

# PESAI Annual Report 2020



**PESAI**

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## 2020 Public / Industry Partners

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Agassiz Soil & Crop Improvement Association, Beausejour  
Agriculture and Agri-Food Canada, Portage la Prairie  
Agriculture and Agri-Food Canada, Ottawa  
Canada Manitoba Crop Diversification Centre  
BASIC Arborg  
Nutrien Ag Solutions  
Hemp Genetics International  
Manitoba Crop Alliance  
Manitoba Crop Variety Evaluation Team  
Manitoba Pulse & Soybean Growers Association  
Manitoba Agriculture and Resource Development  
Parkland Crop Diversification Foundation  
Parkland Industrial Hemp Growers  
Seed Manitoba  
University of Manitoba  
Saskatchewan Crop Development Centre  
Manitoba Flax Growers Association  
Westman Agricultural Diversification Organization Inc.  
Ducks Unlimited  
Montra Crop Science  
BASF  
Canadian Agronomics Inc.  
Foster Ag Services  
Solum Valley Biosciences  
Riddell Seed Co.  
Rutherford Farms Ltd.  
Western Ag Lab

## Who we are?

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

This initiative is the product of a partnership between the agricultural community of Interlake / Eastern Manitoba and Manitoba Agriculture & Resource Development. PESAI's objective is to support innovation, diversification and value-added opportunities in the Eastern and Interlake areas. PESAI receives the 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 field research 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 and workshops, annual reports & DC's website.

*Table 1. PESAI / Manitoba Ag Staff during 2020 crop season.*

<b>Diversification Specialist</b>	<b>Dr Nirmal Hari</b>	<b>Manitoba Ag (MARD)</b>
<b>Diversification Technician</b>	James Lindal	Manitoba Ag (MARD)
<b>Diversification Technician</b>	Britney Gilson*	Manitoba Ag (MARD)
<b>Diversification Technician</b>	Rupinder Kaur**	Manitoba Ag (MARD)
<b>Summer Research Assistant</b>	Kate LeTexier	PESAI
<b>Summer Technician</b>	Eugene Delorme	PESAI
<b>Summer Research Assistant</b>	Justine Pyziak	PESAI
<b>Summer Research Assistant</b>	Kelsey Benson	PESAI

\* Britney resigned from the position on May 8.

\*\* Rupinder joined PESAI as of September 17.

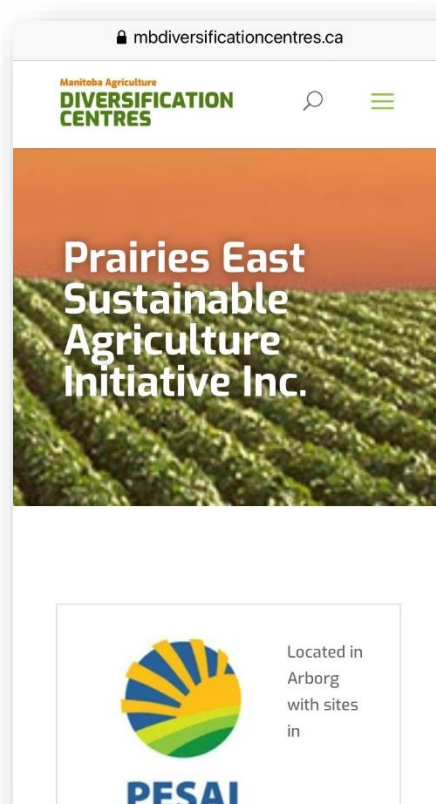
## Board of Directors: 2020-21

An elected Board comprised of agricultural producers and entrepreneurs from the Eastern Prairie region directs PESAI activities. Staff from Manitoba Agriculture and Resource Development helps to carry out PESAI activities.

Table 2. PESAI Board of Directors during 2020-21.

Chair	Adrien Grenier	Woodridge	204-429-2058
<b>Vice Chair</b>	Wayne Foubert	St. Anne	204-232-5069
<b>Secretary</b>	Linda Loewen	Riverton	204-378-2771
<b>Treasurer</b>	Andy Buehlmann	Arborg	204-376-2809
<b>Director</b>	Heinspeter Pausenwein	Whitemouth	204-348-7040
<b>Director</b>	Tim Shumilak	East Selkirk	204-482-5166
<b>Director</b>	Brian Kurbis	Beausejour	204-268-0239
<b>Director</b>	David King	Arborg	204-642-2695
<b>Director</b>	Scott Duguid	Arnes	204-641-4806

For more information about PESAI, please visit [www.mbdiversificationcentres.ca](http://www.mbdiversificationcentres.ca).



## PESAI Extension Activities (2020-21)

PESAI did several extension activities during 2020-21 to communicate about its research projects. The objectives of these activities are:

- 1) Communicating producers / industry about PESAI research projects and partnership / job opportunities
- 2) Encouraging participants for PESAI membership

Manitoba Agriculture & Resource Development staff assisted PESAI in all aspects of extension events, including:

- An announcement of PESAI's project submission deadline was advertised in Eastern and Interlake areas, as well as on social media.
- PESAI's 2020-21 Annual Report was compiled by Manitoba Ag support staff and it was uploaded on DC's website ([www.mbdiversificationcentres.ca](http://www.mbdiversificationcentres.ca)).
- Individual project reports were also uploaded on DC's website. A total of 16 projects reports are available on the website.
- PESAI developed two extension videos this year and these videos could be seen on DCs website. First video is on Soybean/Peas intercropping project while the other video is related to evaluation of annual forages in the Interlake.
- PESAI tweeted 11 times about its research and extension / job activities during 2020-21.

### Tweet Analytics: April 2020 - March 2021

Tweets	Month	Impressions	Retweets	Media Views	Total Engagements
PESAI Summer Openings	January	1637	13	50	140
Intercropping research in Interlake region	November	4390	3	24	71
Testing Fall lentils	October	370	2	25	50
Silage Corn harvesting	October	421	1	118	56
Testing of Winter Wheat	Sept	259	1	9	12
Flax Variety trials	Aug	348	1	14	34
Cereal varietal trials harvesting	Aug	336	2	115	23
Silage Corn variety testing	Aug	554	2	24	39
Spraying and plots advancement	July	873	2	51	97
Canola testing under high moisture conditions	June	826	3	43	65
Seeding trials wrap up	June	423	2	15	26

- Articles published about PESAI research activities during 2020-21

Article	Publication
The challenge of extreme moisture	Better Farming (Oct 2020 issue)
Research from concept to profitability	Pulse Beat (Winter 2020 issue)
GxE: Learning how environmental conditions affect the hemp industry in Canada	DFCC Website

- Small farmer tours (4-5 persons each time) were organized at annual forages / MCVET soybeans / Nutrient Ag soybeans / silage corn trial sites.
- PESAI members were sent 2020 MCVET evaluation results. Top three varieties from each crop type were shortlisted and this list was sent to them.
- Crop tour / Soybean research tour / Annual General Meeting were not held this year because of Covid-19 pandemic restrictions.



## Partner Project Reports

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*Project Reports for Partner-led Projects were submitted to PESAI by the Lead Partner listed. The information contained in the report was not verified.*

### Soil Based Methods to Screen Soybean Plants for Resistance to Iron Deficiency Chlorosis (IDC) and Seedling Vigor on Calcareous Manitoba Soils

#### Project Duration

March 1, 2020 to Jan 31, 2021

#### Objectives

The objective of this project is to develop an improved growth chamber or greenhouse method to enable rapid screening of soybean seedlings for resistance to iron deficiency chlorosis (IDC). IDC is a major stress factor impacting the yield potential and profitability of soybean production in the Interlake and Eastman regions of Manitoba.

#### Collaborators

Kevin Baron (Solum Valley Biosciences), Craig Riddell (Riddell Seed Co.), Rick Rutherford (Rutherford Farms Ltd.)

Email contact: [Kevin.Baron@solumvalley.com](mailto:Kevin.Baron@solumvalley.com)

#### KEY FINDINGS:

- Successfully developed a growth chamber screening methodology to evaluate the IDC tolerance of soybean germplasm with soils sourced directly from commercial fields in the South Interlake region of Manitoba
- Adapted the “Cone-tainer™” tube and tray system used by soybean researchers in the United States to induce symptoms of IDC resulting in significant changes in visual chlorosis score (VCS), relative chlorophyll levels, and dry weight of soybean seedlings within a 4-5 week time frame.
- Evaluated several low-cost sensors and imaging techniques to monitor plant growth and stress tolerance in a quantitative and non-destructive manner.

#### Results

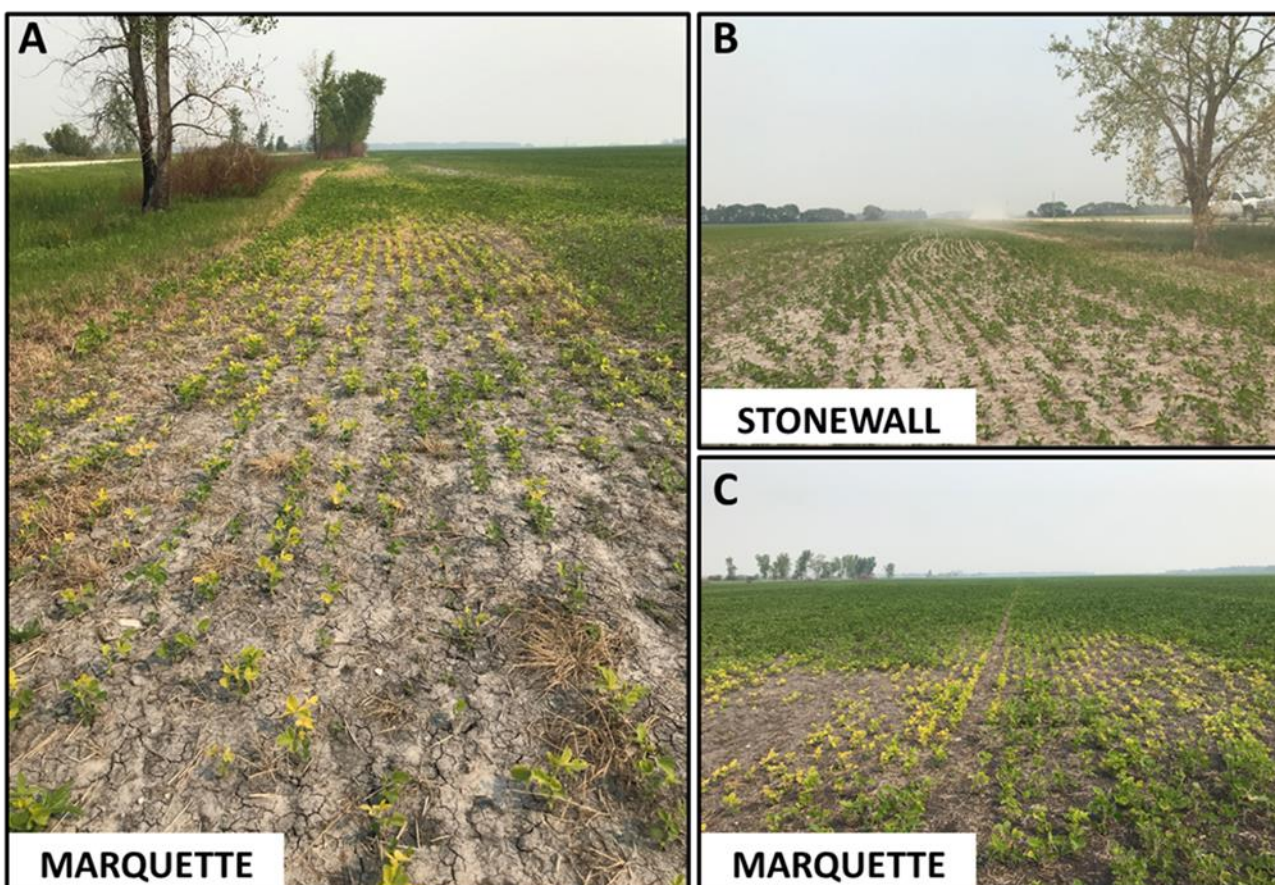
##### **Identify, Source and Characterize Regional Soils Prone to Iron Deficiency Chlorosis (IDC)**

During the 2019 growing season communication with local agronomists and growers led to identification of commercial soybean fields in the R.M. of Woodlands and Rockwood that displayed severe symptoms of iron deficiency chlorosis (Figure 1). Careful selection of soils would increase the likelihood IDC symptoms could be reliably induced with little or no external influence. In the fall of 2019 prior to freeze up multiple buckets of soil (0-6”) were sampled from each of these fields, sample locations geo-referenced and soils collected for subsequent use in growth chamber tests.

In addition to collecting two IDC prone soils from the South Interlake region, a professional potting mix (Sunshine Mix 4 Aggregate Plus), and an agricultural soil from the R.M. of North Cypress-Langford (Carberry: non-IDC reference soil) were submitted to AgVise Laboratories for complete analysis. Based on direct comparison of carbonate and soluble salt



levels against the AgVise IDC risk assessment table (Table 1), Stonewall and Marquette soils were assessed as very high and high, respectively, for risk of developing IDC symptoms (Table 2).



**Figure 1.** Field symptoms of iron deficiency chlorosis (IDC) in the Rural Municipalities of Rockwood and Woodlands. These specific fields were identified, geo-referenced, and sampled in 2019. Soils were submitted to AgVise Laboratories for analysis.

TABLE 1. FIELD RISK OF IDC BASED ON CARBONATE AND SOLUBLE SALT LEVELS			
SOLUBLE SALTS (mmhos/cm)	CARBONATE LEVEL (%)		
	0 to 2.5	2.6 to 5.0	> 5.0
0 to 0.25	Low	Low	Moderate
0.26 to 0.50	Low	Moderate	High
0.50 to 1.0	Moderate	High	Very High
> 1.0	High	Very High	Extreme

\*Adapted with permission from AgVise Laboratories

TABLE 2. CHARACTERIZATION OF SOILS SOURCED FOR GROWTH ROOM IDC ASSAYS								
LOCATION	SOLUBLE SALTS (mmhos/cm)	CARBONATES (%)	pH	Nitrate	O.M. (%)	SAND (%)	SILT (%)	CLAY (%)
STONEWALL (R.M. of Rockwood)	0.61 Very High	7.5 Very High	8.1	170 lb/ac	3.8	54	24	19
MARQUETTE (R.M. of Woodlands)	0.44 High	10.7 High	8.2	36 lb/ac	3.6	38	39	23
CARBERRY (R.M. of North Cypress-Langford)	0.25 Low	0.8 Low	6.7	48 lb/ac	5.0	72	17	11
GREENHOUSE MEDIA (Sunshine Mix 4 Aggregate Plus)	1.31	0.8	6.2	180 lb/ac	> 20% PEAT	-	-	-

Furthermore, the Stonewall soil was high in nitrate levels (170 lbs N/acre), another factor known to increase the severity of IDC symptoms in soybeans (Wiersma, 2010). In contrast, the chemical properties and nutrient levels of the professional grow mix and Carberry soil (low pH, low carbonates) indicate these reference soils were at lower risk for developing IDC symptoms (Table 2). Collectively, these results demonstrate that prior to growth chamber tests both Marquette and Stonewall soils had high risk to generate IDC symptoms with little external influence.

### ***Growth Chamber Screening for Iron Deficiency Chlorosis (IDC)***

Prior to test runs of the IDC assay in the fall of 2020, plant growth facilities were established at Riddell Seed Co. in Warren, MB. Plastic Ray-Leach “Cone-tainer™” cells used in the greenhouse nursery industry were also purchased. Several soybean researchers in the US (Lee et al. 2008; Goos, 2019) employ this equipment as a cost-effective and space-efficient alternative to hydroponic systems to screen germplasm (See Figure 2 and Materials and Methods section). Two regionally adapted soybean varieties (Mahony, Redvers) sourced from Riddell Seed Co. and Rutherford Farms Ltd, were seeded into pots/cells containing sieved and mixed Stonewall, Marquette or Carberry soils (Figure 2). Over a 4-5 week period seedlings were monitored for appearance of IDC symptoms and evaluated for visual chlorosis score (VSCs). Experiments ended with individual soybean seedlings harvested for dry matter assessments at the V2-V3 stage of development. Direct comparison of soybean growth across non-IDC (Carberry) and high IDC risk soils (Marquette, Stonewall) revealed significant differences in visual chlorosis score (VCS) and seedling dry matter (DM) (Table 3).

### ***Hand-Held Sensors to Obtain Quantitative and Non-Destructive Data on Soybean Growth and Stress Tolerance***

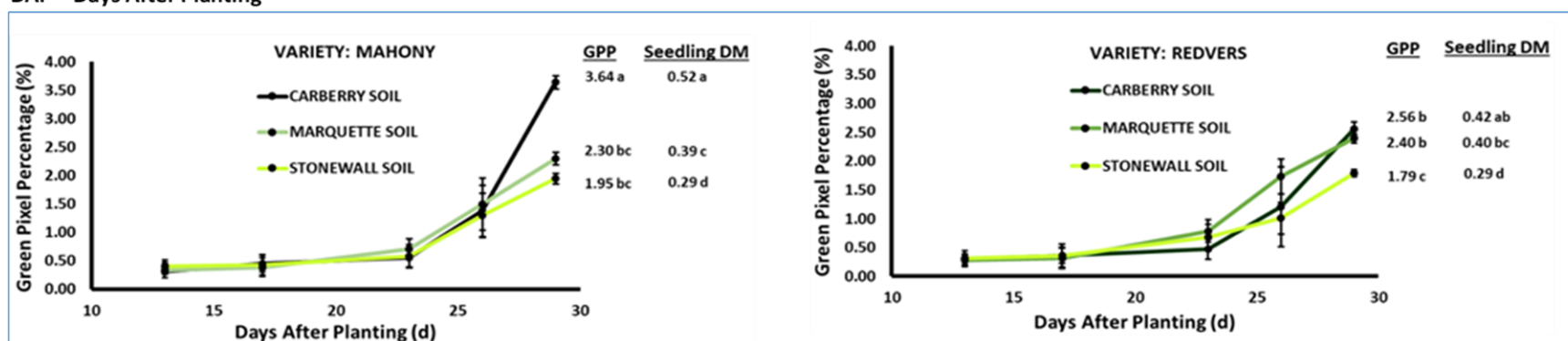
In addition to assessing soybean varieties for symptoms of IDC using the subjective rating system of visual chlorosis scores (VCSs) (1= green and tolerant, 5 = chlorotic and susceptible), the current study evaluated a chlorophyll meter (AtLEAF) (Zhu et al. 2012), a FLIR thermal imaging camera (Prashar and Jones, 2014), and iOS Canopeo app (Patrignani & Ochsner, 2015) to obtain quantitative information regarding the performance of individual soybean seedlings in response to stress (Figure 4; Table 3). These low cost cameras and sensors were evaluated as a means to obtain non-destructive and quantitative information on growth and stress tolerance of seedlings without harvesting plants. These tools will continue to be evaluated in the context of designing screens that can be applied to individual plants in a controlled environment through to field research trial scenario. Significant differences in relative chlorophyll content of unifoliate and trifoliate leaves (Figure 3; Table 3) corresponded with observed changes in visual chlorosis score assigned to whole seedlings (Table 3).

**TABLE 3. EFFECT OF SOIL TYPE AND IDC SOLUTION ON DRY MATTER PRODUCTION, VISUAL IDC SCORE, CHLOROPHYLL CONTENT LEAF TEMPERATURE AND CANOPY COVERAGE OF SOYBEAN VARIETIES**

VARIETY	SOIL TYPE	VISUAL CHLOROSIS SCORE (VCSS)* (1-5 Rating)	AtLEAF LEAF GREENNESS Unifoliate Leaf	AtLEAF LEAF GREENNESS 1st Trifoliate Leaf	Leaf Temperature (Celsius)	Green Pixel Percentage (GPP) 29 DAP	SEEDLING DRY MATTER (DM) g/plant
Mahony	Carberry	1.0 c	37.0 a	35.8 a	28.8 d	3.64 a	0.52 a
Mahony	Marquette	2.8 b	33.7 b	30.2 b	31.3 ab	2.30 bc	0.39 c
Mahony	Stonewall	3.3 ab	31.6 c	30.7 b	33.7 c	1.95 bc	0.29 d
Redvers	Carberry	1.3 c	37.3 a	38.7 a	33.1 ab	2.56 b	0.42 ab
Redvers	Marquette	3.5 a	35.2 b	27.9 b	32.5 b	2.40 b	0.40 bc
Redvers	Stonewall	3.3 ab	34.2 b	30.9 b	34.1 a	1.79 c	0.29 d
CV %		19.34	7.41	14.06	4.49	18.8	1.84
LSD (0.05)		0.4	2.1	3.7	1.1	0.80	0.06
Sign. Diff		Yes	Yes	Yes	Yes	Yes	Yes

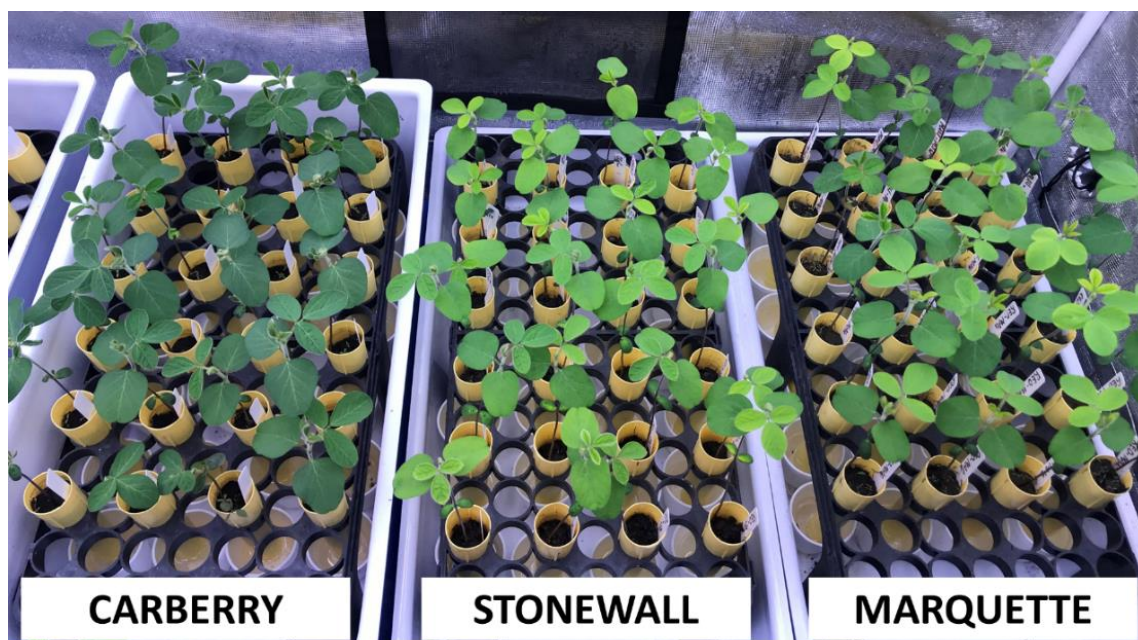
\* = Visual chlorosis score (1 = green leaves, tolerant) (5 = severe chlorosis/yellowing, stunted)

DAP = Days After Planting

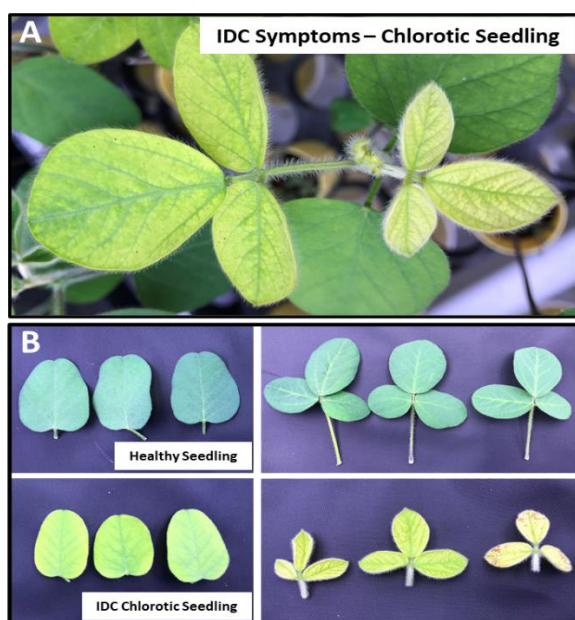


**Figure 5.** Soybean seedlings of two varieties (Mahony, Redvers) were grown within Carberry, Marquette and Stonewall soils (See Figure 2). Following emergence, individual seedlings (n=12 per soil tray) were imaged every 3-6 days until seedlings were harvested for dry matter assessments. The Canopeo App (See Figure 4) was used to estimate % green pixel percentage (GPP) for each seedling. This method has previously been applied to indirectly estimate the biomass of sorghum seedlings without the need to harvest plants (Chung et al. 2017). The relationship between progression of green pixel percentage (GPP = estimate of biomass) and actual seedling dry matter (DM) are displayed side by side on graphs above.



