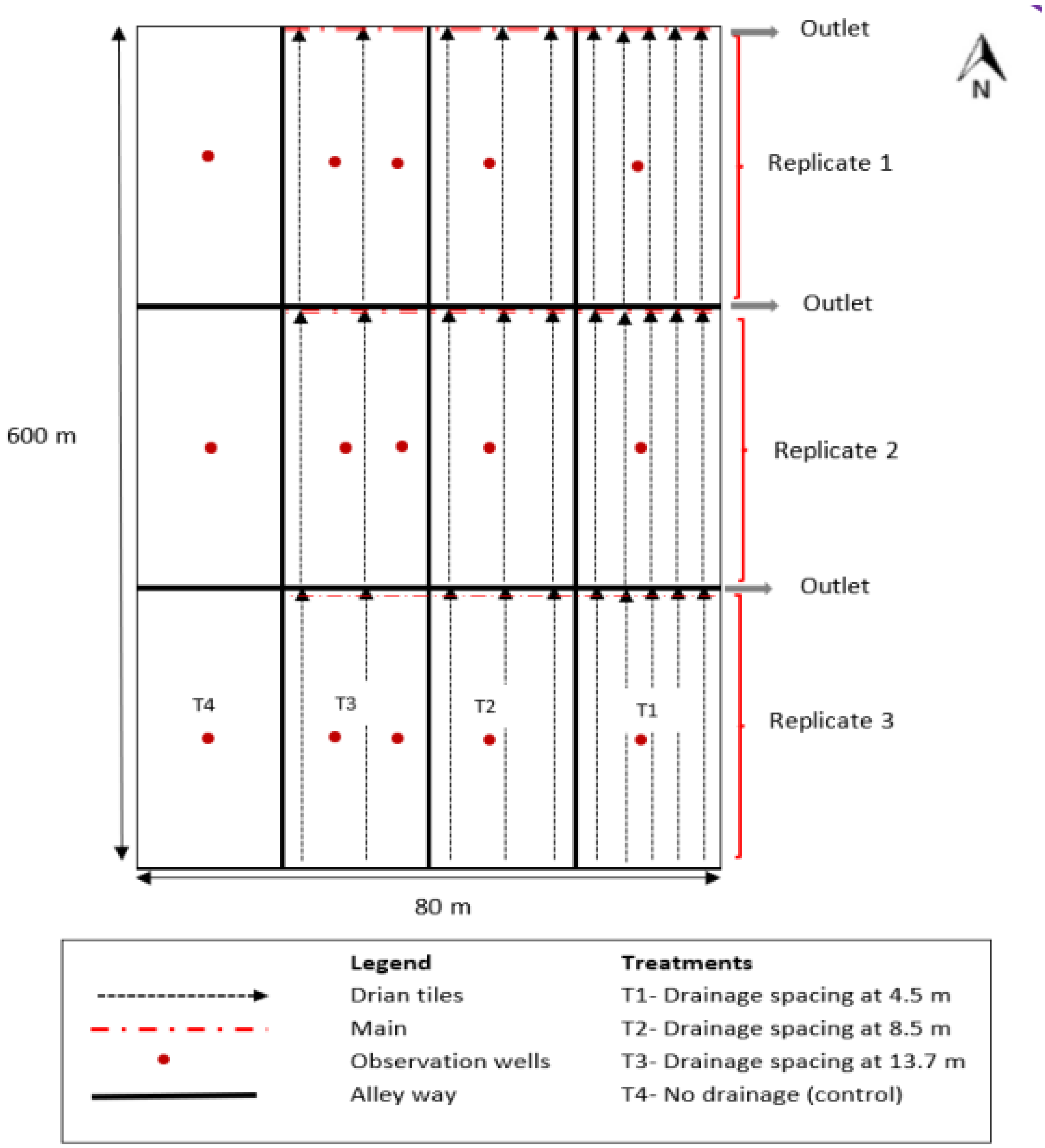


Figure 1: Field layout

Materials & Methods

- Location: PESAI, Arborg, MB.
- A two-year field study (2021-2022) was conducted to evaluate the drainage influence on soybean yield.
- As shown in the Fig. 1, the field has four large plots (600 × 20m/plot) running North-South which is further sub-divided into three replicates.
- Tile spacing of 4.5 m (15'), 8.5 m (30'), 13.7 m (45') and no tile were considered as four different treatments.

- However, this study used the data from the plots with the 4.5 m (15') and 13.7 m (45') spaced drain tiles planted with soybean for 2021 and 2022, respectively.
- In 2021, water table depth was measured in between tiles which were 4.5 m (15') apart.
- In 2022, water table depth was measured on the tile and in between tiles which were 13.7 m (45') apart.
- Tile drains were installed at depths ranging from 0.9 to 1.1 m.
- Piezometers were installed with water level sensors (Solinist Level logger) to measure the water table depth.
- Weather, groundwater level, and yield data were collected.

Reference

Moursi, H., Youssef, M., & Chescheir, G. (2022). Development and application of DRAINMOD model for simulating crop yield and water conservation benefits of drainage water recycling. Agricultural Water Management, 266, 107592.