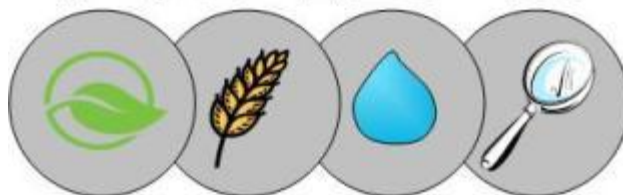


# WADO



Westman Agricultural Diversification Organization

## 2014 Annual Report

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Manitoba 



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## 2014 Industry Partners (Alphabetical Order)

AgQuest  
Agriculture and Agri-Food Canada  
Agrisoma  
ARDI – Agri-Food Research Development Initiative  
Avondale Seeds  
Barker’s Agri-Centre – Melita  
BASF  
Boissevain Select Seeds  
Canada Manitoba Crop Diversification Centre- Carberry  
Canadian Hemp Trade Alliance  
Canadian International Grains Institute  
Ducks Unlimited Canada  
FMC Agricultural Solutions  
FP Genetics  
Gowan Agro Canada  
Indian Head Agricultural Research Foundation  
MAFRI – Crops Branch and GO Teams  
Manitoba Agricultural Services Corporation  
Manitoba Beef Producers  
Manitoba Buckwheat Growers Association  
Manitoba Corn Growers Association  
Manitoba Crop Variety Evaluation Team  
Manitoba Food Development Centre  
Manitoba Pulse Growers Association  
Monsanto  
Mustard 21  
National Sunflower Association of Canada  
Nestibo Agra  
Novozymes  
Parkland Crop Diversification Foundation - Roblin  
Parkland Industrial Hemp Growers  
Paterson Grain  
Pepsico Foods  
Plains Industrial Hemp Processing  
Prairie Agricultural Machinery Institute - Portage  
Prairies East Sustainable Ag Initiative – Arborg  
RM of Pipestone  
RM of Two Borders  
Secan Seeds  
Seed Manitoba  
Southwest Regional Development Committee  
Soya UK Ltd. – Southampton, UK  
Town of Melita  
University of Manitoba  
University of Saskatchewan (CDC)  
Western Feed Grains Development Cooperative  
Winter Cereals Canada

## Farmer Co-operators – 2013-2014 Trial Locations

Barkers Farm – Melita  
Allan Brown Farm – Melita  
Kendall Heise – Isabella  
Tilbury Farms - Melita

Kirkup Farm - Melita  
Jim Anderson Farm – Melita  
Wayne White – Melita

## WADO Directors

WADO functions with a board of directors that assists in communications, activities and project development. The directors are from all across southwest Manitoba and they have a direct connection to farming and agriculture. The directors listed below are those that participated with WADO operations for 2014.

Gary Barker	Melita - Chairman	John Finnie	Kenton
Brooks White	Pierson	Allan McKenzie	Nesbitt
Ryan Martens	Boissevain	Patrick Johnson	Killarney
Kevin Beernaert	Hartney	Neil Galbraith	Minnedosa
Kevin Routledge	Hamiota		

MAFRI staff members located in Southwest Manitoba are also part of the WADO board: Elmer Kaskiw – Shoal Lake, Lionel Kaskiw – Souris, Murray Frank – Brandon, Amir Farooq – Hamiota, as well as Scott Chalmers – Melita

## Got An Idea?

The Westman Agricultural Diversification Organization continually looks for project ideas, value-added ideas, and producer production concerns. If you have any ideas, please forward them to:

Westman Agricultural Diversification Organization (WADO)  
c/o Scott Chalmers MAFRI  
Box 519  
Melita, MB, R0M 1L0  
204-522-3256 (office)  
204-522-5415 (cell)  
204-522-8054 (fax)  
[scott.chalmers@gov.mb.ca](mailto:scott.chalmers@gov.mb.ca)

**All WADO annual reports are posted at the provincial website:**

<http://www.gov.mb.ca/agriculture/innovation-and-research/diversification-centres/index.html>

## Introduction

The Westman Agricultural Diversification Organization Inc. (WADO) manages a wide range of value-added and diversification agriculture research and demonstration projects that are summarized in this report. WADO operates in the southwest region of Manitoba and works in conjunction whenever possible with the other Diversification Centres in Roblin (PCDF), Arborg (PESAI) and the Fed/Prov. Canada/Manitoba Diversification Centres (CMCDC) based in Carberry, Portage and Winkler. WADO owes its success to the excellent cooperation and participation we receive from the WADO Board of Directors, cooperating land owners, local producers, industry partners and cooperating research institutes. WADO acts as a facilitator and sponsor for many of the Ag Extension events held across the province in conjunction with other MAFRI staff and industry personnel. This is all part of WADO's goal of helping farmers and our rural communities do better.