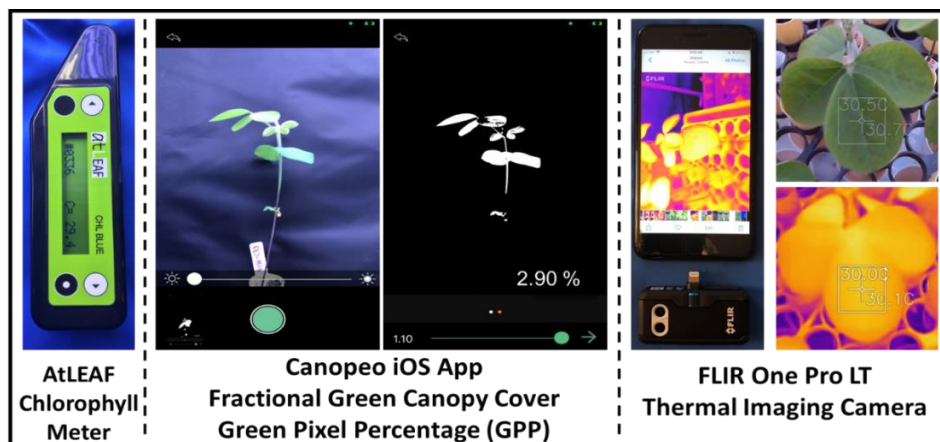


**Figure 2.** Soybean seedlings growing within Ray-Leach “Cone-tainer™” system, a space- efficient tube and tray system used in nursery greenhouse production. White flow trays contain cups filled daily with IDC sub-irrigation solution to induce IDC symptoms. Each white flow tray contains 24 seedlings (n=12, Mahony; n=12 Redvers). Middle (Stonewall soil) and far right (Marquette soil) trays contain two high IDC risk soils (Table 2) showing visible symptoms of chlorosis across Mahony and Redvers cultivars. In contrast, the same two varieties grown in the low IDC risk soil from Carberry (far left) and also receiving the sub-irrigation solution to induce IDC symptoms remain green and do not display visible symptoms of IDC.



**Figure 3.** Plant level symptoms of iron deficiency chlorosis (IDC) in growth room tests. (A) Soybean seedling displaying symptoms of iron deficiency chlorosis. (B) Top panels - Unifoliate leaves (left panel) and trifoliate leaves (right) from seedlings grown in Carberry soil appear healthy and green. Bottom panels – Unifoliate (left panel) and trifoliate leaves (right) with visible reductions in leaf greenness or chlorosis in Stonewall soil.

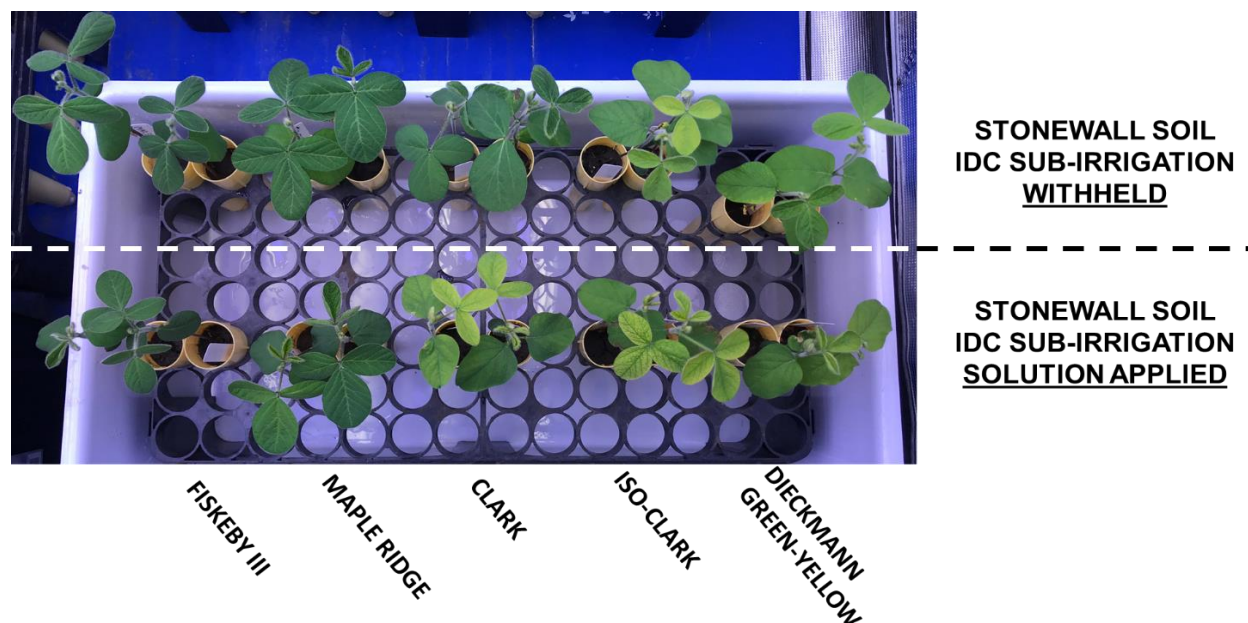




**Figure 4.** A handheld chlorophyll meter (AtLEAF), iPhone app (Canopeo), and thermal imaging camera (FLIR One Pro LT) were utilized to obtain quantitative information regarding leaf greenness/relative chlorophyll content, green pixel percentage (biomass estimate), or leaf temperature of soybean seedlings exposed to IDC stress. These tools are being assessed as a complement to subjective visual chlorosis scores (VSC) often used to rate IDC in soybeans.

### **IDC Symptoms Across Iron Efficient (EFF) and Iron Inefficient (INF) Soybean Plant Introductions.**

Beyond the two cultivars evaluated in the current study, several well-characterized IDC resistant and susceptible soybean lines have been obtained from germplasm stock centres. The reaction of select iron efficient (EFF) and iron-inefficient lines (INF) sown in Stonewall soil with and without IDC solution applied are shown in Figure 6 below.



**Figure 6.** Plant Introductions (PI) obtained from US and Canadian germplasm stock centres and characterized as being iron-efficient (EFF) or inefficient (INF) were also evaluated in the current study. In the above panel Fiskeby III and Maple Ridge are known EFF lines and do not show symptoms of IDC when grown in Stonewall soil and watered or when IDC sub-irrigation solution are applied. In contrast, Iso-Clark and Dieckmann Green-Yellow, two INF lines, demonstrate symptoms of chlorosis with and without IDC sub irrigation solution applied. Iron-efficient Clark does not display symptoms of chlorosis when grown in Stonewall soil and watered but does display symptoms of IDC when sub-irrigation solution is applied.

## Project Findings

The development of a soil-based method to screen for iron deficiency chlorosis is the first step for several related projects. For external clients, such as commodity organizations or private seed companies, N49 Genetics (Kevin Baron, Craig Riddell, Rick Rutherford) has the capacity to screen soybean germplasm for IDC twelve (12) months a year and outside of a field nursery scenario, or even in advance of the planting season. This is advantageous if agronomists or growers are hesitant to plant new genetics that have not been adequately screened on some of the more challenging soils in Manitoba.

Obtaining reliable and consistent visual chlorosis scores (VCSs) between field environments and across growing seasons is also known to be problematic, and this is intimately linked with spatial variability in soil parameters (carbonates, salts) and the unpredictable nature of weather events (e.g. rainfall, cold temperature) that contribute to IDC. If conditions during the growing season are not conducive to IDC symptoms appearing, this method could be accessed to supplement information generated from varietal screening conducted on an annual basis in field environments.

For N49 Genetics, this soil-based method provides a means to continually select IDC resistant seedlings from breeding populations. Over the 2021 and 2022 seasons, N49 Genetics will establish specialized temperature-controlled facilities that enable soybean seedlings to continuously be screened under conditions (soils, daylength, and temperature) that mimic the early season growing conditions in Manitoba and Saskatchewan. Development of a soil-based assay also enables selection of root-related traits (e.g. N<sub>2</sub>-fixation, rhizosphere pH, root foraging) that may not be adequately captured in hydroponic systems.

## Background and Additional Resources

The equipment & techniques developed in this study were adapted from US researchers seeking to replace hydroponic systems with a more rapid, cost-effective and soil-based method of screening soybean germplasm for salt tolerance (Lee et al. 2008). Locally, MPSG-funded research has also contributed to the development of a hydroponic system at AAFC Morden to screening soybean germplasm for IDC (Hou, 2017). During the course of our study, Jay Goos with North Dakota State University also published a technical report detailing a sand:soil culture method of inducing IDC symptoms using the “Cone-tainer™” system (Goos, 2019). Several aspects of the current methodology have drawn up from previously published work.

### References

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## Acknowledgments

The financial support of the Prairies East Sustainable Agriculture Initiative (PESAI) towards greenhouse equipment and laboratory costs associated with development of this methodology is greatly appreciated.

## Materials and Methods

- High risk IDC soils (Marquette, Woodlands), a non-IDC soil (Carberry) and potting mix were mixed and sieved and all used as growth medium.
- Seeds of two cultivars (Mahony n=12 per tray, Redvers n=12 per tray) were planted into “Cone-tainer™” pots and held within trays. One tray per soil type.
- From planting to harvest of seedlings (< 5 weeks), plants were grown under 14h (day):10(dark) light schedule, 25/20°C day/night temperatures and humidity maintained at 55-75%.
- After emergence of seedlings, each cone-tainer tube was submerged into Styrofoam cups containing a sub-irrigation solution (20mM sodium bicarbonate, 80mM sodium chloride, 10mM calcium nitrate) to induce IDC symptoms.
- Over the course of the experiment seedlings were imaged every 3-6 days for seedling biomass/green pixel percentage (Canopeo app), leaf temperature (FLIR camera) or relative chlorophyll levels (AtLEAF meter).
- Prior to harvest of seedlings for dry weight determinations, seedlings were rated for visual chlorosis scores (VCSs) and seedling height measured.
- Data was analyzed as a randomized complete block design, with cells and trays rotated within the growth room on regular interval.

## Intercropping with Soybeans and Peas

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### Project duration

2019- 2021

### Objectives

1. Gain experience in intercropping: observe and evaluate agronomic performance of intercropping compared to mono-cropping
2. Evaluate yield potential, land use equivalency and profitability of intercropping compared to mono-cropping
3. Overall, start a knowledge base on if and how intercrops can be utilized in cropping systems in the Interlake

### Collaborators

Prairies East Sustainable Agriculture Initiative Inc. (PESAI) – Arborg, MB

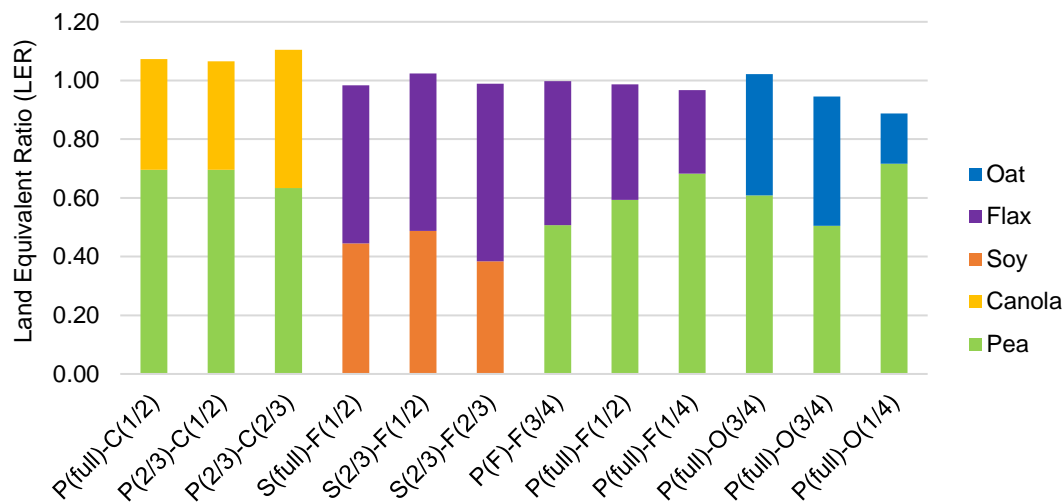
### Project Findings

This was the second successful year of experimenting with intercropping in the Interlake region of Manitoba. Treatments included three seeding rate combinations of pea-canola, soybean-flax, pea-flax and pea-oat compared to pea, canola, flax, soybean and oat monocrops. Results of the experiment including treatment descriptions, agronomic practices, yield, gross and marginal revenues and general observations are listed in Tables 2 and 3 and each intercrop treatment is discussed at the end of the report. The 2020 growing season at Arborg was dry with 70% of normal growing season precipitation (Table 1) compared to 55% of normal precipitation in 2019.

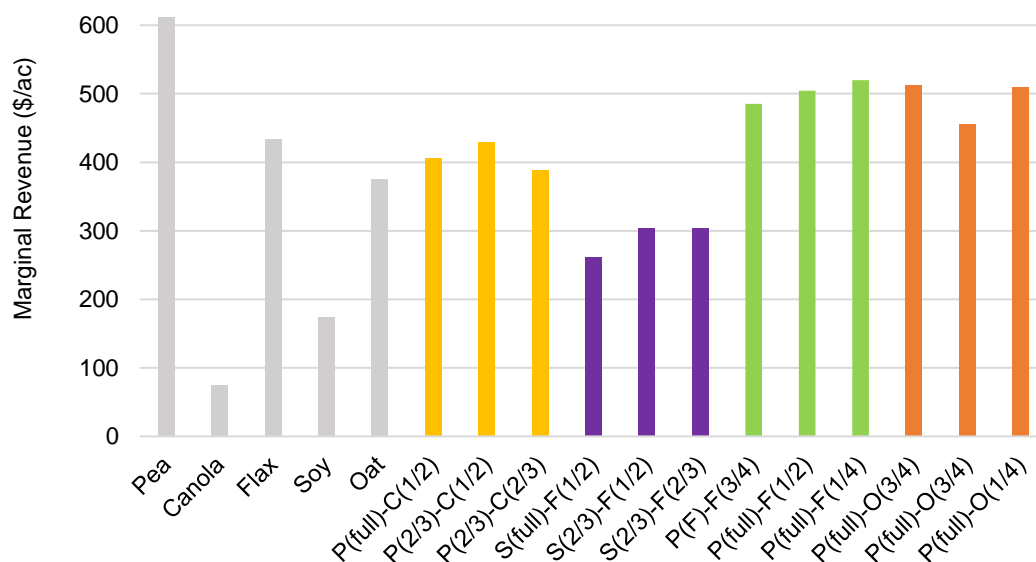
In both years of study, flax and pea have produced the highest marginal revenue of the monocrops. Canola was challenged with flea beetles and grasshoppers in 2020. Pea-canola was the only intercrop to consistently over-yield in 2019 and 2020 (Fig. 1) while marginal revenues were impressive for pea, pea-oat and pea-flax (Fig. 2). After two years of study in Arborg, we have been able to draw some conclusions on optimum seeding rate ratios, consistency of over-yielding and profitability (see individual intercrop treatment discussions). The pea-oat intercrop was sampled for total dry matter and forage nutrient analysis (Table 4) which will be helpful for livestock farmers.



## Results



**Figure 1.** Average total Land Equivalent Ratio (LER) for each intercrop treatment composed of each partial LER crop component ( $n=3$ ) at Arborg, MB in 2020.



**Figure 2.** Average marginal revenue of monocrop and intercrop treatments at Arborg, MB in 2020.

**Table 1.** Seasonal growing degree days, crop heat units and precipitation at Arborg in 2020.

	May	June	July	August	May-August
<b>Growing degree days (GDD)</b>	177	364	466	417	1425
<b>Normal % growing degree days</b>	86	108	107	108	104
<b>Crop heat units (CHU)</b>	314	557	741	660	2293
<b>Normal % crop heat units</b>	85	101	104	103	100
<b>Precipitation (mm)</b>	12	83	61	33	190
<b>Normal % precipitation</b>	23	107	101	42	70

Source: <https://web43.gov.mb.ca/climate/SeasonalReport.aspx>

Table 2. Seeding rates, varieties, seed depth, plant stand, plant height, yield and profit of intercrop treatments in 2020 at Arborg, MB.

No.	Treatment	Crop	Seed rate strategy	Variety	Seeding rate (seeds/m <sup>2</sup> )	Plant stand* (plants/m <sup>2</sup> )	Land Equivalent Ratio ‡	Height (cm)	Yield † (bu/ac)	Gross ‡ revenue (\$/ac)	Marginal revenue ‡ (\$/ac)
1	Pea	Pea	Full	CDC Amarillo	100	80	1.0	68	90.4	722.94	612.47
2	Canola	Canola	Full	5545 CL	108	52	1.0	83	19.3	217.20	74.78
3	Flax	Flax	Full	CDC Glas	700	394	1.0	55	35.7	500.15	433.66
4	Soybean	Soybean	Full	NSC Watson	49	47	1.0	55	25.5	290.34	173.77
5	Oats	Oats	Full	Souris	355	149	1.0	77	105.2	394.48	376.35
6	Pea-canola	Pea Canola	Full 1/2	CDC Amarillo 5545 CL	100 54	86 25	1.07	60 76	62.9 7.3	585.17	406.21
7	Pea-canola	Pea Canola	2/3 1/2	CDC Amarillo 5545 CL	67 54	42 33	1.07	60 79	62.8 7.2	583.13	429.56
8	Pea-canola	Pea Canola	2/3 2/3	CDC Amarillo 5545 CL	67 72	53 36	1.10	57 74	57.3 9.1	560.56	388.13
9	Soy-Flax	Soybean Flax	Full 1/2	NSC Watson CDC Glas	49 350	47 223	0.98	44 58	11.3 19.2	398.59	261.91
10	Soy-Flax	Soybean Flax	2/3 1/2	NSC Watson CDC Glas	33 350	35 185	1.02	45 62	12.4 19.2	409.80	304.00
11	Soy-Flax	Soybean Flax	2/3 2/3	NSC Watson CDC Glas	33 467	35 335	0.99	46 61	9.8 21.6	413.92	303.97
12	Pea-Flax	Pea Flax	Full 3/4	CDC Amarillo CDC Plava	100 525	62 273	1.0	57 62	45.8 17.5	611.98	485.46
13	Pea-Flax	Pea Flax	Full 1/2	CDC Amarillo CDC Plava	100 350	68 175	0.99	60 61	53.6 14.1	625.60	504.31
14	Pea-Flax	Pea Flax	Full 1/4	CDC Amarillo CDC Plava	100 175	76 86	0.97	67 55	61.7 10.2	635.79	519.75
15	Pea-Oat	Pea Oat	Full 3/4	CDC Amarillo Souris	100 266	78 100	1.02	59 78	55.0 43.6	602.94	513.28
16	Pea-Oat	Pea Oat	Full 1/2	CDC Amarillo Souris	100 178	80 90	0.95	64 77	45.6 46.4	538.70	455.53
17	Pea-Oat	Pea Oat	Full 1/4	CDC Amarillo Souris	100 89	79 36	0.89	62 71	64.8 18.0	585.65	509.63

\*Optimum plant stands for monocrops: peas (7-8 plants/ft<sup>2</sup> or 70-80 plants/m<sup>2</sup>), canola (5-7 plants/ft<sup>2</sup> or 50-70 plants/m<sup>2</sup>), flax (37-56 plants/ft<sup>2</sup> or 396-599 plants/m<sup>2</sup>), soybean (4 plants/ft<sup>2</sup> or 40 plants/m<sup>2</sup>) and oats (18-23 plants/ft<sup>2</sup> or 194-248 plants/m<sup>2</sup>).

† Average crop yields in the Bifrost-Riverton municipality: 36.8 bu/ac peas, 30.1 bu/ac canola, 17.8 bu/ac flax and 31.3 bu/ac soybean (MASC, 1993-2019).

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

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

(Market prices from Manitoba Agriculture 2021 Costs of Production: \$8.00/bu peas, \$11.25/bu canola, \$14.00/bu flax, \$11.40/bu soybean and \$3.75/bu oats)

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

Table 3. Seeding depth, weed control, fertility and general notes/observations of intercrop treatments in 2020 at Arborg, MB.

No.	Treatment	Crop	Seed rate	Depth	Herbicides/weed control*	Fertilizer applied†	General notes and observations
1	Pea	Pea	Full	1.5"	Pre-emerge: Authority In-crop: Odyssey	15 lbs/ac P <sub>2</sub> O <sub>5</sub>	Pea aphids were sprayed July 20. Harvest date Aug 26.
2	Canola	Canola	Full	0.75"	Pre-emerge: None In-crop: Odyssey	38 lbs N/ac; 15 lbs/ac P <sub>2</sub> O <sub>5</sub>	Sprayed for flea beetles in June and for flea beetles and grasshoppers in August. Desiccated Sept 2.
3	Flax	Flax	Full	0.75"	Pre-emerge: Authority 480 In-crop: Clethodim	15 lbs/ac P <sub>2</sub> O <sub>5</sub>	Desiccated Sept 4.
4	Soybean	Soybean	Full	1"	Pre-emerge: Authority 480 In-crop: Glyphosate	15 lbs/ac P <sub>2</sub> O <sub>5</sub>	Harvest date Sept 15.
5	Oats	Oats	Full	1.5"	Pre-emerge: None In-crop: None	15 lbs/ac P <sub>2</sub> O <sub>5</sub>	Harvest date Aug 19.
6	Pea-canola	Pea	Full	0.75"	Pre-emerge: None In-crop: Odyssey	15 lbs/ac P <sub>2</sub> O <sub>5</sub>	Pea-canola was sprayed for flea beetles in June and for a late season attack of flea beetles and grasshoppers in August. Pea-canola was desiccated Sept 2.
		Canola	1/2				
7	Pea-canola	Pea	2/3	0.75"		None	
		Canola	1/2				
8	Pea-canola	Pea	2/3	0.75"	Pre-emerge: Authority 480 In-crop: Clethodim	None	To achieve row separation, soybean was seeded down the mid-row resulting in 4.5-inch separation from the flax row. Maturity of both crops aligned well. Harvest date was Sept 15.
		Canola	2/3				
9	Soy-Flax	Soybean	Full	0.75"		15 lbs/ac P <sub>2</sub> O <sub>5</sub>	
		Flax	1/2				
10	Soy-Flax	Soybean	2/3	0.75"	Pre-emerge: Authority 480 In-crop: Clethodim	None	Pea-flax was desiccated Sept. 4.
		Flax	1/2				
11	Soy-Flax	Soybean	2/3	0.75"		None	
		Flax	2/3				
12	Pea-Flax	Pea	Full	1"	Pre-emerge: Authority 480 In-crop: Clethodim	None	Wild oats were a problem in the trial area. Hand-weeding was done but the weed pressure may be a confounding factor.
		Flax	3/4				
13	Pea-Flax	Pea	Full	1"		15 lbs/ac P <sub>2</sub> O <sub>5</sub>	
		Flax	1/2				
14	Pea-Flax	Pea	Full	1"	Pre-emerge: None In-crop: None	None	Hand weeding for wild oat patches
		Flax	1/4				
15	Pea-Oat	Pea	Full	1.5"		None	Harvest date was Aug 26.
		Oat	3/4				
16	Pea-Oat	Pea	Full	1.5"		15 lbs/ac P <sub>2</sub> O <sub>5</sub>	
		Oat	1/2				
17	Pea-Oat	Pea	Full	1.5"	Hand weeding for wild oat patches	None	
		Oat	1/4				

\*There was a wild oat patch running through Replicate 2 that was hand weeded in all treatments. Pea-oat and oat treatments were also hand weeded for wild oats.

†All intercrop treatments were to receive 15 lbs P<sub>2</sub>O<sub>5</sub>/ac but only 1 of each intercrop treatment received the starter P due to human error.

Table 4. Forage nutrient analysis of oat monocrop and pea-oat intercrop from Arborg 2020. Samples were collected on July 9, 2020 at pea flowering (R2) and oat heading (inflorescence).

	Feed Basis	Oat	Pea-Oat
Moisture (%)	As Fed	3.0	4.2
Dry Matter (%)	As Fed	96.8	95.8
Crude Protein (%)	As Fed	10.0	14.5
Relative Feed Value	Dry Matter	96.0	110.0
Total Dry Matter (lbs/ac)	Dry Matter	10,220	9,002
Calcium (%)	As Fed	0.2	0.7
Phosphorus (%)	As Fed	0.3	0.3
Magnesium (%)	As Fed	0.2	0.4
Potassium (%)	As Fed	2.6	2.7
Sodium (%)	As Fed	0.4	0.3
Acid Detergent Fibre (%)	As Fed	33.6	33.3
Neutral Detergent Fibre (%)	As Fed	58.2	51.1
Non Fibre Carbohydrates (%)	As Fed	18.4	19.9
Total Digestible Nutrients (%)	As Fed	59.7	58.9
Metabolizable Energy (Mcal/kg)	As Fed	2.2	2.2
Net Energy for Lactation (Mcal/kg)	As Fed	1.4	1.3
Digestible Energy (Mcal/kg)	As Fed	2.6	2.6
Net Energy for Maintenance (Mcal/kg)	As Fed	1.3	1.3
Net Energy for Gain (Mcal/kg)	As Fed	0.8	0.0

### Pea-Oat

The pea-oat treatments produced LERs from 0.89 to 1.02 indicating that over-yielding did not occur compared to oat and pea monocrops. Among the intercrop treatments, the pea (full rate)-oat (3/4 rate) produced the highest LER (1.02) and marginal revenue (\$513/ac) but marginal revenue was still lower than monocrop peas which yielded 90 bu/ac. In 2019, we could not calculate LER (no oat monocrop in the trial) but the pea (full rate)-oat (1/2 rate) was more economical than both crops seeded at 2/3 rate.



**From two years of study at Arborg, the over-yielding benefit and optimum seeding rate ratio for pea-oat intercropping remains somewhat unclear. It is likely that a full pea seeding rate should be maintained and that there is good weed suppression (no in-crop herbicide has been required).**

In 2020, we also collected above ground biomass samples at pea flowering and oat heading for forage analysis. Samples were collected from each replicate of the oat monocrop and pea (full)-oat (1/2 rate) intercrop treatments. The overall average values for each treatment are in Table 4. Pea-oat intercrop dry matter was slightly lower but CP and RFV were higher. It is important to note that grain varieties were used and different results may be expected with forage varieties.



### **Pea-canola**

All pea-canola treatments produced a land equivalent ratio (LER) greater than 1 (Table 2), indicating that over-yielding occurred. Over-yielding also occurred in all treatments in 2019. Peas yielded very well in the intercrop (57-63 bu/ac) and monocrop treatments (90 bu/ac). Canola yielded poorly in the monocrop (19 bu/ac) and the intercrop treatments (7-9 bu/ac), likely due to early and late season insect damage and above average temperatures through flowering. The mean daily temperature



in July 2020 was 20.0°C compared to the long-term average of 18.6°C. The pea-canola treatment where both crops were seeded at 2/3 of a full rate produced a slightly higher LER than the other two treatments. The pea-canola treatment with peas seeded at 2/3 rate and canola at 1/2 rate resulted in the highest marginal revenue (\$430/ac) which was \$24-42/ac higher than the other two treatments but much lower than the monocrop peas (\$613/ac). In both years of study, the established plants stand of the pea (2/3 rate)-canola (1/2 rate) treatment were similar - 21 pea plants/m<sup>2</sup> and 17-24 canola plants/m<sup>2</sup> which is 31% establishment for pea and 35% establishment for canola.

***Intercropping pea and canola in 2019 and 2020 consistently resulted in over-yielding (LER from 1.07 to 1.20). Seeding peas at 2/3 rate (67 seeds/m<sup>2</sup>) and canola at a 1/2 rate (54 seeds/m<sup>2</sup>) resulted in the most economic pea-canola intercrop. Overall, intercrop peas produced 70 to 106% of monocrop pea yield and canola produced 16-37% of monocrop canola yield.***

In both years, the additional cost of a higher canola rate was not offset by increased yield. In 2020, a third treatment was included that used a full rate of pea and 1/2 rate of canola, but the additional seed cost of a higher pea rate was not offset by increased yield. Marginal revenues of canola treatments in both 2019 and 2020 were reduced due to insecticide applications. More favorable growing conditions for canola would shift the economics for monocrop canola and may alter the yield ratio between pea and canola in the intercrops.

Pea-canola intercrops have been well studied in Manitoba and has consistently over-yielded compared to pea and canola monocrops. At Carman and Kelburn, MB from 2001-2003<sup>1</sup>, Dr. Martin Entz's research team found that pea-canola resulted in over-yielding 100% of the time under conventional management with an average LER of 1.21. Pea-canola intercrops were studied in on-farm trials at Carman, MB in 2015<sup>2</sup> and 2016<sup>3</sup>. Peas and canola were seeded in the same mixed row at ~2/3 of a full rate (110 lbs/ac peas and 3-4 lbs/ac canola; 180 lbs/ac monocrop peas; 5-6 lbs/ac monocrop canola) with three supplemental N rate comparisons. Increasing N rate in the intercrops increased canola yield, reduced pea yield and reduced marginal revenue. In both years of on-farm study at Carman, LERs ranged from 1.04 to 1.16 and marginal revenue was highest with the 0N or low N rate.

### **Soybean-Flax**

The soybean-flax treatments produced a land equivalent ratio close to 1 (0.98 to 1.02) indicating that over-yielding did not occur. Flax yielded very well in the monocrop treatment (36 bu/ac) while soybeans were below average (26 bu/ac). In the intercrop treatments, flax yielded 19-22 bu/ac (54-61% of monocrop flax) and soybean yielded 10-12 bu/ac (38-49% of monocrop soybean). Among the intercrop treatments, LERs were similar but marginal revenue was highest where soybean was seeded at 2/3 rate (33 seeds/m<sup>2</sup>) and flax at a ½ rate to 2/3 rate (350-395 seeds/m<sup>2</sup>). At 36 bu/ac flax, however, the intercrop treatments were not as profitable as monocrop flax in 2020.



***From two years of study at Arborg, intercropping soybean and flax has produced LERs from 0.55 to 1.02 and has not been consistently economical compared to monocrop flax. Out of the seeding rate combinations tested, a soy-flax intercrop should be seeded in separate rows with a 2/3 rate of soybean (33 seeds/m<sup>2</sup>) and ½ to 2/3 rate of flax (350-395 seeds/m<sup>2</sup>).***

In 2019, soybean and flax were seeded in the same row which resulted in the flax outcompeting soybean. This has also been observed at Melita (Scott Chalmers, personal communication). Variety choice is an important consideration to ensure that both crops mature at a similar time. With CDC Glas flax, we used S007Y4 soybean in 2019 which matured later than the flax and in 2020, we used NSC Watson, which matured earlier and closer to flax. The intercrops were not desiccated.

### **Pea-Flax**

Pea-flax treatments produced a land equivalent ratio (LER) close to 1 (Table 2), indicating that over-yielding did not occur. Marginal revenue for all intercrop treatments (\$485-520/ac) was higher than monocrop flax (\$434/ac) which yielded 36 bu/ac but lower compared to monocrop peas (\$613/ac) which produced an exceptional yield of 90 bu/ac. Among the intercrop treatments, the LERs were similar (0.97-1.0), but the marginal revenue was highest with the pea (full rate)-flax (1/4 rate). In 2019, we tested pea (full rate)-flax (1/2 rate) and pea (2/3 rate)-flax (2/3) rate - both the LER and marginal revenue of the two seeding rate combinations were similar. In both years of study, peas matured ahead of flax and a desiccant was applied to facilitate timely harvest.



***From two years of study at Arborg, intercropping pea and flax has resulted in LERs from 0.98 to 1.02. Marginal revenue of intercropping in 2019 was lower than flax and pea monocrops and in 2020, pea-flax marginal revenue was higher than flax but lower than peas. More work is needed to identify the optimum seed rate ratio for pea-flax***

***intercropping. In 2019, it was also observed that flax chlorosis may be reduced with intercropping.***

### **Background / References / Additional Resources**

Intercropping is the practice of seeding, growing and harvesting two or more crops together. The concept is to utilize crop combinations that complement one another through mechanisms such as resource use efficiency and potentially result in over-yielding and greater profitability compared to monocropping. Careful consideration needs to be given to how the crops are be seeded, managed, harvested and separated. The most common intercrop grown commercially in Manitoba is pea-canola. Beginning in 2019, we started to test pea-canola, soybean-flax, pea-flax and pea-oat intercrop combinations at Arborg, MB. For each intercrop combination, 2-3 seeding rate ratios were tested and compared to pea, soybean, canola, flax and oat monocrops.

To assess the productivity of intercrops compared to their component crops grown in monoculture, the land equivalent ratio (LER) is used. LER is a ratio of the individual crop yields from the intercrop divided by the respective monocrop yield. It is desirable to achieve a LER > 1 which indicates over-yielding (more would be required to produce the same yield with as individual monocrops compared to the intercrop). Gross and marginal revenues are also calculated because seasonal growing conditions and market prices are important variables that affect the productivity, yield and economic return of cropping in a given year.

Pea-canola intercropping has consistently over-yielded and gross revenues have been highest for peas, flax and intercrops containing peas

<sup>1</sup> *Agronomic Benefits of Intercropping Annual Crops in Manitoba. (n.d.). University of Manitoba Department of Plant Science Natural Systems Agriculture.*  
<https://www.umanitoba.ca/outreach/naturalagriculture/articles/intercrop.html>

<sup>2</sup> *Manitoba Pulse & Soybean Growers. 2015. On-Farm Evaluation of Peaola Intercropping.*  
<https://manitobapulse.ca/wp-content/uploads/2018/02/On-Farm-Evaluation-of-Peola-Intercropping-2015.pdf>

<sup>3</sup> *Manitoba Pulse & Soybean Growers. 2016. On-Farm Evaluation of Peaola Intercropping. Retrieved*  
<https://manitobapulse.ca/wp-content/uploads/2018/02/On-Farm-Evaluation-of-Peola-2016.pdf>

### **Materials & Methods**

The intercropping trial was seeded into tilled wheat residue on May 21, 2020 at Arborg, MB with a plot seeder on 9" row spacing. All intercrops were seeded in the same, mixed row except soybean-flax where soybean was seeded down the mid-row fertilizer tube to achieve row separation (4.5"). Soil type at the research site is a heavy clay (Fyala series) and background soil test levels were 112 lbs N/ac and 11 ppm P<sub>2</sub>O<sub>5</sub>. Specific agronomic practices used for each intercrop treatment are listed in Tables 2 and 3.

*Data collection:*

- 1) Plant density 5 weeks after seeding (# of plants on 2m or row x 2 rows)
- 2) General observations and pictures (disease, insects, weeds, lodging)
- 3) Plant staging July 1 (stage crops on a whole plot basis)
- 4) Maturity (record date of maturity for each crop)
- 5) Biomass and forage nutrient analysis for pea-oat and oat treatments (At oat heading, collect above ground biomass from 0.25m<sup>2</sup> in 2 areas of the plot (front and back) and combine for a composite sample for each plot)
- 6) Canopy height at maturity in 3 areas of the plot (front, middle, back)
- 7) Grain yield and moisture

## Weather Data 2020 – Arborg & Beausejour sites

*Table 1. Seasonal weather summary at Arborg site from May 1 – September 30, 2020*

	Actual	Normal	% of Normal
Growing degree days	1604	1554	103
Crop heat Units	2609	2616	100
Total precipitation (mm)	212	320	66

*Table 2. Seasonal weather summary at Beausejour site from May 1– October 04, 2020*

	Actual	Normal	% of Normal
Growing degree days	1667	1634	102
Crop heat Units	2715	2661	102
Total precipitation (mm)	290	354	82

Overall Arborg site was relatively drier this year and it received 66% of the normal rainfall from May 1 to September 30. Similarly, Beausejour site also got 82% of the normal rainfall from May 1 to October 4.

May was relatively a drier month. Arborg site received only 23% of the normal rainfall during seedling emergence period (May 12-June 02). First seeding began May 12<sup>th</sup> at Arborg site and May 19<sup>th</sup> at Beausejour site.

Arborg site, however, received good moisture in the month of June (107% of the normal precipitation) which helped most of the crop types. However, a significant rain at the end of June month resulted in flooding in MCVET peas trial. In contrast to 2019, 2020 fall was relatively drier at both sites and harvesting operations were finished in time.

Winter cereals at both sites suffered winter injury during 2019-20 winter. Due to this winter injury, MCVET winter wheat at Arborg site and MCVET Fall Rye at Beausejour site got written off.

Both sites had more than normal Growing degree-days (GDD) during 2020 crop season. GDD is a good indicator how crops will grow during the season. To calculate GDD, first determine the mean temperature for the day. This is usually done by taking the maximum and minimum temperatures for the day, adding them together and dividing by two. The base temperature (e.g. 0°C for cereals, 5°C for canola) is then subtracted from the mean temperature to give a daily GDD. If the daily GDD calculates to a negative number, it is made equal to zero. Each daily GDD is then added up (accumulated) over the growing season.

More information on current and seasonal weather conditions can be accessed at <https://www.gov.mb.ca/agriculture/weather/index.html>.



## Manitoba Crop Variety Evaluation Trials (MCVET Trials)

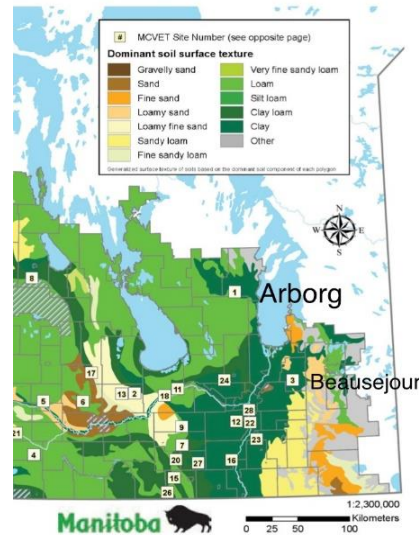
PESAI is one of the many sites that are part of the MCVET, which facilitates variety evaluations of many different crop types in this province. PESAI managed two MCVET sites (Arborg and Beausejour) during 2020 growing season.

The purpose of the MCVET varietal evaluation 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.

During 2020, PESAI did variety trials in Spring Wheat, Winter Wheat, Fall Rye, Oats, Barley and Soybeans (both Roundup Ready and Conventional) at both sites. Peas, Silage Corn, Hemp and Flax variety evaluations were conducted only at Arborg site (See Table 1).

From each MCVET site across the province, yearly data is collected, combined, and summarized in the 'Seed Manitoba' guide (See Table 1 and Table 2). Hard copies are available at most Manitoba Agriculture and Ag Industry Offices. Seed Manitoba guide and the websites [www.seedinteractive.ca](http://www.seedinteractive.ca) and [www.seedmb.ca](http://www.seedmb.ca), provide valuable variety performance information for Manitoba farmers.

The Tables 1 & 2 on the following pages outline agronomy practices followed for 2020 trials at both sites.



*Aerial view of 2020 Arborg MCVET site*

Table 1. Agronomy practices followed for 2020 MCVET trials at Arborg site

Crop Type	Stubble	Seeding Date	Fertility Applied (N-P-K in lbs/ac)	Weed / Insect Control (rate/acre)	Harvest Date	No of Plots
Spring Wheat	Fallow	12-May	55-20-0	Curtail @ 0.81L on June 1 Coragen @ 100ml on June 2	24-Aug	123
Oats	Fallow	12-May	55-20-0	Curtail @ 0.81L on June 1 Coragen @ 100ml on June 2	18-Aug	24
Barley	Fallow	12-May	55-20-0	Curtail @ 0.81L on June 1 Coragen @ 100ml on June 2	17-Aug	54
Winter Wheat	Canola	16-Sep	30-25-0 (100-0-0 in spring)	No Spray	10-Aug	24
Fall Rye	Canola	16-Sep	30-25-0 (100-0-0 in spring)	No Spray	10-Aug	15
Peas	Canola	12-May	3-15-0	Centurion @ 75 ml + Amigo @ 1L/100L water on June 3 Centurion @ 75 ml + Amigo @ 1L/100L water on June 10 Reglone @ 0.83L on Aug 25	02-Sep	78
Conv. Soybeans	Canola	15-May	2-10.5-0	Centurion @ 75 ml + Amigo @ 1L/100L water on June 10 Centurion @ 75 ml + Amigo @ 1L/100L water on July 02 Coragen @ 100ml on Aug 11 Silencer @ 34ml on Aug 20	29-Sep	39
RR Soybeans	Canola	18-May	4-20-0	Glyphosate @ 0.67 L on June 08 Glyphosate @ 0.67 L on June 23 Glyphosate @ 0.67 L on July 07 Coragen @ 100 ml on Aug 11 Silencer @ 34ml on Aug 20	29-Sep	132
Silage Corn	Corn	25-May	75-15-0 Broadcasted and P= 35 applied	Glyphosate @0.67 L on June 20	02-Oct	90
Flax	Wheat	13-May	4-20-0	Centurion @ 75 ml + Amigo @ 1L/100L water on June 3 Centurion @ 75 ml + Amigo @ 1L/100L water on June 10 Reglone @ 0.83L on Aug 31	08-Sep	27
Hemp	Fallow	15-May	55-20-0	Pardner @ 0.4 L on June 22	08-Sep	20

Table 2. Agronomy practices followed for 2020 MCVET trials at Beausejour site

Crop Type	Stubble	Seeding Date	Fertility Applied (N-P-K in lbs/ac)	Weed / Insect Control (rate/acre)	Harvest Date	No of Plots
Winter Wheat	Canola	18-Sep	30-25-0 (100-0-0 in spring)	No Spray	12-Aug	24
Fall Rye	Canola	18-Sep	30-25-0 (100-0-0 in spring)	No Spray	12-Aug	15
Spring Wheat	Canola	19-May	75-25-0	Coragen @ 100ml on June 5 Coragen @ 50ml on July 10	21-Aug	90
Oats	Canola	19-May	75-25-0	Coragen @ 100ml on June 5 Coragen @ 50ml on July 10	21-Aug	24
Barley	Canola	19-May	75-25-0	Coragen @ 100ml on June 5 Coragen @ 50ml on July 10	21-Aug	27
Conv. Soybeans	Canola	20-May	4-20-0	Basagran Forte @ 0.91L on June 29 Coragen @ 50ml on July 10	7-Oct	42
RR Soybeans	Canola	19-May	4-20-0	Glyphosate @0.67 L on June 29 Coragen @ 50 ml on July 10	8- Oct	132

Table 3. Yield comparison of Spring Wheat varieties at Arborg site.

Variety	Yield (bu/acre)	Protein (%)	Variety	Yield (bu/acre)	Protein (%)	Variety	Yield (bu/acre)	Protein (%)
Ellerslie	87	15.1	PT598	95	14.6	CDC Reign	100	14.4
Jake	89	15.6	AAC Russell VB	96	15.7	Daybreak	102	14.6
CDC Ortona	91	15.2	AAC Magnet	97	14.6	WPB Whistler	102	12.1
Tracker	91	14.9	AAC Starbuck VB	97	15.4	Alderon	103	12
Carberry	92	15.3	SY Gabbro	97	15	BW5072	103	14.7
SY Natron	92	15.1	AAC Wheatland VB	99	15	BW5055	104	14.2
AAC Brandon	93	15.2	AAC Cirrus	99	14.5	LNR15-1741	104	13.6
AAC Broadacres	94	15.5	BW5044	99	14.6	AAC Hodge VB	105	14.5
AAC Redstar	94	14.7	CS12200109-11	99	14.8	AAC LeRoy VB	105	15
Bolles	94	15.7	AAC Redberry	100	14.7	HY2068	106	13.3
Parata	94	16.3	RedNet	100	14.8	Sparrow VB	109	12.9
SY Brawn	94	15.4	SY Torach	100	15	BW1093	109	14.4
BW5031	94	15.3	BW5045	100	14.8	Accelerate	115	13.1
CDC SKRush	95	14.6	CS11200214-17	100	14.6			
Varieties differ if yield difference is 4 bu/acre								

Table 4. Yield comparison of Spring Wheat varieties at Beausejour site.

Variety	Yield (bu/acre)	Protein (%)	Variety	Yield (bu/acre)	Protein (%)	Variety	Yield (bu/acre)	Protein (%)
Ellerslie	56	14.9	AAC Starbuck VB	69	14.7	AAC Russell VB	75	14.9
PT598	58	14.5	SY Gabbro	69	14.5	AAC LeRoy VB	76	14.3
SY Natron	59	15.5	CDC SKRush	71	13.7	AAC Broadacres	77	14.2
CDC Ortona	61	14.8	AAC Redberry	72	14.3	SY Brawn	77	14.2
Parata	61	14.6	AAC Wheatland VB	72	14.1	HY2068	77	12.5
Tracker	64	14.6	RedNet	72	14.6	Daybreak	81	14.3
AAC Redstar	66	14.7	SY Torach	72	15.1	Sparrow VB	82	11.8
BW5031	66	14.6	AAC Cirrus	72	15.3	Alderon	83	12.6
Carberry	67	14.7	Bolles	74	15	Accelerate	85	13.7
AAC Brandon	68	14.4	AAC Magnet	75	14.4	WPB Whistler	91	12.7
Varieties differ if yield difference is 9 bu/acre								



Table 5. Yield comparison of Conventional Soybeans varieties at Arborg Site.

Variety Name	Norfolk	AAC Hall	Fjord	Reynolds	Kebek	OAC Prudence	Meteor	CER14-640	CER10-11.97	SVX21T00S2	Siberia	CER14-142	SVX21T000S1	Varieties differ if yield difference is 12 bu/acre
Yield (bu/acre)	37	40	40	41	44	44	44	45	46	46	47	48	49	

Table 6. Yield comparison of Conventional Soybeans varieties at Beausejour site.

Variety	Norfolk	Fjord	Kebek	AAC Hall	Reynolds	Siberia	SVX21T000S1	OAC Prudence	Meteor	CER10-11.97	SVX21T00S2	CER14-640	CER14-142	Varieties differ if yield difference is 16 bu/acre
Yield (bu/acre)	33	45	45	46	49	50	50	52	53	54	56	57	60	

Table 7. Yield and Protein comparison of Barley varieties at Arborg Site.

Variety	AC Metcalfe	AB Advantage	TR17635	FB209	CDC Copper	SR18524	AB Tofield	KWS Coralie	ACC Synergy	KWS Kellie	AB BrewNet	TR16742	CDC Churchill	AB Wrangler	TR18647	AB Cattellac	TR18645	Esma	Varieties differ if yield difference is 8 bu/acre
Yield (bu/acre)	107	108	109	112	114	114	115	116	118	118	119	122	124	124	124	126	128	133	
Protein (%)	14.0	14.0	14.0	13.5	13.7	14.1	13.3	12.1	13.0	12.5	14.1	13.1	13.0	13.5	13.4	14.4	13.8	12.4	

Table 8. Yield comparison of Oats varieties at Beausejour Site.

Variety	ORE3541M	ORE3542M	Summit	CDC Arborg	CFA1502	CDC Endure	AAC Douglas	CDC Skye	Varieties do not differ significantly in yield
Yield (bu/acre)	137	138	138	152	152	158	160	162	

Table 9. Yield comparison of Oats varieties at Arborg Site.

Variety	ORE3542M	ORE3541M	CDC Skye	AAC Douglas	CFA1502	Summit	CDC Arborg	CDC Endure	Varieties do not differ significantly in yield
Yield (bu/acre)	164	171	177	179	183	185	189	191	

Table 10. Yield comparison of Flax varieties at Arborg Site.

Variety	WestLin 72	FP2573	CDC Dorado	CDC Rowland	CDC Glas	VT50	AAC Prairie Sunshine	AAC Marvelous	Varieties do not differ significantly in yield
Yield (bu/acre)	46	54	50	56	57	57	58	61	

Table 11. Yield comparison of Fall Rye varieties at Arborg site.

Variety	Hazlet	KWS Daniello	KWS Trebiano	KWS Bono	KWS Gatano	Varieties differ if yield difference is 7 bu/acre
Yield (bu/acre)	79	86	88	89	91	

Table 12. Yield comparison of Hemp varieties at Arborg site.

Variety	Petera	Altair	CRS-1	Vega	Varieties differ if yield difference is 83 lbs/acre
Yield (lb/acre)	320	577	641	724	

Table 13. Yield comparison of Winter Wheat varieties at Beausejour site.

Variety	AAC Goldrush	AAC Icefield	W563	Emerson	AAC Network	W520	AAC Wildfire	W522	Varieties do not differ significantly in yield
Yield (bu/acre)	61	63	63	67	68	68	69	79	

Table 14. Yield comparison of Herbicide Tolerant Soybeans Varieties at Beausejour site.

Variety	Yield (bu/acre)	Variety	Yield (bu/acre)
B0011RX	35	TH 88007R2X	48
SI 000919XT	35	B0040L1	48
TH89004 R2X	40	Akras R2	49
NSC Wynyard RR2X	41	S001-D8X	50
Fresco R2X	43	P001A48X	50
RX00797	43	Renuka R2X	50
S003-Z4X	43	SI 007XTN	50
P005A83X	43	PV 12S007 R2X	51
RX000918	44	DKB002-32	51
Prince R2X	44	PV 19s006R2X	51
B0030L1	44	NSC Culross RR2X	52
Bourke R2X	45	TH 88005R2XN	52
SI 001XTN	46	DKB003-29	53
Foote R2	46	Merritt R2X	54
S005-C9X	46	NSC Cartier RR2X	54
Sunna R2X	46	P007A90R	55
Devo R2X	47	DKB005-52	55
TH87003 R2X	47	S007-A2XS	57
PV 16s004 R2X	47	NSC Sperling RR2Y	58
NSC Redvers RR2X	48	P005A27X	58
S007-Y4	48	P006A37X	60
Varieties differ if yield difference is 13 bu/acre			



# Evaluating Silage Corn varieties in Interlake region

## Project duration

2020

## 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 2020. At Arborg site, the tested silage corn varieties differed in their yield potential (see Table 1). The yield varied from 13.3 – 22.3 Mt/acre (at 65% moisture). Among all varieties tested, 932S recorded the highest yield, while variety DKC29-89RIB had the lowest yield. Moisture content at harvest also varied (range: 49.8-61.7%) among corn varieties. Similarly, corn varieties also differed in 50% silking period and the varieties 932S and PV61180RIB took greater number of days (78) 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* – Randomised block design with three replications

*Treatments* – 30 silage corn varieties (see Table 1)

*Plot size* – 18m<sup>2</sup>

*Plant population* – 32,000 plants/acre

*Data collected* – plant stand, 50% silking, yield

## Agronomic information

*Stubble, soil type* – Corn, Heavy clay

*Fertilizer applied* – N 75 lbs/ acre, P 30 lbs/acre

*Pesticides applied* – Glyphosate@0.67 L/acre on June 30<sup>th</sup>

*Seeding/Harvesting date* – May 25/ Oct 2



Table 1. Evaluating silage corn varieties for yield and quality at Arborg site.

CHU#	Hybrid	Distributor	Yield (Mt/ac)*	Moisture (%)	Days 50% Silk	TDN (%)	ADF (%)	NDF (%)	NE/Gain Mcal/kg	NE/Lact Mcal/kg
2100	DKC24-06RIB	DEKALB	16.7	54.9	74	70.5	26.4	48.1	1.06	1.61
2100	TH6875 VT2P	Thunder Seed	16.8	55.3	73	65.0	31.5	54.7	0.91	1.47
2125	PS 2210VT2P RIB	PICKSEED	17.1	56.0	75	65.8	30.7	50.5	0.93	1.50
2150	AS1017RR EDF	PRIDE Seeds	19.8	51.7	73	66.3	30.2	51.1	0.95	1.51
2150	913S	NorthStar G.	16.7	58.5	76	65.8	30.8	52.9	0.93	1.49
2150	TH4076 HDRR	Thunder Seed	18.1	55.1	75	59.2	36.9	60.1	0.73	1.33
2175	DKC26-40RIB	DEKALB	16.1	54.6	71	69.6	27.2	48.7	1.04	1.59
2175	PV 61276RIB	Proven Seed	16.7	55.4	72	68.0	28.6	49.4	1.00	1.55
2200	PV 61177SRR	Proven Seed	18.9	56.7	74	63.7	32.7	54.8	0.87	1.44
2200	PS 2320RR	PICKSEED	14.8	53.5	72	65.6	31.0	52.8	0.92	1.49
2200	A4323G2 RIB	PRIDE Seeds	15.2	53.1	72	70.4	26.4	49.7	1.06	1.61
2200	HZ 1451	Horizon Seeds	14.2	55.6	73	67.4	29.3	49.4	0.98	1.53
2200	MS 7420 R	Maizex Seeds	16.8	51.6	74	68.0	28.7	51.0	0.99	1.55
2250	A4705HMRR	PRIDE Seeds	19.2	50.3	71	65.6	30.9	51.9	0.93	1.49
2250	HZ 1685	Horizon Seeds	18.0	50.6	75	68.4	28.3	50.9	1.01	1.56
2250	TH4126 RR	Thunder Seed	16.6	52.2	73	62.7	33.7	57.2	0.84	1.42
2250	CP1725RR	CROPLAN	17.9	52.3	75	63.8	32.6	55.8	0.87	1.45
2250	MS 8022 R	Maizex Seeds	18.4	59.3	71	63.7	32.7	55.9	0.87	1.44
2275	DKC29-89RIB	DEKALB	13.3	61.7	74	61.6	34.6	59.1	0.81	1.39
2275	PS 2333RR	PICKSEED	17.6	55.7	73	69.4	27.4	47.7	1.03	1.58
2300	PV 61180RIB	Proven Seed	17.8	57.7	78	68.7	28.1	49.4	1.01	1.57
2300	TH6180 VT2P	Thunder Seed	19.0	53.8	72	63.0	33.3	57.4	0.85	1.43
2300	CP2123VT2P/RIB	CROPLAN	15.9	56.6	76	66.6	30.0	51.5	0.95	1.51
2350	HZ 675	Horizon Seeds	17.8	57.2	76	66.4	30.2	52.3	0.95	1.51
2350	932S	NorthStar G.	22.3	49.8	78	60.0	36.1	61.6	0.76	1.35
2375	HZ 1912	Horizon Seeds	18.0	55.0	74	64.7	31.8	52.7	0.90	1.47
2400	HZ 2220	Horizon Seeds	20.1	52.2	74	65.7	30.8	53.2	0.93	1.49
Site Ave.			17.3	54.6	74					
CV			10.39	7.97	1.66					
Sign Diff			Yes	Yes	Yes					
LSD			2.9	7.2	2					

#CHU – Corn heat units

\*Yield at 65% moisture content.

# Evaluating short season, cold and disease tolerant Corn inbreds in Interlake region

## Project duration

2018-2022

## Objectives

Development and release of early maturing cold tolerant corn inbreds with emphasis on the 1800-2000 CHU market.

## Collaborators

Lana Reid, AAFC Ottawa

## Project Findings

This was the third year of testing. Inbred line evaluations will be again done in 2021 and AAFC will share data once the project is completed.

## Background / Additional Resources

Canada annually produces more than 13 million metric tons of grain corn with a farm gate value greater than \$2 billion from 1.3 million ha. Historically, grain corn was concentrated in areas of the country with the highest available heat units and adequate moisture supply (i.e. southern Ontario); however many production areas in eastern and western Canada have less than 2800 CHU. Production in these heat-limited environments is expanding rapidly as demand for grain corn increases. There is a lack of suitable early hybrids with acceptable early season cold tolerance for these expanding regions of corn production. As well, climate change has resulted in a significant increase in common diseases and the arrival of new diseases to Canada. This evolving crisis will affect trade and severely damage growers and their grain customers.

This project has aimed to develop and release of early maturing cold tolerant corn inbreds with emphasis on the 1800-2000 CHU market. This objective will be achieved using conventional corn breeding methodology enhanced by double haploid inbred production and specialized screening techniques for cold tolerance. Multiple yield trials in Alberta, Manitoba, Quebec, Ontario and PEI are planned.

## Materials & Methods

*Experimental Design* – Randomised block design with three replications

*Treatments* – Thirty corn lines provided by AAFC Ottawa.

*Plot size* – 9 m<sup>2</sup>

*Data collected* – plant stand, disease incidence, grain yield, test weight

### **Agronomic info**

*Stubble, soil type* – Fallow, heavy clay

*Fertilizer applied* – N – 90 lbs/acre and P – 40 lbs/acre were applied at seeding.

*Pesticides applied* – sprayed 2,4-D @ 310 ml/acre on June 18

*Seeding/harvesting date* – May 22 / Oct 22

# Evaluating Organic Acids in Canola-Soybean crop rotation

## Project Duration

2019-2021

## Objectives

To determine if organic acid products (MX-3, VX-8) have any effect on crop productivity in Canola-Soybeans crop rotation. This was the second year of evaluation and these products were applied to soybean crop.

## Collaborators

Kevin Shale, Montra Crop Science

## Results

During 2020 crop season, organic acids did not have any effect on plant stand, plant vigor, days to maturity, plant height and grain yield of soybean (Table 1). The use of organic acids did not change protein content in the grains. There was no difference for Calcium, Phosphorous, Magnesium, Potassium, Copper, Iron, Manganese and Zinc content in grains among different treatments and control (data not shown).

*Table 1: Effects of organic acids on agronomic traits and yield of soybeans in Arborg.*

Treatment	Plant Stand (plant/m <sup>2</sup> )	Plant Vigor (1-5 scale)	Days to Maturity	Plant Height (inches)	Yield (bu/ac)	Crude Protein (%)
MX-3 75%	53.5	3.9	113.0	18.8	40.0	35.8
MX-3 100%	60.5	3.9	113.1	19.8	38.7	35.8
VX-8 75%	60.0	3.8	113.0	20.6	39.8	36.1
VX-8 100%	57.8	3.9	113.3	20.9	39.6	35.8
CONTROL	57.0	3.9	113.1	20.0	40.2	35.7
Signi Diff	No	No	No	No	No	No
P	0.568	0.771	0.722	0.308	0.547	0.942
CV%	12.4	5.8	0.3	8.1	4.6	1.8

*75 or 100% - denotes the herbicide rate used in crop for the control of weeds.*

## Project Findings

This was the second year of testing and Organic acids (MX-3 & VX-8) did not have any effect on Canola yield during 2019. Results are similar this year again and soybean yield did not see any increase from the use of organic acids. Both organic acids were applied along with 75 & 100% rates of herbicides (glyphosate in this case) and were compared with control plots. Control soybeans plots got 100% rate of the herbicide. Soybean yield was similar irrespective of whether 75% or 100% of glyphosate rate were applied on the plots.

## Background / References / Additional Resources

Humic products improves the field efficacy across ranges of field conditions for improving crop yield and soil health (Olk *et al.*2018). Humic compounds such as fulvic acid and humic acid are formed by chemical and microbial degradation of plant and animal material and are a principal



component of soil organic matter (Canellas *et al.* 2015). In general, the application of fulvic and humic acid fertilizer amendments have been shown to enhance root growth, increase nutrient uptake, alleviate stress, and increase yield in various crops (Canellas *et al.* 2015). However, studies conducted in Ontario on dry bean (*Phaseolus vulgaris* L.) in 2010 and 2011 using fulvic acid (LX7<sup>®</sup>, MTS Environmental Inc.) or humic acid (Plant XL<sup>®</sup>, Alpha-Agri) fertilizers showed no response. Twenty fulvic acid field trials and 15 humic acid field trials indicated that these fertilizers were ineffective, as plant vigour, height, 100-seed weight, and yield were similar to a control treatment (Mahoney *et al.* 2017).



Broadcast pre-plant or post-plant application of leonardite did not affect the emergence, chemical composition, or yield of wheat or canola in Manitoba (Dilk 2002). The efficiency of phosphorus (P) fertilizer was studied with and without humic acid, derived from leonardite. Application of leonardite in a P fertilizer band significantly increased the P concentration of canola tissue in the early stages of development. However, the increase in P concentration did not result in an increase in yield.

In the current study, product MX-3 did have 5% fulvic acid and it was sprayed in furrows after seeding. Additional sprays of this product were applied during early phase of the crop growth. Another granular product, VX-8 was applied with the seed.

## References

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- KJ Mahoney, C McCreary, D Depuydt, CL Gillard (2017) Fulvic and humic acid fertilizers are ineffective in dry bean. *Canadian Journal of Plant Science*, 2017, 97(2): 202-205, <https://doi.org/10.1139/cjps-2016-0143>

Canellas LP, Olivares FL, Aguiar NO, Jones DL, Nebbioso A, Mazzei P, Piccolo A. (2015) Humic and fulvic acids as biostimulants in horticulture. *Sci. Hortic.* **196**: 15-27.

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## Materials & Methods

*Experimental Design* – Replicated block design with four replications

*Treatments*:

- 1) **Montra MX-3 100%\***: Foliar applied liquid organic acid (spray in furrows after seeding on the same day @ 1 L/acre) + 100% herbicide rate applied on the crop + insecticide applied (when needed)
- 2) **Montra MX-3 75%\***: Foliar applied liquid organic acid (spray in furrows after seeding on the same day @ 1 L/acre) + 75% herbicide rate applied on the crop + insecticide applied (when needed)
- 3) **Montra VX-8 100%\***: MX-3 bonded to Verxite for dry application (applied with seed @ 6 Kg/acre) + 100% herbicide rate applied on the crop + insecticide applied (when needed)
- 4) **Montra VX-8 75%\***: MX-3 bonded to Verxite for dry application (applied with seed @ 6 Kg/acre) + 75% herbicide rate applied on the crop + insecticide applied (when needed)
- 5) **Control** – Herbicides (100% rate) + Insecticide applied (when needed)

\*All treatments except Control got two more sprays (June 16 & July 9) of Montra MX-3 during early phase of crop growth.

*Variety* – S0009-M2

*Plot size* – 9.12m<sup>2</sup>

*Data collected* – Plant stand, plant vigor, days to maturity, plant height and yield

### **Agronomic information**

*Stubble, soil type* – Canola, Heavy clay

*Fertilizer applied* – N 4lbs/ acre, P 20 lbs/acre at the time of seeding.

*Pesticides applied* – Glyphosate@0.67 L/acre - June 08

Coragen@100ml/acre for grasshoppers-Aug 11

Silencer@ 34ml/acre for grasshoppers- Aug 20

*Seeding/Harvesting date* – May 18 / Sep 23

# Does balanced fertility program increases yield of new Winter Wheat varieties?

## Project duration

2019-2020

## Collaborators

Ducks Unlimited Canada

Western Ag Lab

## Objectives

The purpose of this project is to compare standard fertility practices followed by producers (100% spring) with a balanced fertility program. The balanced fertility recommendation is determined by Western Ag lab based on extensive soil analysis.

## Results

Winter wheat yield was not influenced by variety, fertilizer management practice or interaction of the two factors at Melita but winter wheat varieties did vary for protein content. Gateway had 13.5% protein compared to 12.2% both in Elevate and Wildfire.

Although there were relatively low grain yields at Roblin compared to other sites, but there was a significant influence of variety and variety x fertilizer management practice. Fertilizer management practice alone, however, did not have any effect on winter wheat yield. Wildfire yielded more compared to Elevate and Gateway. Wildfire grown with balanced fertilizer management practice had higher grain yield ( $4692 \text{ kg ha}^{-1}$ ) compared to all other variety x fertility interactions (Table 1). Similar to Melita, protein content was high for Gateway variety (15.6%) compared to Elevate (14.6%) and Wildfire (14.2%). Fertilizer management practice also influenced protein content at Roblin. Winter wheat receiving balanced fertilizer practice had 15.1% protein compared to 14.5% in plots with producers practice.

At Carberry, there was a significant influence of variety and fertility management practice on winter wheat grain yield. Wildfire, Elevate and Gateway yielded  $6864 \text{ kg ha}^{-1}$ ,  $6336 \text{ kg ha}^{-1}$  and  $5822 \text{ kg ha}^{-1}$ , respectively. Balanced fertilizer management practice resulted in approximately 8.33% more grain yield compared to producers practice.

At Arborg, variety significantly influenced winter wheat grain yield and protein content, while fertility management practice had influence on yield alone. Wildfire had the highest yield ( $6082 \text{ kg ha}^{-1}$ ) while Gateway and Elevate had  $5233 \text{ kg ha}^{-1}$  and  $5110 \text{ kg ha}^{-1}$ , respectively. Gateway variety continued to show similar trends as at other sites. This variety has higher protein content (13.3%) compared to Elevate (12.2%) and Wildfire (12.3%).

Combining data from all sites revealed significant influence of variety on yield and protein content while fertility management practice influenced yield only. Overall, Wildfire had higher yield ( $5473 \text{ kg ha}^{-1}$ ) followed by Elevate ( $4891 \text{ kg ha}^{-1}$ ) and Gateway ( $4588 \text{ kg ha}^{-1}$ ). On the other hand, Gateway had protein content of 14.3% compared to 13.3% for Elevate and Wildfire. Balanced fertility management significantly influenced winter wheat grain yield resulting almost 8% increase in yield (Table 1).

Table 1. Winter wheat yield (kg ha<sup>-1</sup>) and protein content (%) as affected by variety and fertility program at different Manitoban sites during 2019/2020 season.

			Location									
			Melita		Roblin		Carberry		Arborg		All Sites	
Treatment			Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein
Variety	Elevate	1	4884	12.2b	3234b	14.6b	6336b	14.4	5110b	12.2b	4891b	13.3b
	Gateway	2	4420	13.5a	2875b	15.6a	5822c	14.8	5233b	13.3a	4588c	14.3a
	Wildfire	3	4803	12.2b	4145a	14.2b	6864a	14.6	6082a	12.3b	5473a	13.3b
Fertility	100%Spring	A	4628	12.6	3292	14.5b	6065b	14.8	5089b	12.6	4769b	13.6
	Balanced	B	4776	12.7	3545	15.1a	6616a	14.4	5861a	12.5	5199a	13.7
Variety x Fertility	1,A		4706	12.4	3258bc	14.5	6157	14.6	4538	12.3	4665	13.4
	1,B		5062	12	3210bc	14.6	6515	14.2	5681	12.1	5117	13.2
	2,A		4312	13.2	3019bc	15.0	5489	14.9	4692	13.6	4378	14.2
	2,B		4528	13.8	2732c	16.0	6154	14.6	5774	12.9	4797	14.4
	3,A		4866	12.1	3598b	14.0	6549	14.8	6038	12.1	5263	13.2
	3,B		4739	12.3	4692a	14.5	7180	14.4	6126	12.4	5684	13.4
P values	Variety		0.21	0.004	<0.001	0.001	<0.001	0.371	0.024	0.007	<0.001	<0.001
	Fertility		0.5	0.675	0.143	0.022	0.001	0.055	0.014	0.548	<0.001	0.738
	Var x Fert		0.644	0.361	0.012	0.226	0.49	0.968	0.225	0.282	0.988	0.351
	CV%		10	5	10	3	4	3	10	4	8	4

## Project Findings

Results from this study indicate that balanced fertilizer management approach could be a better option than the producer's practice of applying all nitrogen in spring. This is largely due to the fact that winter wheat requires adequate starter nitrogen during early days of establishment in fall and when it resumes development in spring. Winter wheat variety Wildfire proved to be yielding greater than Elevate and Gateway. Gateway, however, consistently had higher protein content than other two varieties. Continued field studies would be necessary to further validate these findings.

## Background / References / Additional Resources

Following decades of extensive work in winter wheat production in North America, many researchers and producers have begun to implement best management practices to obtain higher grain yield and improve profitability in the crop. Management practices presently being implemented to improve winter wheat production include; increasing seeding rate, application of starter fertilizer by banding during seeding, variety selection, pest control (Anderson, 2008) and split application, during planting in fall and at tillering or stem elongation in spring (Schulz et al., 2015).

Fertility management, in particular nitrogen and phosphorus, remains the integral part of the overall management package aimed at achieving higher yields in winter wheat (Halvorson et al. 1987). Recommended fertilizer management, particularly nitrogen, 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 escalating cost of production per unit area, which is the main goal that producers aim to achieve. There is still a knowledge gap on the rates as well as timing of application of nitrogen fertilizer, particularly in Western Canada, that would result in improved yield without compromising the quality of grain and economic returns. Therefore, there is a great need to continue with research on the best management practices that can be availed to producers to improve economic returns in winter wheat production.

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## Materials and Methods

This study was done at four locations; Melita, Arborg, Carberry and Roblin in Manitoba in the fall of 2019 (Table 3). In Arborg, wheat was seeded onto canola stubble to a depth of 1" on September 17 using a 8-row dual disc seeder. The soil was characterized as Fyala heavy clay. As a preventative measure for fungal diseases such as fusarium head blight (FHB) and stem rust, a spray application was done with Prosaro at 0.325 L ac<sup>-1</sup> at 75% heading. The treatment structure consisted of a factorial arrangement of two fertilizer management practices and three winter wheat varieties in a randomized complete block design. The three winter wheat varieties utilized were; Gateway, Elevate and Wildfire. Fertilizer treatments included:

- Producer's practice at 100 lbs of nitrogen (urea plus agrotain) per acre applied in spring and 30 lbs phosphorus banded at seeding in fall and,
- Balanced fertility practice as per Western Ag recommendations split applied with 50% banded at seeding and the other 50% urea plus Agrotain broadcasted in spring.



A summary of fall soil tests conducted at Melita, Roblin, Carberry and Arborg, and fertilizer treatments for 2019/2020 are presented in Table 2.

*Table 2. Fall soil test results by site and fertilizer treatments for winter wheat in 2019/2020 season.*

<b>Fall Soil Test - All Values (lbs/ac)</b>				
<b>Location</b>				
<b>Nutrient</b>	<b>Melita</b>	<b>Roblin</b>	<b>Carberry</b>	<b>Arborg</b>
N	31	39	38	53
P	11	76	32	4
K	84	132	179	19
S	205	22	16	523
Zn	1.0	0.64	0.52	0.08
<b>Producer Practice Application (all N applied in Spring)</b>				
N	100	100	100	100
P	30	30	30	30
K	0	0	0	0
<b>Balanced fertilizer recommendations (from Western Ag Laboratory) 50% N applied in fall</b>				
N	155	135	145	125
P	55	15	40	55
K	85	30	20	50
S	0	10	10	0
Zn	0	0	0	2

Table 3: Site description and agronomics for winter wheat trial in 2019/2020 season.

Location	Melita	Carberry	Roblin	Arborg
Cooperator	WADO	CMCDC	PCDF	PESAI
Legal	NW23-3-27W1	South ½ of 8-11-14 W1	NE 20-25-28 W1	NW 16-22-2 E1
Rotation (2 yr)	LL Canola - Spring Wheat	Canola (2019), Soybean (2018)	Barley silage (2019 & 2020)	Spring Wheat - Canola
Soil Series	Ryerson Loam	Ramada Clay Loam	Erickson clay loam	Fyala heavy clay
Soil Test Done? (Y/N)	Yes	Yes	Yes	Yes
Field Prep	no till	no till	harrowed	no till
Stubble	Spring Wheat	Canola	Barley	Canola
Burnoff	Roundup 0.75L +	Roundup 0.67 L + Heat 29 g	Glyphosate 0.67 L	No burnoff
Rate per ac/Products)	Aim 15 ml			
Soil Moisture at Seeding	Excellent	Good	Good	Good
Seed Date	Sep/16	Sep/16	Sep/19	Sep/17
Seed depth (Inches)	0.5	1.5	0.625	1.0
Seeder (drill/planter?)	Knife drill	Knife drill	Disc drill	Disc drill
Errors at seeding	none	N/A	None	None
Topdressing	May/04	May/07	May/12	May/12
Herbicides (Date, Rate/ ac, Name)	Achieve 0.2 L Mextrol 0.5 L + turbocharge 1%	Fitness 90 ml	Axial 0.5 L Prestige XC 0.18 L	None
Fungicides (Prosaro)	23-Jun	26-Jun	09-Jun	19-Jun
Harvest Date	Aug/03	Aug/11	Aug/24	Aug/10
Total Precipitation (mm) (Seeding > Harvest)	332	415	319	345

# Developing a Risk Model to Improve the Effectiveness of Fusarium Head Blight Mitigation in Western Canada

## Project duration

2018-2023

## Objectives

The purposes of this project are:

1. To develop weather-based models to assess the risk of FHB infection and DON in spring wheat, winter wheat, barley and durum crops with different FHB resistance ratings.
2. To develop an interactive prairie-wide viewer and FHB/DON risk-mapping tool that is accessible to producers and industry to assist with fungicide application decisions.

## Collaborators

Dr Paul Bullock, Dept of Soil Sciences, University of Manitoba

## Results

The results will be shared after the completion of this project.

## Project Findings

This was the second year of testing at PESAI site and data has been sent to U of M. Researchers are compiling data from all 15 sites (in three prairies provinces) and will report later on.

## Background / Additional Resources/ References

Fusarium Head Blight (FHB) is the most serious fungal disease affecting wheat and other cereals in Western Canada and most cropping areas of the world. Producers can lower FHB risk by growing cereals with higher FHB resistance ratings and with the application of a proper fungicide near the time of anthesis. Fungicide can reduce losses in yield, grade and mycotoxin infection such as deoxynivalenol (DON) when weather conditions favor FHB development, the crop is susceptible and *Fusarium* spp. are present in significant quantities.

When fungicide is applied when weather conditions are not conducive to FHB infection, there is a financial loss to the producer and unnecessary pesticide application with potential environmental side effects. Research has shown that fungicide application does not always provide a tangible benefit.

De Wolf et al (2003) developed a logistic regression model based on the combinations of temperature, relative humidity, rainfall and durations of specified weather conditions for 7 days prior to anthesis to predict FHB incidence. Prediction accuracy of these models ranged from 62-85%. A weather-based decision management tool that alerts producers when FHB risk is high has the potential to improve FHB management with significant financial benefit.

## References

De Wolf E.D., Madden L. V. and Lipps P. E. (2003) Risk assessment models for wheat Fusarium head blight epidemics based on within season weather data. *Phytopathology* 93: 428-435.

## Materials & Methods

During 2020, these trials were established at various sites across the three Prairie provinces. Evaluations were done on spring wheat, winter wheat, barley and durum cultivars with different FHB resistance ratings. Weather stations were installed at all the sites for getting intensive weather data for model development.

*Experimental Design* – Randomised block design with four replications.

*Treatments* – three winter wheat varieties– Emerson, AAC Gateway, Moats

three spring wheat varieties – AAC Elie, AAC Brandon, Muchmore

three barley varieties – AAC Connect, AAC Synergy, CDC Copeland

one durum wheat variety - Strongfield

*Plot size* – 8.22m<sup>2</sup> (winter wheat), 9.12m<sup>2</sup> (spring cereals)

*Data collected* – Plant density (at 3-leaf stage), growth stages (starting from BBCH 47 to 49) on weekly basis, spore traps, FHB infection rates, grain yield & moisture, DON levels in grains

### ***Agronomic info***

*Stubble, soil type* – Wheat stubble, heavy clay

*Fertilizer applied* – Soil nutrient levels (lbs/acre): N – 112 P– 22, K – 380

Applied (lbs/acre): N -64 P -20 (Spring cereals); N- 30 P-25 (Winter wheat)

*Pesticides applied* – Axial @ 0.5L/acre on June 1

Puma Advance @ 0.41L/acre on June 8

Coragen @ 50ml/acre on July 17

*Seeding/harvesting date* – May 13 & Sep 17 (WW) / Aug 17

# Management practices for high yielding Spring Wheat

## Project Duration

2018, 2020

## Collaborators

Anne Kirk, Rejean Picard, and Earl Bargaen, Manitoba Agriculture and Resource Development  
James Frey, Scott Chalmers, Nirmal Hari, Haider Abbas, Manitoba Agriculture Diversification Centres

## Objectives

To quantify the yield benefit of intensive management practices in spring wheat, and to determine if these management practices provide the same benefit to a variety of cultivars.

## Results and Discussion

### **Plant Height**

The four cultivars included in this study varied in plant height, with AAC Cameron VB being the tallest at all sites and AAC Viewfield being the shortest (data not shown).

There were no significant height differences between management practices at the Roblin site in both years of the study. At the locations where there were height differences between management practices, the PGR reduced height relative to the standard and additional N treatments (Figure 1 and 2). Compared to standard management, the addition of a PGR reduced plant height by 6, 5, and 2 cm at Arborg, Carberry, and Melita, respectively in 2018 (Figure 1). In 2020, the additional of a PGR reduced plant height by 7, 4, and 8 cm compared to the standard treatment at Arborg, Carberry, and Melita, respectively.

There was a significant interaction between management and cultivar at Arborg in 2018, but not in any other site years. This significant interaction indicates that not all cultivars had the same height response to management. Response to the PGR varied for the four cultivars, with no significant difference between standard management and the addition of the PGR for AAC Brandon. The height difference between the standard management treatment and the PGR treatment for AAC Cameron and AAC Viewfield were 4 and 6 cm, respectively. AAC Viewfield, the shortest variety, had a 13 cm height difference between the standard and PGR treatments (Figure 3).

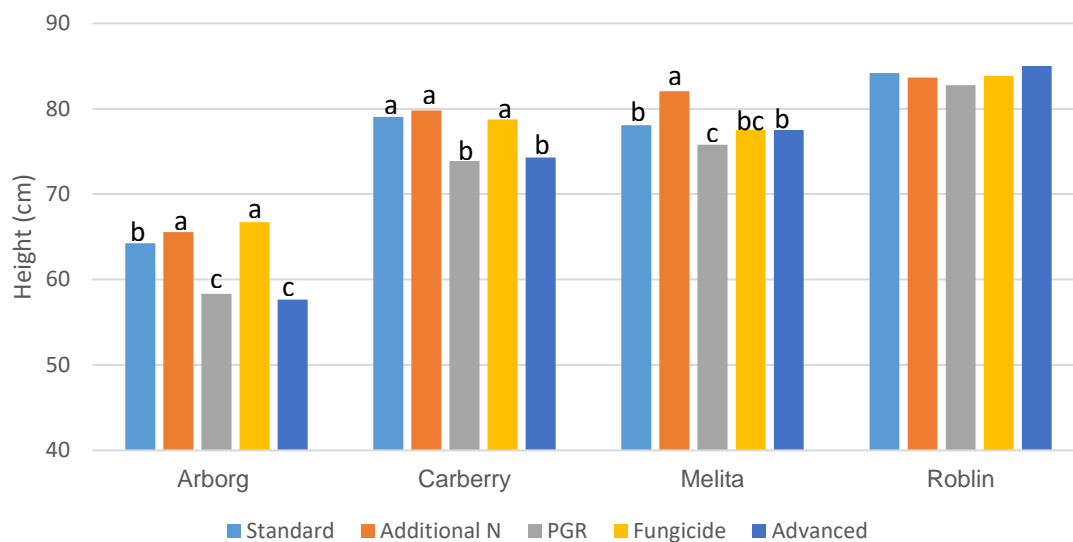
### **Lodging**

There was no lodging at any of the sites in 2018 and 2020.

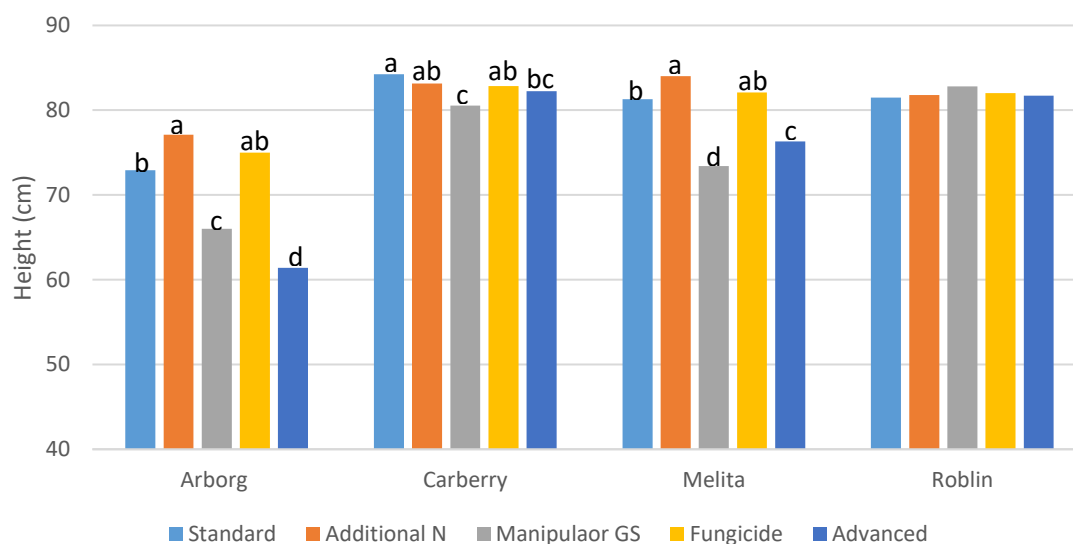
### **Yield**

There was no significant yield difference between cultivars at any of the sites in 2018 and 2020. Yield differences between management treatments were significant at Arborg and Melita in 2018 (Figure 4) and Arborg, Carberry and Melita in 2020 (Figure 5). Yield was not reported at Roblin in 2020. There was no significant interaction between cultivar and management in either year, indicating that the cultivars had similar yield responses to the management treatments (data not shown).

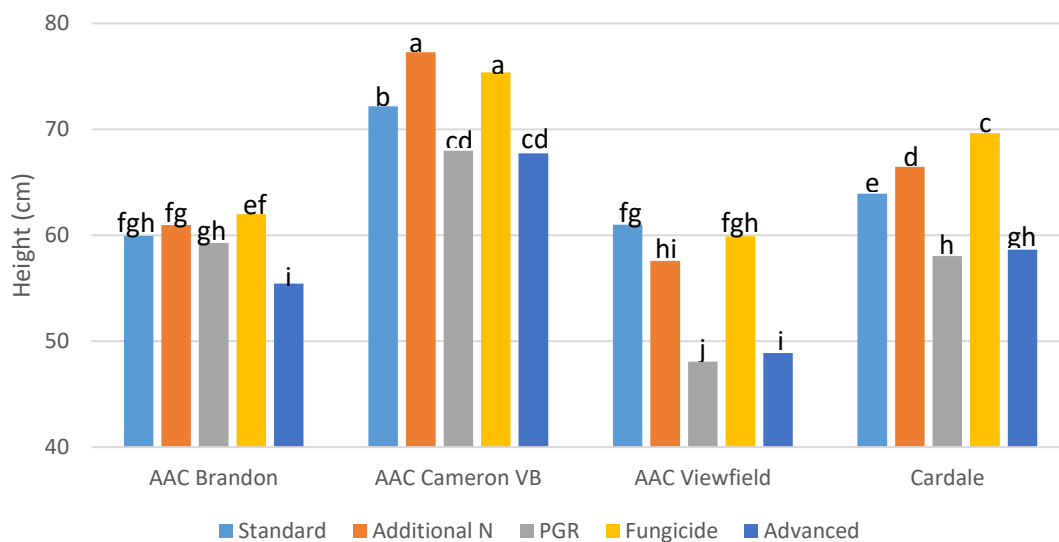




**Figure 1.** Height (cm) of the five treatments averaged across cultivars at Arborg, Carberry, Melita, and Roblin in 2018. Letters above the bars show statistically significant differences. Treatments within the same site with the same letter are not significantly different ( $P < 0.05$ ).

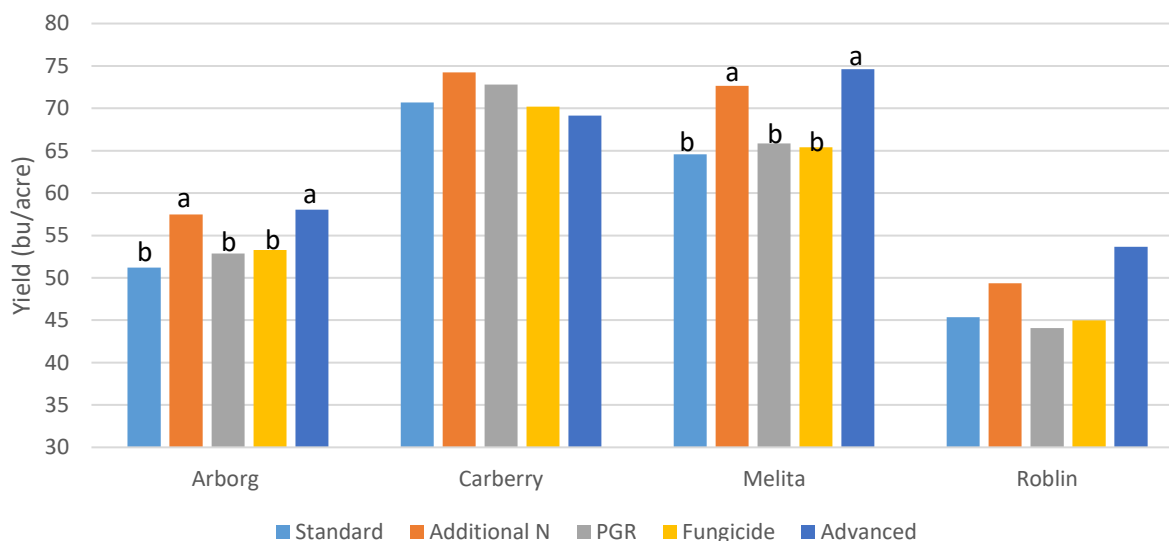


**Figure 2.** Height (cm) of the five treatments averaged across cultivars at Arborg, Carberry, Melita, and Roblin in 2020. Letters above the bars show statistically significant differences. Treatments within the same site with the same letter are not significantly different ( $P < 0.05$ ).

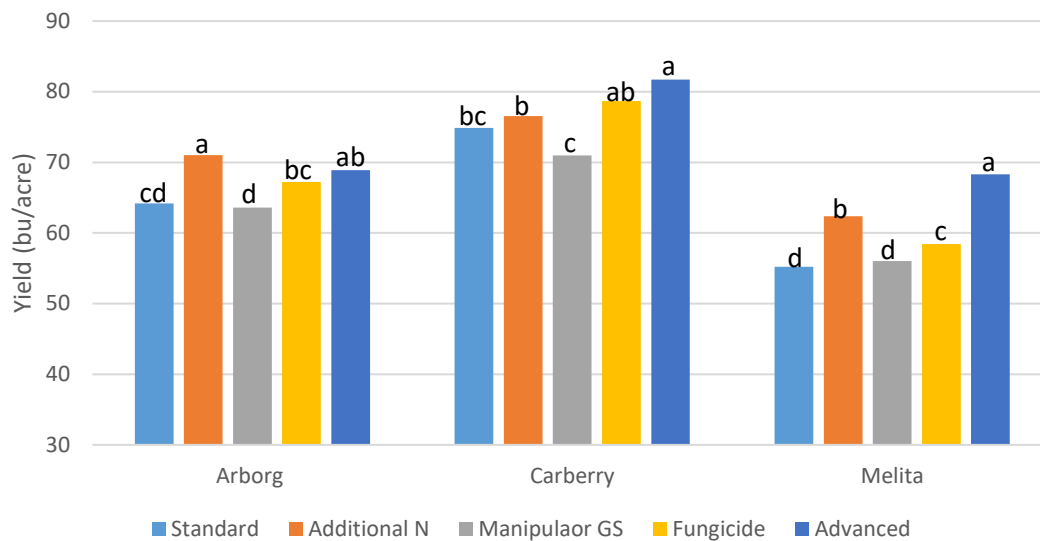


**Figure 3.** Height (cm) of the five treatments for each cultivar at Arborg 2018. Letters above the bars show statistically significant differences. Bars with the same letter are not significantly different ( $P < 0.05$ ).

At Arborg and Melita 2018, the additional N and advanced management treatments yielded significantly more than the other three treatments, indicating that the additional 50 lb/acre of N resulted in a yield advantage (Figure 4). In 2020, the results were less clear. Compared to the standard treatment, additional N resulted in a significant yield increase at Arborg. Both additional N and fungicides resulted in a significant yield increase compared to standard at Melita, but the advanced treatment was highest yielding overall (Figure 5). Overall, additional N resulted in a yield increase in four of seven site years, and fungicides resulted in a yield increase in one of seven site years.



**Figure 4.** Yield (bu/ac) of the five treatments averaged across varieties at Arborg, Carberry, Melita, and Roblin 2018. Letters above the bars show statistically significant differences. Treatments within the same site with the same letter are not significantly different ( $P < 0.05$ ).



**Figure 5.** Yield (bu/ac) of the five treatments averaged across varieties at Arborg, Carberry, and Melita 2020. Letters above the bars show statistically significant differences. Treatments within the same site with the same letter are not significantly different ( $P < 0.05$ ).

### Protein

Protein was measured on composite samples; therefore, results were not statistically analyzed. Of the management practices studied, treatments with higher N rates had the highest protein concentrations at most locations. Protein concentrations were similar between management treatments at Melita 2020 and Roblin 2018 (Table 4).

**Table 4.** Protein concentration (%) comparisons among different wheat varieties & treatments.

	Arborg		Carberry		Melita		Roblin
	2018	2020	2018	2020	2018	2020	2018
----- Protein (%) -----							
<b>Variety</b>							
AAC Brandon	14.3	12.2	15.9	15.1	12.0	12.3	11.6
AAC Cameron VB	13.9	12.0	16.2	14.6	12.1	11.3	11.0
AAC Viewfield	13.5	11.4	15.0	15.7	11.8	11.8	10.4
Cardale	14.1	12.4	17.1	16.1	12.3	12.7	11.5
<b>Management</b>							
Standard	13.2	11.5	15.7	15.3	11.7	11.9	11.3
Manipuator	13.2	11.3	15.7	15.2	11.4	11.7	11.0
Fungicide	13.0	12.0	15.9	15.4	11.5	11.7	11.0
Additional N	15.3	12.4	16.4	15.4	12.9	12.7	11.3
Advanced	15.1	12.8	16.6	15.6	12.9	12.3	11.1

## Background / Additional resources / References

Canadian Western Red Spring (CWRS) wheat cultivars are increasingly high yielding, and may require specific management practices to achieve their yield potential. A study looking at rates of yield gain in CWRS cultivars found that yields rose 0.67% per year between the early 1990's and 2013 (Thomas and Graf 2014). Higher yielding CWRS cultivars may require specific management practices in order to achieve their yield potential. While there are a variety of management practices promoted as increasing yields, this project will focus on nitrogen (N) rates, plant growth regulators (PGR's), and fungicides.

Targeting higher yields often means increasing N rates, which brings with it the increased risk of lodging. PGR's may be a good fit for management systems with higher N rates as they have been shown to reduce plant height in spring wheat (Clark and Fedak 1977), and can be used as a risk management tool to reduce lodging and maintain yield (Strydhorst et al., 2017). The PGR Manipulator (chlormequat chloride) is registered for use in Canada but more information about this PGR is needed as response depends on crop type and cultivar, application timing, and weather conditions.

Fungicides to control FHB and leaf diseases are commonly used on spring wheat in Manitoba. Ransom and McMullen (2008) reported yield increases of 6-44% with foliar fungicide use, with the greatest increases occurring when susceptible cultivars were grown under high disease pressure.

### References

Clark, R.V. and Fedak, G. 1977. Effects of chlormequat on plant height, disease development and chemical constituents of cultivars of barley, oats, and wheat. *Can. J. Plant Sci.* 57: 31-36.

Ransom, J.K. and McMullen, M.V. 2008. Yield and disease control on hard winter wheat cultivars with foliar fungicides. *Agron. J.* 100: 1130-1137.

Strydhorst, S., Hall, L., and Perrott, L. 2017. Plant growth regulators: what agronomists need to know. *Alberta Agriculture and Forestry Agri-Facts.* Agdex 100/548-1.

Thomas, J.B. and Graf, R.J. 2014. Rates of yield gain of hard red spring wheat in western Canada. *Can. J. Plant Sci.* 94: 1-13.

## Materials and Methods

Field trials were established at Arborg, Carberry, Melita and Roblin in the 2018 and 2020 growing seasons. Treatments were laid out in a randomized complete block design with three replicate blocks in a two-factor split plot. There were four cultivars and five management practices, for 20 treatments in total (Table 1).

**Table 1.** Treatments used in the trial.

Cultivar (Main plot)	Management (Sub Plot)
AAC Brandon	Standard (100 lb N/ac, no PGR, no fungicide)
AAC Cameron VB	Additional N (150 lb N/ac, no PGR, no fungicide)
AAC Viewfield	PGR (100 lb N/ac, PGR Manipulator applied at BBCH 31-32, no fungicide)
Cardale	Fungicides (100 lb N/ac, no PGR, fungicides at flag leaf and anthesis)
	Advanced (150 lb N/ac, PGR, fungicides at flag leaf and anthesis)

Herbicides were applied pre-seed and during the growing season as necessary. Plots were seeded at a rate of 280 plants/m<sup>2</sup>. Fungicides were applied at flag leaf and anthesis in treatments requiring fungicides, with products differing between locations. Fungicides applied at

flag leaf included Acapella, Headline, Prosaro, and Twinline. Prosaro was applied at anthesis for fusarium head blight (FHB) management. The plant growth regulator Manipulator 620 (chlormequat chloride) was applied at 1.8 L/ha as a single dose between Zadoka GS31 to 32. Data collection included plant height, lodging, grain yield and protein concentration in the grains.

**Table 2.** Agronomic information from different MB sites.

Arborg			Carberry		Melita		Roblin	
	2018	2020	2018	2020	2018	2020	2018	2020
Soil Series	Peguis Clay		Wellwood Loam		Waskada Loam	Newstead Loam	Erickson Loamy Clay	
Previous Crop	Canola	Canola	Canola	Canola	Soybean	Spring wheat	Oat	Barley
Seed Date	11-May	19-May	15-May	04-May	07-May	07-May	15-May	11-May
Plot Size	8.2 m <sup>2</sup>	8.2 m <sup>2</sup>	7.5 m <sup>2</sup>	8.4 m <sup>2</sup>	13 m <sup>2</sup>	13 m <sup>2</sup>	8.4 m <sup>2</sup>	12 m <sup>2</sup>
Harvest Date	20-Aug	20-Aug	30-Aug	24-Aug	13-Aug	18-Aug	23-Aug	01-Sep



*Fig 1. Plant height differences among different treatments at Arborg site in 2020.*

**Table 3.** Growing season summary (May 1 - September 30). Data from Manitoba Agriculture Growing Season Report: [web43.gov.mb.ca/climate/SeasonalReport.aspx](http://web43.gov.mb.ca/climate/SeasonalReport.aspx)

	Arborg		Carberry		Melita		Roblin	
	2018	2020	2018	2020	2018	2020	2018	2020
Precipitation (mm)	249	212	300	249	242	187	418	235
Normal precipitation <sup>1</sup>	320	320	307	307	338	338	300	300
Growing degree days	1668	1604	1747	1634	1780	1712	1461	1424
Normal GDD <sup>1</sup>	1554	1554	1524	1524	1637	1637	1396	1396

<sup>1</sup>Based on 30-year averages



# Linseed Coop Evaluation in Interlake

## Project duration

2018-2021

## 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. Helen Booker (flax breeder), CDC Saskatoon

## Funding

Manitoba Flax Growers Association, BASF

## Results

Significant yield differences were found among flax entries tested at Arborg site. The new entries FP2602, FP2604 & FP2605 & CDC Dorado were relatively low yielding lines in the test. No variety yielded higher than check CDC Glas (Table 1). CDC Bethune matured earlier than all other varieties tested, whereas FP2602 took almost 12 more days than CDC Bethune.

Table 1. Performance of different flax entries at PESAI Arborg site during 2020 season.

Variety	Yield (bu/ac)	% of CDC Glas	Days to maturity
<b>Checks</b>			
CDC Bethune	50.3abc	98	85.7d
AAC Bright	50.5abc	98	91.0abcd
CDC Glas	51.3abc	100	88.7bcd
<b>SVPG Entries</b>			
CDC Dorado	45.1cd	88	89.0bcd
AAC Marvelous	50.1abc	98	91.7abcd
AAC Prairie Sunshine	48.2bcd	94	92.3abc
CDC Rowland	49.8abc	97	92.3abc
<b>Test Entries</b>			
FP2573	53.9ab	105	90.7bcd
FP2591	56.8a	111	91.3abcd
FP2592	50.2abc	98	94.7abc
FP2599	53.6ab	104	91.0abcd
FP2600	52.9ab	103	92.3abc
FP2597	52.6ab	103	89.7bcd
FP2596	48.0bcd	93	88.3cd
FP2598	47.5bcd	93	90.7bcd
FP2601	47.0bcd	92	94.0abc
FP2602	44.2cd	86	97.3a
FP2603	47.2bcd	92	92.0abcd
FP2604	44.5cd	87	95.0ab
FP2605	42.4d	83	93.7abc
C.V. %	4.8		2.2
P	<0.0001		<0.0001

Means contain different letters are statistically different at  $P < 0.05$ .

## Project Findings

The year 2020 was the third year of testing for the flax entries. The entries differed in their yield performance and days to maturity at Arborg site. A complete project report will be compiled by Dr Helen Booker.

## Background / Additional Resources / References

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 size and density significantly effect the productivity of linseeds (Fila et al 2018). Rainfall is beneficial to seed yield, both before and after flowering, whereas higher post-flowering air temperature has a negative effect.

The current coop trial was conducted at Melita, Roblin, Arborg and Carberry sites in Manitoba. There were also other sites across Saskatchewan, Alberta and Quebec in various soil zones but they will not be discussed in this report. For more information, flax breeder Dr Helen Booker can be contacted at 1-306-966-5878.

### References

G. Fila, M. Bagatta, C. Maestrini, E. Potenza and R. Matteo (2018) Linseed as a dual-purpose crop: evaluation of cultivar suitability and analysis of yield determinants. *The Journal of Agricultural Science*, Volume 156(2): 162 – 176  
[//doi.org/10.1017/S0021859618000114](https://doi.org/10.1017/S0021859618000114)[\[Opens in a new window\]](#).



## Materials and Methods

*Experimental Design* – Randomised block design with three replications.

*Treatments* – Twenty flax entries (See Table 1).

*Plot size* – 7.1m<sup>2</sup>

*Data collected* – plant height, lodging, days to maturity, grain yield, stem dry down, determinate growth habit

Only yield results are presented in the current report and other results will be reported in the overall report by Dr Helen's team. Subsamples were sent back to the Crop Development Centre in Saskatoon for fatty acid and protein analysis.

### Agronomic info

*Stubble, soil type* – Wheat, heavy clay

*Fertility*– Soil nutrient levels (N-P-K:lbs/acre): 112-22-380

Fertilizer applied (N-P-K:lbs/acre): 4-20-0

*Pesticides applied* – Centurion @75ml/acre + Amigo@1L/100L on June 3

Centurion @75ml/acre + Amigo@1L/100L on June 10

Reglone@0.83L/acre on Aug 25

*Seeding/harvesting date* – May 22 / Sept 10

# Evaluating Herbicide Efficacy in Flax

## Project duration

2020-2021

## Collaborators

Helen Booker, Saskatchewan Crop Development Centre

## Objectives

The purpose of this project is –

- 1) To compare efficacy of standard herbicide (Authority) treatments to experimental herbicide (Armezon) treatments in controlling weeds in flax.
- 2) To determine any safety concerns from the use of herbicide combinations.

## Results

### **Roblin site**

Weed injury was different among herbicide treatments after two weeks of application (2 WAA) at Roblin (Table 1). Application of Authority as a pre-seed injured 73% of the sampled weeds compared to 43% observed for a tank mix of Armezon + Bromoxynil + Select applied in-crop. High efficacy of Authority applied prior to seeding could have been as a result of activation by rainfall following herbicide application.

All other herbicide options, including Armezon applied in-crop alone were not effective, with only 5 to 8% weed injury at 2 WAA and were not different from each other in terms of efficacy.

Flax injury was high both at 2 (47%) & 4 (22%) WAA when Armezon + Mextrol + Select (treatment 8) were applied post emergence in a single tank mix. All other herbicide treatments proved to be safe at Roblin site.

A combination of Armezon + Mextrol + Select applied to flax resulted in lower plant height compared to other herbicide options. This might influence flax development and ultimate yield in the long term. On the other hand, a tank mix of Armezon + Bromoxynil + Select resulted in crop height that was not significantly different from treatments 1, 3, 4 and 5 and is acceptable compared to treatment 8 (Table 1). Therefore, Armezon + Bromoxynil + Select applied in-crop and Authority applied pre-seed could be better options when considering herbicide injury percentages and crop height impact. There were no significant yield differences observed regardless of herbicide treatment applied but numerically, in-crop application with Armezon achieved the highest seed yield of 4041 kg ha<sup>-1</sup>.

Overall high coefficient of variation for weed injury was as a result of treatment 9 (Armezon + Bromoxynil + Select) and 3 (Authority pre-seed), which had lots of variation. Flax emergence lower than expected due to excessively dry conditions at crop establishment. The site was seeded on the 27<sup>th</sup> of May but only received about 5.1 mm of rainfall between the 26<sup>th</sup> of May and the 5<sup>th</sup> of June (<https://web43.gov.mb.ca/Climate/DailyReport.aspx>).

*Table 1. Effect of different herbicide treatments on weed injury, weed density, flax emergence, crop injury, crop height and yield at Roblin.*

Treatment	Weed Injury (%) 2 WAA	Weed Density at flower (pl/m <sup>2</sup> )	Flax Emergence (pl/m <sup>2</sup> )	Crop Injury (%)		Plant height (cm) 2 WAA	Yield (kg/ha)
				2 WAA	4 WAA		
1. UTC (no weeding)	*	51	155	*	*	39abc	3097
2. UTC (Hand weeded check)	*	*	149	*	*	44a	1939
3. Authority (pre-seed)	73a	53	134	0b	0b	40ab	2976
4. Armezon (in crop)	8c	72	136	0b	0b	35bcd	4041
5. Authority + Armezon	5c	52	158	3b	0b	37abcd	3141
6. Authority + [Mextrol + Select (in crop)]	5c	60	150	3b	0b	31cd	3110
7. Authority + [Bromoxynil + Select (in crop)]	5c	41	157	2b	0b	30d	3013
8. Armezon + Mextrol + Select	5c	68	146	47a	22a	16e	2418
9. Armezon + Bromoxynil + Select	43b	62	180	3b	1b	33bcd	2864
P value (treatment)	<b>0.001</b>	0.573	0.794	<b>&lt;0.001</b>	<b>0.014</b>	<b>&lt;0.001</b>	0.320
Coefficient of Variation (%)	33	10	21	85.8	196.2	14	29

#### **Melita site**

At Melita, herbicide combinations resulted in greater weed injury than in single herbicide treatments (Table 2). Higher weed injury for combination treatments involving Authority were probably as a result of adequate rainfall for herbicide activation following application.

Herbicide combinations also caused greater reduction in weed densities compared to Armezon or Authority applied alone. Overall, weed density was lower at Melita compared to Arborg and Roblin, which could be due to site specific differences.

*Table 2. Effect of different herbicide treatments on weed injury, weed density, flax emergence, crop injury, crop height and yield at Melita.*

Treatment	Weed Injury (%) 2WAA	Weed Density at flower (pl/m <sup>2</sup> )	Flax Emergence (pl/m <sup>2</sup> )	Crop Injury (%)		Plant height (cm) 2WAA	Yield (kg/ha)
				2WAA	4WAA		
1. UTC (no weeding)	*	23a	541			37a	2473
2. UTC (Hand weeded check)	*	*	537			36ab	2508
3. Authority (pre-seed)	27bc	13ab	520	0d	0b	37a	2512
4. Armezon (in crop)	7c	21a	567	0d	0b	37a	2376
5. Authority + Armezon	45bc	6bc	473	10cd	0b	34ab	2762
6. Authority + [Mextrol + Select (in crop)]	78ab	4c	500	20bc	0b	31bc	2490
7. Authority + [Bromoxynil + Select (in crop)]	92a	4c	537	10cd	2b	32abc	2603
8. Armezon + Mextrol + Select	72ab	4c	506	43a	8a	26cd	2596
9. Armezon + Bromoxynil + Select	93a	5c	524	37ab	10a	24d	2526
P value (treatment)	<b>0.005</b>	<b>0.003</b>	0.627	<b>0.001</b>	<b>0.008</b>	<b>0.002</b>	0.699
Coefficient of Variation	28	26	10	68.4	140.7	11	9

Armezon (in-crop) application alone caused little injury on weeds and flax than when applied in combination with other herbicides. It did not have a negative impact on flax height compared to combination herbicides. Crop injury recovery was observed at 4 WAA of combination herbicides involving Armezon, which explains the ability of flax to recover in the short term after herbicide treatment.

Flax emergence did not differ among treatments and overall Melita site had good stand establishment. This was probably due to adequate soil moisture at crop establishment stage. There were no significant differences in flax seed yield across all treatments.

### Arborg site

Weed injury was high among all combination treatments including Armezon applied in-crop at Arborg site. It ranged from 60% to 87% compared with Authority (pre-seed) that only caused 10% injury (Table 3). It is quite possible that Authority was not effective due of low rainfall received within two weeks of application. Authority applications require a moderate rainfall of between 10-20 mm within 10 to 14 days for proper activation. During the 2-week period from application of Authority, Arborg site only received 3.8 mm rainfall (<https://web43.gov.mb.ca/Climate/DailyReport.aspx>), which was not adequate for its activation.

*Table 3. Effect of different herbicide treatments on weed injury, weed density, flax emergence, crop injury, crop height and yield at Arborg.*

Treatment	Weed Injury (%) 2WAA	Weed Density at flower (pl/m <sup>2</sup> )	Flax Emergence (pl/m <sup>2</sup> )	Crop Injury (%)		Plant height (cm) 2WAA	Yield (kg/ha)
				2WAA	4WAA		
1. UTC (no weeding)	*	96a	264	*	*	42ab	1889e
2. UTC (Hand weeded check)	*	*	313	*	*	47a	3553a
3. Authority (pre-seed)	10b	93ab	293	8	12ab	35bc	2217de
4. Armezon (in crop)	60a	109a	304	13	13ab	20d	2574cd
5. Authority + Armezon	67a	104ab	317	13	7c	32c	3198ab
6. Authority + [Mextrol + Select (in crop)]	80a	11c	279	12	6c	46a	3007bc
7. Authority + [Bromoxynil + Select (in crop)]	78a	68abc	315	17	8bc	22d	3052b
8. Armezon + Mextrol + Select	87a	15bc	315	28	15a	17d	2944bc
9. Armezon + Bromoxynil + Select	85a	70a	277	23	13ab	19d	3116ab
P value (treatment)	<b>&lt;0.001</b>	<b>0.037</b>	0.29	0.242	<b>0.007</b>	<b>&lt;0.001</b>	<b>&lt;0.001</b>
Coefficient of Variation	12	17	10	15.2	25.7	13	10

Weed density at flower differed among different treatments. Weed density was lower in Authority + {Mextrol + Select (in-crop)} and Armezon + Mextrol + Select herbicide combinations.

Similar pattern in crop injury recovery was observed at Arborg site as at Melita and Roblin sites. Crop recovered significantly at 4 WAA. Authority in combination with Armezon or Mextrol & Select resulted in less crop injury at 4WAA.

Crop height was reduced in treatments 4, 5, 7, 8 & 9. It looks like Armezon alone or in combination with bromoxynil did have its effect on flax height.

Flax seed yield was higher in combination herbicide treatments. Overall, flax yield ranged from 1889 kg ha<sup>-1</sup> to 3553 kg ha<sup>-1</sup>, with the lowest being the non-weeded check as expected. Although it caused significantly high percentage in weed injury during the first 2 WAA, the MCPA component in Mextrol with Armezon + Mextrol + Select appeared to have reduced



flax seed yield. Probably application rates of the Mextrol component might need to be revised so as to reduce the impact on yield but not compromising on weed control.

### **Combined site analysis**

A combined site analysis conducted to determine performance of herbicide treatments across different environments found no significant differences in efficacy on weed injury, weed density at flowering stage and flax emergence. However, Armezon + Bromoxynil + Select combination caused the highest weed injury while other treatments ranged from 25 to 58% (Table 4).

Crop injury at 2 and 4WAA varied significantly and application of Armezon (pre-seed) + Mextrol + Select (in-crop) caused the highest flax injury (39% & 15%, respectively). There were also significant recoveries from herbicide injury within the 2-week period from the initial observation. The impact of treatments 8 and 9 were not significantly different on crop injury at 4 WAA.

Flax height was significantly affected due to different herbicide options applied. Treatments 7, 8 and 9 resulted in shortened flax plants at 2 WAA. There were also significant treatment x site interactions in flax plant height, weed density at 2 WAA and crop yield. Site differences may have influenced results of this study. Selection of herbicide options to use will likely be based on their performance in a specific geographical area.

*Table 4. GLM Combined (Melita, Arborg and Roblin sites) analysis of variance for weed injury, weed density, flax emergence, crop injury, crop height and crop yield during 2020 testing.*

Treatment	Weed Injury (%) 2WAA	Weed Density at flower (pl/m <sup>2</sup> )	Flax Emergence (pl/m <sup>2</sup> )	Crop Injury (%)		Plant height (cm) 2WAA	Yield kg/ha
				2WAA	4WAA		
1. UTC (no weeding)	*	57	320	*	*	39ab	2486
2. UTC (Hand weeded check)	*	*	333	*	*	42a	2667
3. Authority (pre-seed)	37	53	315	3c	4b	37abc	2568
4. Armezon (in crop)	25	67	336	4c	4b	31bcd	2997
5. Authority + Armezon	39	54	316	9bc	2b	34abcd	3034
6. Authority + Mextrol + Select (in crop)	54	25	309	12bc	2b	36abc	2869
7. Authority (pre-seed) + Bromoxynil + Select (in crop)	58	38	336	9bc	3b	28cde	2889
8. Armezon (pre-seed) + Mextrol + Select (in crop)	54	29	322	39a	15a	20e	2653
9. Armezon + Bromoxynil + Select (in crop)	74	46	327	21b	8ab	25de	2835
P value (treatment)	0.647	0.058	0.821	<b>0.003</b>	<b>0.023</b>	<b>0.004</b>	0.876
P value (Site)	0.22	0.202	0.159	0.291	0.208	<b>&lt;0.001</b>	0.392
P value (Site x Treatment)	<b>0.015</b>	0.075	0.481	0.056	0.082	<b>0.007</b>	<b>0.048</b>

Weed species composition differed across all the three sites (Table 5). Arborg had predominantly redroot pigweed in treatments 1, 2, 4 and 8 while lambs quarters was only present in treatment 1 and 2. At Melita, biennial wormwood was predominant in treatments 1, 3, 4 and 6 while volunteer wheat appeared in more than 50% of the treatments. At Roblin, volunteer canola was predominant in all treatments followed by green foxtail.

Table 5. Summary of four major weed species (ranked as most to least) by site after herbicide treatment at flower stage.

Treatment	Arborg	Melita	Roblin
1	RRP> C> D> LQ	BW> D> VW> CT	C> GF> LQ> SP
2	RRP> D> C> LQ	D>W	C> GF> LQ> D
3	WB> D	BW> VW> WB> K	C> GF
4	RRP> C> WB> D	BW> D> WB> VW	C> GF
5	D> WB> RRP	WB> CT> VC> BW	C> GF> D
6	C> D> RRP> WB	BW> VW> WO> VW	C> GF> D
7	D	D> VW> RRP> BW	C> GF> SP
8	RRP> C> D	WB> BW	C> GF> LQ

**Key** RRP – Redroot pigweed, C – volunteer canola, D – Dandelion, WB – Wild Buckwheat, LQ – Lambs quarters, BW – Biennial Wormwood, WO – Wild Oat, K – Kochia, VW – Volunteer Wheat, CT – Canadian Thistle, GF – Green foxtail, SP – Shepherd’s purse

## Project Findings

Interestingly there were no flax injuries with Authority + Mextrol option but Armezon in combination with Mextrol caused injuries. Based on these preliminary findings, this combination should be avoided in real farm situations unless if further studies with reduced applications rates of Mextrol can prove otherwise. Armezon on its own did not seem to show crop injury, but it stunted the height of flax, which could reduce seed yield. Arborg was the only site that showed yield loss based on herbicide use in general. At this site, Armezon showed yield loss both in sole use, and in combination with Mextrol. The study will be conducted again in 2021 before recommendations can be made available for registration of Armezon in flax. There might be need to consider reducing Mextrol application rates when used in combination with Armezon in order to address crop injury concerns.

## Background / References / Additional Resources

Flax (*Linum usitatissimum*) is an important crop known for its value in food and fiber industrial markets around the world. However, flax has a low competitive ability with weeds compared to other crops. Various weed management strategies that include; competitive varieties, early seeding, increased seeding rates and the use of pre- and post-emergence herbicides can help to control weeds and reduce yield losses than using only one control method (Kurtenbach et al., 2019). Pre-emergence weed control is crucial in flax to reduce yield loss since flax is a weak competitor with weeds (Berglund and Zollinger, 2007).

Post-emergence weed control, if done timely, usually results in better weed control and allow more time for flax recovery from possible herbicide injury. There is currently a challenge in herbicide options for flax as a result of herbicide resistance. Furthermore, herbicide injury concerns after the use of different herbicide combinations need to be examined. There is need to investigate possible alternative options, herbicide combinations and timings of application for control of both broad leaf weeds and grasses.

Armezon® herbicide, which is classified as Group 27, is an effective tank-mix option that is currently registered as a post-emergence herbicide for the control of tough broad leaf weeds and grasses in corn and has potential for use in flax for control of Group 1 resistant grasses (Table 6). Currently, the herbicide is not registered for use in flax but extensive field trials can provide data for registration. Therefore, this study is evaluating several herbicides including Authority, Mextrol, Koril, Select and experimental Armezon used alone or tank mixed with

compatible herbicides to see their effectiveness in weed control and protecting yield losses. The study also aims to assess any safety concerns with the use of different herbicide mixes in flax.

Table 6. List of weeds controlled by Armezon, Authority, Mextrol, Koril and Select herbicides.

Weeds Controlled	Herbicide Name				
	Armezon	Authority	Mextrol	Koril	Select
	Herbicide Group				
	27	14	4 + 6	6	1
Barnyard Grass	S				C
Foxtail Green	S				C
Foxtail Yellow	S				C
Quack grass					C
Volunteer Cereals					C
Wild Oats					C
Wild Buckwheat		C	C	C	
Night-flowering Catchfly			C		
Chickweed	S				
Cleavers		S			
Cocklebur			C	C	
Dandelion					
Flixweed			C		
Hemp-nettle					
Kochia	C	C	C	C	
Lambs quarters	S	C	C	C	
Round leaved Mallow					
Wild Mustard	C		C	C	
Red Root Pigweed	C	C	S	C	
Russian Thistle	S		C	C	
Shepherds Purse			C		
Annual Smartweed	S		C	C	
P. Sow thistle			TG		
Stinkweed			C	C	
Canada Thistle			TG		
Vol. Canola	C		C	C	

C – Control, S – Suppress, TG – Top growth

## References

- Berglund, D. R. and Zollinger, R. K. 2007. *Flax Production in North Dakota*. North Dakota Extension Service, North Dakota State University 58105: A-1038.
- Kurtenbach, M. E., Johnson, E. N., Gulden, R. H., Duguid, S., Dyck, M. F., Willenborg, C. J. 2019. *Integrating Cultural Practices with Herbicide Augments Weed Management in Flax*. *Agronomy Journal* **111** (4): 1904-1912. <https://doi.org/10.2134/agronj2018.09.0593>.

## Materials and Methods

The trial was conducted at Melita, Roblin and Arborg sites in Manitoba, as randomized complete block design with the following nine herbicide treatments replicated three times:

1. UTC (no weeding)
2. UTC (Hand weeded check)

3. Authority (pre-seed) @ 100 ml/acre
4. Armezon (in crop) @ 15 ml/acre + Merge @ 0.25L/100L water
5. Authority (pre-seed) + Armezon (in crop)
6. Authority (pre-seed) + (Mextrol 450 @ 0.5L/acre + Select @ 100 ml/acre + Amigo in crop)
7. Authority (pre-seed) + (Bromoxynil @ 0.49L/acre [Koril] + Select @ 100 ml/acre)
8. Armezon + (Mextrol 450 + Select + Amigo)
9. Armezon + (Bromoxynil + Select)

Herbicide treatments were applied using a calibrated CO<sub>2</sub> backpack sprayer. Herbicide formulation and treatment description is summarized in Table 7.

*Table 7. Herbicide formulation and treatment description for flax herbicide trial in 2020*

Trade name	Chemical	App. Rate g a.i./L	Field Rate ml/ac	Water Vol. Rate gal/ac	Treatments
Armezon	Topramezone	336	15	10	4,5,8,9
Merge	Adjuvant		0.25L/100L	10	3,4
Authority	Sulfentrazone	480	100	10	3,5,6,7
Mextrol	MCPA + Bromoxynil	225 + 225	500	10	6,8
Koril	Bromoxynil	235	490	10	7,9
Select	Clethodim	252	100	10	6,7,9,9
Amigo	Surfactant		0.5L/100L	10	6,8

Plot management varied from site to site. Summary of site description, agronomic management followed, spray information and assessment dates are presented in Tables 8 and 9.



*Flax herbicide trial at Arborg site.*

Table 8. Spraying information for Arborg, Melita and Roblin sites.

Spraying information		Arborg	Melita	Roblin
Spray Tip		TeeJet AI80015	TeeJet AI8002	BFS Orange AI 01
Water Volume (imp. Gal/ac)		10	10	10
Burnoff		NA	08-May	29-May
Burnoff Product (Rate)		NA	Roundup (0.5 L/ac) + Aim (15 ml/ac)	Roundup (0.64L/ac)
Pre-emerg app date		22-May	08-May	29-May
In-crop app date		13-Jun	04-Jun	25-Jun
Assessments				
Crop Injury	2WAA	26-Jun	18-Jun	08-Jul
	4WAA	13-Jul	02-Jul	22-Jul
Weed Injury date 2WAA		26-Jun	26-Jun	08-Jul
Weed count date at flower		13-Jul	02-Jul	27-Jul
Crop height date 2WAA		13-Jul	20-Jul	22-Jul

Table 9. Characterization and Agronomy information for Arborg, Melita and Roblin sites.

Description	Arborg	Melita	Roblin
Research Group	PESAI	WADO	PCDF
Legal Land Location	NW 16-22-2 E1	SE 26-3-27 W1	NE 20-25-28 W1
Soil Series	Fyala heavy clay	Newstead Loam	Erickson clay loam
Stubble	wheat	spring wheat	silage barley
Field Prep	harrowed	harrowed, no till	harrowed, no till
Soil Test N-P-K (lbs/ac)	112-22-380	35-18-900	66-92-1224
Fertilizer App		108-35-20-8-2 Zn	
N-P-K-S-Zn (lbs/ac)	50(B)-20 (SB)-0	(SB)	54-10-0 (SB)
Seeder Type	disc drill	Knife drill	disc drill
Rows and Spacing (inches)	8 (7.5)	6 (9.5)	5 (9.5)
Seed Date	21-May	08-May	27-May
Seed Depth	0.75"	0.5"	0.5"
Fungicide/Insecticides	NA	NA	NA
Desiccation Product	Reglone	Reglone	Reglone
Harvest Date	08-Sep	24-Aug	04-Sep
Growing Season Meteorology information (Seed Date - Harvest Date)			
GGDs actual Base 5°C	1403	1380	1157
GGDs normal	1242	1313	1141
Precipitation actual	195	168	225
Precipitation normal	252	272	215

GDD – growing degree days, B – broadcast, SB – side banded, NA – not applicable



## iQ Granular Starter – Does it have any effect on canola production?

**Project Duration** – 2020

**Objectives** – Assessing the effects of iQ granular starter on canola production

**Collaborators** – Tim Dyck, Canadian Agronomics

### Results

There was no effect on the days to maturity and plant height, when iQ granular starter was applied to canola plots in addition to recommended fertilizers (Table 1). iQ treated canola plots observed lower yield in comparison to control canola plots.

*Table 1. Effect of iQ granular starter on canola growth & yield at Arborg site.*

Treatment	Plant Stand (plants/ft <sup>2</sup> )	Days to Maturity	Plant Height at maturity (inches)	Yield (bushels/acre)
iQ granular starter	17.0	82.5	40.7	54.7
Control	15.4	82.2	39.9	60.3
P	0.375	0.260	0.556	0.045
CV %	18.2	0.6	5.3	7.3
Significant Difference	No	No	No	Yes

### Project Findings

The testing at Arborg site did not show any improvement in the canola yield, when iQ granular starter was applied in addition to recommended fertilizers. Arborg site was relatively drier during 2020 growing season and this might have attributed to poor efficacy of iQ granular starter.

### Background / Additional resources / References

iQ is an organic layer poultry compost, starter fertilizer approved by Organic Materials Review Institute (OMRI). Canadian Agronomics, who markets this product, revealed that iQ increases porosity, organic matter/carbon, and microbial activity in the soil. This product is reported to be beneficial in canola production (Canadian Agronomics website).

#### Reference:

<https://canadianagronomics.ca/iq-granular-starter/>



## **Materials and Methods**

*Experimental Design* – strips with six replications

*Treatments* – Comparing iQ starter granular with control canola plots

*Plot size* – 8.22m<sup>2</sup>

*Data collected* – plant stand, days to maturity, plant height at maturity and yield

### **Agronomic info**

*Stubble, soil type* – Fallow, heavy clay

*Fertilizer applied* – Soil nutrient levels (lbs/acre): N – 75, P – 25

*Pesticides applied* – Decis@ 50ml/acre on June 25 (for flea beetles)

Liberty@1.35L/acre on July 02

Silencer@34ml/acre for flea beetles on Aug 14

Silencer@34ml/acre for flea beetles on Aug 20

Reglone@0.83L/acre on Aug 25

*Seeding/harvesting date* – May 27 / Sept 02

# Comparing Annual Forages for productivity

## Project Duration

2020

## Objectives

To compare multiple green feed forage blend combinations to evaluate their suitability for harvest as ruminant feed. In addition to comparing quality, quantity (MT/ac) and compatibility of the blends, their regrowth potential was also assessed in order to create best recommended practices for producers in the Interlake region and beyond.

## Collaborators

Bailey Sigvaldason, Foster Ag Services

## Results

Haymaker Oats and Arborg Oats were comparable all season in terms of the plant height, however, differences were noted in the leaf size and diameter of the stem (data not shown). The plots with forage peas began to lodge later in the season, more notably in the Arborg Oats and Forage Peas blend.

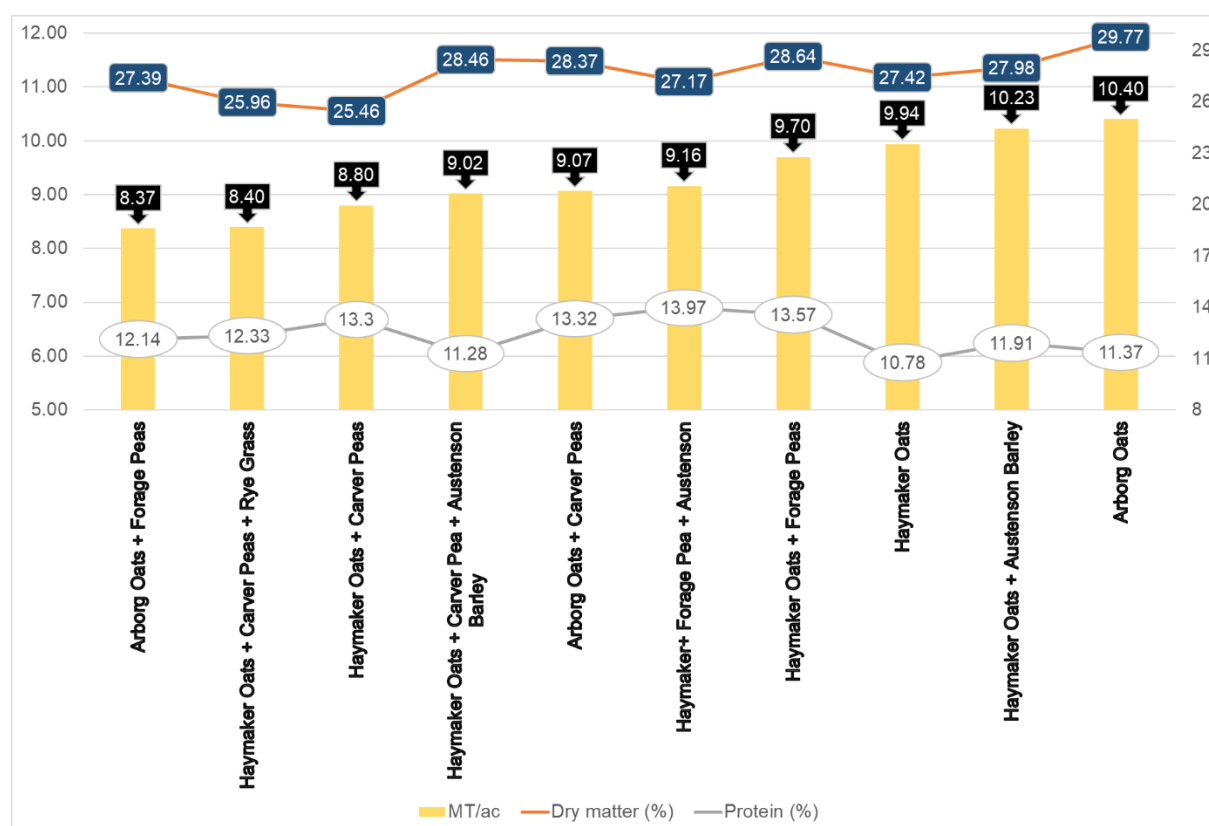


Fig 1. Production (MT/ac at 65% moisture), dry matter (%) and protein content (%) comparisons among different forages / forage blends tested at Arborg site.

The plots of Arborg Oats had maximum tonnage (10.4 MT/ac) followed by Haymaker Oats & Austenson Barley blend (10.23 MT/ac). Protein content, however, was less than 12 per cent in both forage treatments. The plots of Haymaker Oats, Austenson Barley and Forage peas had maximum protein content (13.97%), however, forage tonnage from these plots was only 9.16 MT/ac putting it in the middle of all tested forages / forage blends.

In general, blending peas with annual cereal crops improved protein quality of the forage blends. Dry matter of different forages / forage blends varied from 25.5 – 29.8% (Fig 1). Quality analysis (ADF, NDF & TDN) results are given in Fig 2.

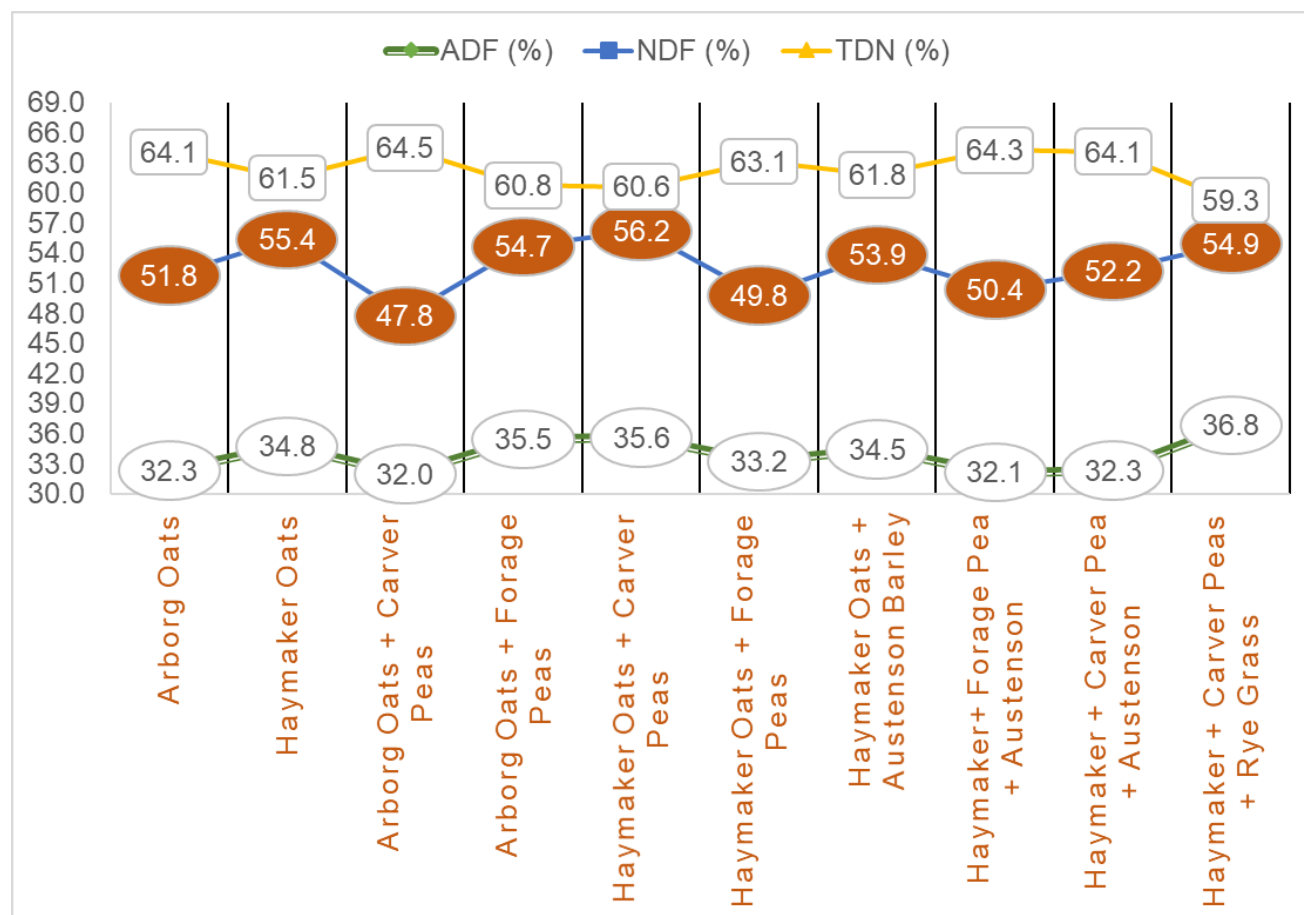


Fig 2. Acid Detergent Fiber (ADF), Neutral Detergent Fiber (NDF) and Total digestible Nutrients (TDN) comparisons among tested forages / forage blends at Arborg site.

### Project Findings

Tonnage differences were evident among forages / forage blends tested in the current study. Higher tonnage were recorded from cereals grown either alone or in blends (Oats and Barley together), however, higher protein content were recorded in cereal / peas blends. Data from this project could be used to plan annual forages / forage blends as per specific needs of the producers.

One blend tested had Italian rye grass in it. The Italian Rye Grass had little regrowth after harvest at this site. The survival of the rye grass will be monitored into the spring to assess if this is a good option for early spring grazing.

## Materials & Methods

*Experimental Design* – Demonstrations with three replicates

*Treatments* – The following forage / forage blends were seeded for the comparisons -

1. Arborg Oats at 3 bu /acre
2. Haymaker Oats at 3 bu/acre
3. Arborg Oats at 2 bu/acre and Carver Peas at 1 bu/acre
4. Arborg Oats at 2 bu/acre and Forage Peas at 1 bu/acre
5. Haymaker Oats at 2 bu/acre and Carver Peas at 1 bu/acre
6. Haymaker Oats at 2 bu/acre and Forage Peas at 1 bu/acre
7. Haymaker Oats at 2 bu/acre and Austenson barley at 2 bu/acre
8. Haymaker Oats , Forage Peas, and Austenson Barley all at 1 bu/acre
9. Haymaker Oats, Carver Peas and Austenson Barley all at 1 bu/acre
10. Haymaker Oats at 2 bu/acre and Carver Peas at 1 bu/acre with Italian Rye Grass at 12 lbs/acre

*Plot size* – 8.22m<sup>2</sup>

*Data collected* – plant stand, plant height at maturity and forage yield

### **Agronomic info**

*Stubble, soil type* – Fallow, heavy clay

*Soil nutrient levels (N-P-K:lbs/acre):* 290-38-540

*Fertilizer applied (lbs/acre):* N – 75, P – 25

*Seeding/harvesting date* – May 26 / Aug 7





# Excess moisture effects on Canola growth and yield

## Project Duration

2019-2021

## Objectives

The purpose of this project is -

- 1) To quantify the tolerance and recovery of current cultivars of canola to excess moisture stress, with the intention of identifying a cultivar that has improved tolerance.
- 2) To find out how timing of excess moisture stress affects yield.

## Collaborators

Canadian Agricultural Partnership funding  
Curtis Cavers, AAFC Portage la Prairie

## Results

Flooding did not affect plant stand. However, it did influence plant height at maturity, lodging and days to maturity. Flooding stress at later crop stage resulted in shorter canola plants (Table 1). In contrast, canola took more days to mature, when flooded at early crop stage. Although lodging differences were evident among the flooding treatments, but overall lodging scores were low enough to cause any significant yield loss. Canola suffered significant yield losses when flooded at later crop stage.

Table 1. Effect of flooding on canola growth and grain yield at Arborg site.

Treatment	Plant Stand (plants/ft <sup>2</sup> )	Plant height (inches)	Days to Maturity	Lodging (1-5 scale)	Yield (bu/acre)
Early Flooding	38.2	35.7b	84.0b	1.11a	49.6a
Late Flooding	36.4	30.8a*	79.8a	1.42b*	10.7b*
No Flooding	37.1	35.2b	80.7a	1.03a	45.6a
<b>Significant Difference</b>	<b>No</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
<b>P</b>	<b>0.75</b>	<b>&lt;0.0001</b>	<b>0.005</b>	<b>&lt;0.0001</b>	<b>&lt;0.0001</b>
<b>CV%</b>	<b>15.0</b>	<b>7.0</b>	<b>3.7</b>	<b>7.9</b>	<b>11.4</b>

\* Severe disease incidence was noticed in the plots.

## Project Findings

Canola grew shorter in plots where flooding stress was imposed at later crop stage. Flooding stress at early crop stage resulted in delayed maturity. Grain yield was severely affected when plots were flooded at later crop stage. This might not be only due to flooding effect as these plots also showed severe root rot symptoms after flooding stress. Variety-flooding interaction was not significant for the grain yield. All canola varieties were able to tolerate flooding stress at the early crop stage. No Canola variety, however, exhibited flooding tolerance when plots were flooded at later crop stage.

## Background / References / Additional Resources

Extreme moisture in Manitoba soil causes significant losses to farmers. Canola is quite



susceptible to water logging and shows a yield reduction if exposed to excess moisture in the earlier phase of crop growth. Wet soils cause an oxygen deficiency, which reduces root respiration and growth (Canola Council of Canada). This attributed to reduced nutrient uptake in canola.

Zhou and Lin (1995) reported that plant height, stem width and the number of primary branches per plant were decreased by waterlogging at seedling and floral bud appearance stages of Canola. Pods per plant and seeds per pod were also reduced, giving 21.3% and 12.5% decrease of seed yield from the control for treatments at the seedling and floral bud appearance stages, respectively. No significant difference in seed yield was observed between the control and treatments applied at flowering and pod formation stages.

W. Zhou, and X. Lin (1995) *Effects of waterlogging at different growth stages on physiological characteristics and seed yield of winter rape (Brassica napus L.)*. *Field Crops Research* **44**: 103-110.

## Materials & Methods

*Experimental Design* – Replicated block design with three replications

*Treatments* – Four canola varieties were grown in flooded (early- and late-crop stage) and non-flooded set ups. Early flooding plots were flooded between June 20-July 4 and a total of 5 inches of flooding was applied in addition to natural precipitation. Flooding was started, when the canola crop was at 2-3 leaf stage.

Flooding was started in late-flooded plots on July 8, when the crop was at early flowering stage. Flooding continued until July 29 and a total of 7.5 inches of flooding was applied in addition to natural rainfall.

*Varieties* – L233P, L234PC, L252, L255PC

*Plot size* – 9.12m<sup>2</sup>

*Data collected* – plant stand, plant height, days to maturity, lodging and grain yield

### **Agronomic information**

*Stubble, soil type* – Fallow, Heavy clay

*Fertilizer applied* – Early/ late flooding sets: N 55 - P 25 – K 0 (lbs/acre)

Control set: N 43 - P15 – K 0 (lbs/acre)

*Pesticides applied* – Liberty@1.35 L/acre + Decis @ 50ml / acre on Jun 16

Decis @ 50ml /acre on Jun 25

Liberty @1.35 L/acre on July 02 (Only late flooding and control sets)

Coragen @ 50ml/acre for grasshoppers on July 10

Coragen @100ml/acre for grasshoppers on Aug 11 (only Control set)

Silencer @ 34ml/acre for flea beetles on Aug 14 (only Control set)

Silencer @ 34ml/acre for flea beetles on Aug 20

*Seeding / Harvesting date* – Jun 02 / Sep 04

## Excess moisture effects on Spring Wheat growth & yield

### Project Duration

2019-2021

### Objectives

The current study was planned to see the effect of early and late flooding on four commonly grown wheat varieties in Manitoba. Plots were also grown under no flooding conditions as control for comparisons.

### Collaborators

Canadian Agricultural Partnership funding  
Curtis Cavers, AAFC Portage la Prairie

### Results

Flooding influenced the days to maturity and yield of the wheat varieties tested at Arborg site (Table 1). Wheat plots flooded at early crop stage took more days to mature as compared to control wheat plots or plots flooded at later crop stage. However, lower yield was recorded in early and late flooding plots as compared to no flooding plots. Grain protein content was relatively lower when the plots were flooded at later crop stage. Varieties also differed in grain protein & AAC Cameron had less protein content (Table 2). Flooding did not have any effect on crop lodging.

Table 1. Effect of flooding on wheat growth and grain yield at Arborg site.

Treatment	Plant Stand (plants/1m row)	Days to Maturity	Lodging (1-5 Scale)	Yield (bu/acre)	Protein content (%)
Early Flooding	48.9	101.2b	1.15	42.7a	13.99b
Late Flooding	49.2	85.0a	1.10	73.1b	12.35a
No Flooding	52.8	85.5a	1.15	84.5c	14.57b
<b>Significant Diff</b>	<b>No</b>	<b>Yes</b>	<b>No</b>	<b>Yes</b>	<b>Yes</b>
<b>P</b>	<b>0.06</b>	<b>&lt;0.0001</b>	<b>0.87</b>	<b>&lt;0.0001</b>	<b>&lt;0.0001</b>
<b>CV%</b>	<b>8.5</b>	<b>2.2</b>	<b>10.0</b>	<b>7.4</b>	<b>5.7</b>

The variety – flooding interaction was significant ( $p = 0.023$ ) in the current evaluation (Fig 1). In general, all wheat varieties produced greater yield when grown under no flooding conditions. Variety AAC Brandon suffered yield loss (12.6 bushels/acre) when the plots of this variety were flooded at later crop stage. There was no yield reduction in other three varieties tested, when late flooding stress was imposed.

All wheat varieties suffered significant yield loss when their plots were flooded at early crop (2-3 leaf) stage. Wheat variety AAC Cameron, however, suffered comparatively less yield reduction as compared to other three varieties.



Table 2. Grain protein comparisons among tested wheat varieties.

Variety	Cardale	AAC Viewfield	AAC Brandon	AAC Cameron
Protein (%)	14.2a	14.0a	13.8a	12.5b
Significant difference	Yes			

## Project Findings

Continuous flooding at 2-3 leaf stage delayed wheat maturity and exhibited significant yield loss. Flooding at later crop stage did not have any effect on maturity, although it also reduced yield. Flooding at early crop stage produced nutrient deficiency symptoms in tested wheat varieties. Nutrient deficiency symptoms, however, were not so evident in plots of variety AAC Cameron. This might be a reason why this variety did not suffer yield loss up to the extent as seen in other three wheat varieties. These tests will be repeated next year again.

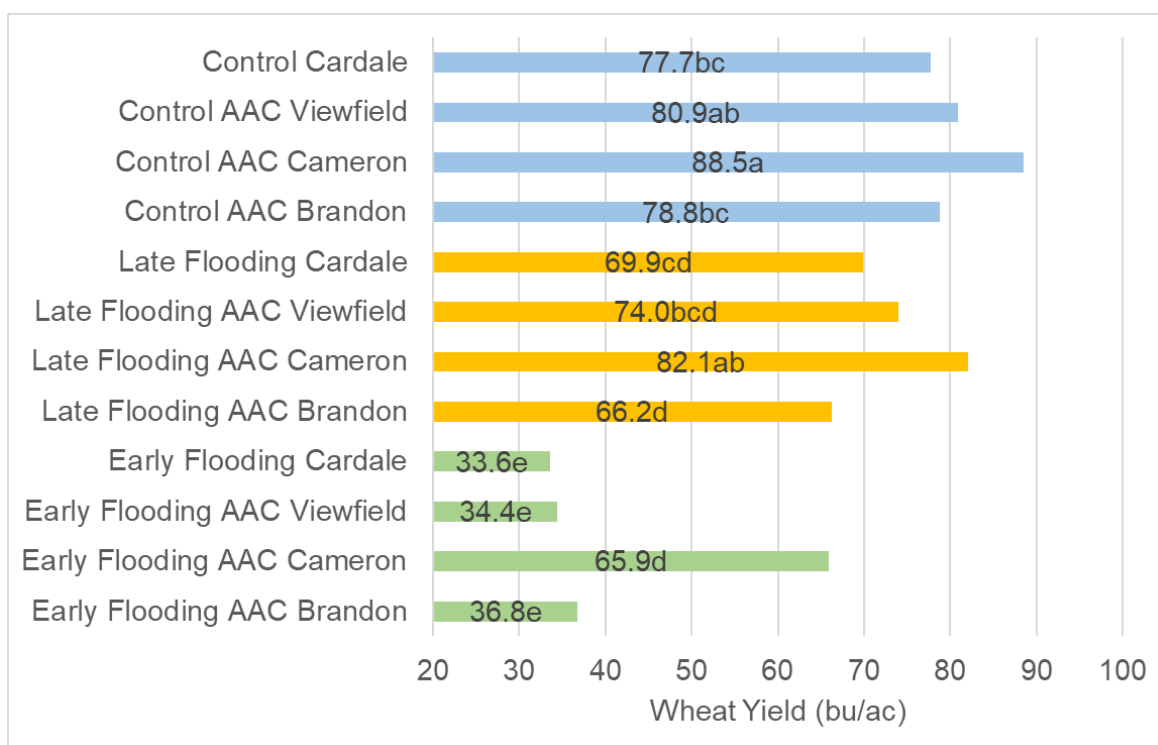


Fig 1. Variety-Flooding interaction results from the 2020 Arborg test.

## Background/References/Additional Resources

Wet soils cause an oxygen deficiency and reduction in nutrient uptake. Early flooding can significantly reduced tillering, plant height, delayed head emergence significantly affecting the grain yield. Excessive soil moisture also delays agronomic operations. The impact of these losses on farm net income is significant. During 1966-2015, excess moisture accounted for 38% of all crop losses in Manitoba (MASC).

Manitoba crop insurance data from 1965-1972 showed clay soils subjected to excess moisture in July experienced the highest yield loss (2-6 bu/ac/day) for barley, oats, wheat and flax crops (Rigaux and Singh,1977).

Additionally, farmers experience loss of nutrients due to extreme moisture as well as loss of soil. Excess water conditions may impact the ability of a plant to take up inorganic nutrients due to the effects on processes associated with solute movement across membranes (Barrett-Lennard 2003). Uptake of essential nutrients such as N, P, and K takes place against gradients of chemical and electrical potential, which requires energy inputs from aerobic respiration; respiration is inhibited under anaerobic conditions making nutrient uptake energetically

unfavorable (Greenway and Gibbs 2003). For example, Huang et al. (1995) reported reduced concentrations of N, P, K, Mg, and Zn in wheat shoots under waterlogged conditions (and an increased concentration of these same elements in the wheat roots).

*Barrett-Lennard, E. G. 2003. The interaction between waterlogging and salinity in higher plants: causes, consequences and implications. Plant Soil 253: 35-54.*

*Greenway, H. and Gibbs, J. 2003. Mechanisms of anoxia tolerance in plants. II. Energy requirements for maintenance and energy distribution to essential processes. Func. Plant Biol. 30: 999-1036.*

*Huang, B. R., Johnson, J. W., Nesmith, D. S. and Bridges, D.C. 1995. Nutrient accumulation and distribution of wheat genotypes in response to waterlogging and nutrient supply. Plant Soil 173: 47-54.*

*Rigaux, L. R. and Singh, R. H. Benefit-cost evaluation of improved levels of agricultural drainage in Manitoba, Volume 1-3, Research Bulletin No. 77-1, Department of Agricultural Economics and Farm Management, University of Manitoba, June 1977.*

## **Materials & Methods**

*Experimental Design* – Replicated block design with three replications

*Treatments* – Four wheat varieties were grown in flooded (early- and late-crop stage) and non-flooded set ups. Early flooding plots were flooded between June 20-July 4 and a total of 5 inches of flooding was applied in addition to natural precipitation. Flooding was started, when the wheat crop was at 2-3 leaf stage.

Flooding was started in late-flooded plots on July 8, when the crop was at soft dough stage. Flooding continued until July 29 and a total of 7.5 inches of flooding was applied in addition to natural rainfall.

*Varieties* –AAC Brandon, AAC Cameron, AAC Viewfield and Cardale

*Plot size* – 9.12m<sup>2</sup>

*Data collected* – Plant stand, days to maturity, lodging, grain yield

### ***Agronomic information***

*Stubble, soil type* – Fallow, Heavy clay

*Fertilizer applied* – Early/Late flooding sets: N-55: P-25 (lbs/acre)

Control set: N-43: P-15 (lbs/acre)

*Pesticides applied* – Axial @ 0.5lit/acre + Buctril @ 0.4lit/acre

(only late flooding & control sets on June 30)

Coragen @ 50ml/acre for grasshoppers on July 17

Coragen @100ml/acre for grasshoppers on Aug 11 (only control set)

*Seeding/Harvesting date* – June 02/ Sep 11



# Determining tile drainage effects on wheat, soybeans and canola productivity in heavy clay soils

## Project Duration

2019-2022

## Objectives

The main objective of this research is to assess the impact of tile drainage spacing's (15', 30' and 45' wide) and water table management on the yield and quality of wheat, soybeans and canola.

## Collaborators

Dr Ramanathan Sri Ranjan, University of Manitoba  
Canadian Agricultural Partnership Program

## Results

Tile drainage did not have any effect on plant height and grain yield of the crops tested (Table 1). Grain yield was little higher (all three crops) from the plots grown in between the tiles but the results were not significant. Tile drainage resulted in delayed maturity of soybeans and canola while it did not have any effect on wheat maturity. Soybeans and canola grown on no-tile plots matured relatively faster than when grown over or in between tiles.

*Table 1. Effect of tile drainage on the growth parameters & yield of wheat, canola & soybeans at Arborg site during 2020.*

Treatment	Wheat (Over 15' wide tiles)				Soybeans (Over 30' wide tiles)			Canola (Over 45' wide tiles)	
	Head counts/ft <sup>2</sup>	Days to maturity	Plant height (inches)	Yield (bu/acre)	Days to maturity	Plant height (inches)	Yield (bu/acre)	Days to maturity	Yield (bu/acre)
Over tiles	53.1	90.3	30.4	53.7	<b>114.7b</b>	27.9	29.4	<b>87.7b</b>	25.5
Bet. tiles	57.7	90.0	30.9	55.7	<b>115.0b</b>	31.2	30.3	<b>87.0b</b>	28.8
No tile	54.7	90.3	31.7	53.6	<b>112.7a</b>	28.8	28.0	<b>84.7a</b>	23.8
Signi Diff	No	No	No	No	<b>Yes</b>	No	No	<b>Yes</b>	No
P value	0.258	0.630	0.695	0.535	<b>0.002</b>	0.211	0.691	<b>0.006</b>	0.092
CV%	5.5	0.5	5.6	6.2	0.4	7.0	12.9	0.8	12.3

*Different letters in each column denotes statistically significant differences among treatments.*

## Project Findings

Tiles did not have any effect on the crop yield during 2020 season. The year 2020 had been considerably a dry year at Arborg site and the site received less than 70 per cent of the normal rainfall during the growing period. Therefore, it was difficult to assess the effect of tile drainage on the crop production. Canola and soybean yields were relatively on the lower side depicting these crops were deficit in soil moisture. The data collected from this research will be used to develop computer models that can simulate tile drainage operation under different rainfall patterns.

## Background / Additional Information / References

The presence of heavy clay soils in the Interlake contributes to high moisture content, particularly during the spring. Excessive soil moisture delays agronomic operations and as a result can have a shorter cropping season and sometimes decreased yield. Excess moisture is a big constraint in crop production in Manitoba. The Manitoba Agricultural Services Corporation (MASC) reported that between 1996 and 2014, approximately 40% of crop losses were the result of excess moisture (with some reports placing that number at 55% from 2005-2014).

Removal of surface water alone might not be a solution to excess moisture if the soil below the surface remains saturated. Draining water from the root zone is important to gain access to a field and to avoid loss of moisture-sensitive crops. Subsurface drainage systems help to remove excess soil moisture from the root zone. The amount of water removed daily is dependent on the drainage rate of the system, which must be carefully considered during the design process. The drainage rate determines the capability of the system to prevent soil saturation during high intensity rainfall events. Other parameters affecting the drainage rate are soil type, topography, tile installation depth and spacing of tile drains.

Tile drainage is becoming popular as a way to control excess moisture in the field to increase crop productivity. Yet, the economic return on investment (ROI) on installing tile drainage is not known for wheat, canola, and soybeans in Manitoba. This research will allow us to assess the impact of water management through controlled drainage on yield and quality of wheat, canola, and soybeans. Detailed soil moisture measurements along with water table depth at different times will help us model water flow within the rootzone and its impact on crop yield.



Data collected in this study will be used to calibrate computer models (HYDRUS, DrainMOD) for this location so that weather data from different years could be modeled to assess the long-term impact of tile drainage. The Prairies East Sustainable Agriculture Initiative (PESAI) research site has drains placed at 15', 30', and 45' allowing different degrees of drainage. Rotating the three crops on these different spacings will help assess the impact of different drainage intensities.

## **Materials and Methods**

*Experimental Design* – Randomised block design with three replications

*Treatments* – Agronomic data collection was done over the tiles and in between the tiles (centre point between two tiles in a plot). Data was also collected from the plots where on tiles were installed. The following were the crop varieties used for the current study -

Wheat: AAC Brandon with seeding rate of 2.5 bushels/acre

Canola: L233P with seeding rate of 7 lbs/acre

Soybean variety: S0009-M2 with seeding rate of 70lbs/acre

*Plot size* – Tiled plots: About one acre each

Non-tiled plots: 60m x 20m

*Data collected* – Plant height, days to maturity and grain yield, head counts (for wheat only)

### **Agronomic info**

*Stubble, soil type* – Canola was seeded on Soybean stubble, where as Soybeans were seeded on Wheat stubble. Wheat was seeded on Canola stubble. Arborg soil is a heavy clay soil.

*Fertilizer applied* – (N-P: lbs/acre): Wheat plots: 50 - 20

Canola plots on tiles: 100-20

Canola Control plots: 50-20

Soybean plots: 0-20

*Pesticides applied* – Wheat: Axial @ 0.5L/acre + Buctril @ 0.4L/acre on June 12

Canola: Liberty @1.35L/acre + Decis @ 50ml/acre on June 16

Decis @ 50ml/acre on June 25

Liberty @1.35L/acre on July 02

Reglone @0.83L/acre on Aug 25

Soybean: Glyphosate @0.67L/acre on June 22

*Seeding / harvesting date* – Wheat: May 18/ Aug 25

Canola: May 21/ Sep 02

Soybean: May 27/ Sep 23

For harvesting, two 20-metre long strips were combined from each plot on and in between the tiles. Plant phenology and yield data were analysed using MINITAB.