WADO receives the majority of its operating funds from the Agricultural Sustainability Initiative (ASI) and other Growing Forward (GF) programs. Smaller amounts of additional funding come from the MCVET committee and other Industry Partners for the contract work that WADO is able to provide to these organizations.

## WADO Staff

Scott Chalmers P.Ag., is the Diversification Specialist for MAFRI in Southwest Manitoba. Scott is responsible for project development, general operations, summer staff management, plot management, data collection and analysis. Scott has been working with WADO since 2007.

WADO enjoyed excellent staff in 2014. They were an important reason we were able to successfully handle more than 1850 plots throughout the SW region. A full salute goes out to: Aly Turnbull from Pipestone, Liam Bambridge from Melita, Chantal Elliott of Pipestone and Jessica Mayes of Pierson.



Scott Chalmers



Liam has been with WADO for three summers. He is currently at the University of Manitoba taking his second year of the Agriculture Diploma program. Melita is Liam's former stomping grounds.

Aly has worked with WADO on and off for three years. In 2013 she completed the Land and Water Resource Diploma from Assiniboine Community College in Brandon. After spending time in Australia she returned to the area and resumed her position with WADO until February of 2014. Aly is now employed in the oilfield in the environmental sector throughout Saskatchewan and Manitoba.

Chantal has spent two summers with WADO. She is currently working on her second year of an Environmental Science degree at the University of Manitoba. Chantal grew up on an organic farm near Pipestone, MB.

Jessica has been a summer student with WADO since 2013. She is a Grade 11 student at Pierson School. She plans to return to WADO during the summer of 2015.



From left to right: Jessica, Chantal, Scott, Aly, Liam

## 2014 Weather Report and Data – Melita Area

Seeding conditions were poor due to excess moisture and frequent rains with tight opportunity breaks. Approximately 300,000 acres were left unseeded in the municipalities of Edward, Arthur, Albert and Brenda. Farmers had to be resourceful and resilient to get crops sown, many utilizing night time seeding to maximize opportunities. Most crops that were seeded experienced cool soil temperatures, excess moisture and moisture related diseases. Melita and area experienced two significant weather events during the growing season. At the end of June an unusual weather system brought rains between 5" and 10" to a large part of SE Saskatchewan and SW Manitoba. This caused overland flooding, flooded fields and washed out roads. Several plots needed to be



Photo (above): Highway 445 west of Melita

pumped off to minimize crop damage. Other trials were completely lost due to the flood. The extremely wet conditions caused delays to field work and spraying which in turn led to weed and disease control issues.

Rain was also an issue for WADO and area farmers during August. Over 100 mm of rain throughout the month caused harvest issues such as delays, difficulties operating machinery in moisture soaked soil and downgrading in the quality of crops. Due to the ample rain fall, crop maturity was pushed well into September and October leading to a late harvest.

**Figure 1: Melita – WADO 2014 Season Report by Month (Data taken from ACIS Weather Station)**

	April	May	June	July	August	September	October	Total
Precip (mm)	67.1	104.8	152.5	40.6	102.3	21.7	5.2	494.2
Normal Percip. <sup>1</sup>	31.2	56.4	74.7	59.7	51.6	39.5	29.4	342.5
Temp Ave oC	6.5	11.6	16.5	19.4	19.2	13.7	7.02	
Norm. Temp <sup>1</sup>	4.6	11.59	16.8	19.49	18.52	12.69	5.58	
CHU	39.79	352.7	584.2	730.6	707.7	414.4	17.13	2789.6
GDD	15.61	208.3	344.6	445.5	439.3	262.4	51.5	1700.1

**Figure 2: Season Summary April to October (Data taken from ACIS Weather Station)**

	Actual	Normal	% of Normal
Number of Days	214		
Growing Degree Days	1700.1	1765.5	96.30%
Corn Heat Units	2789.6	2745.7	101.60%
Total Percipitation	495.8	342.5	145%

To calculate growing degree days (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 2. The base temperature (0°C for cereals, 5°C for both alfalfa and 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.

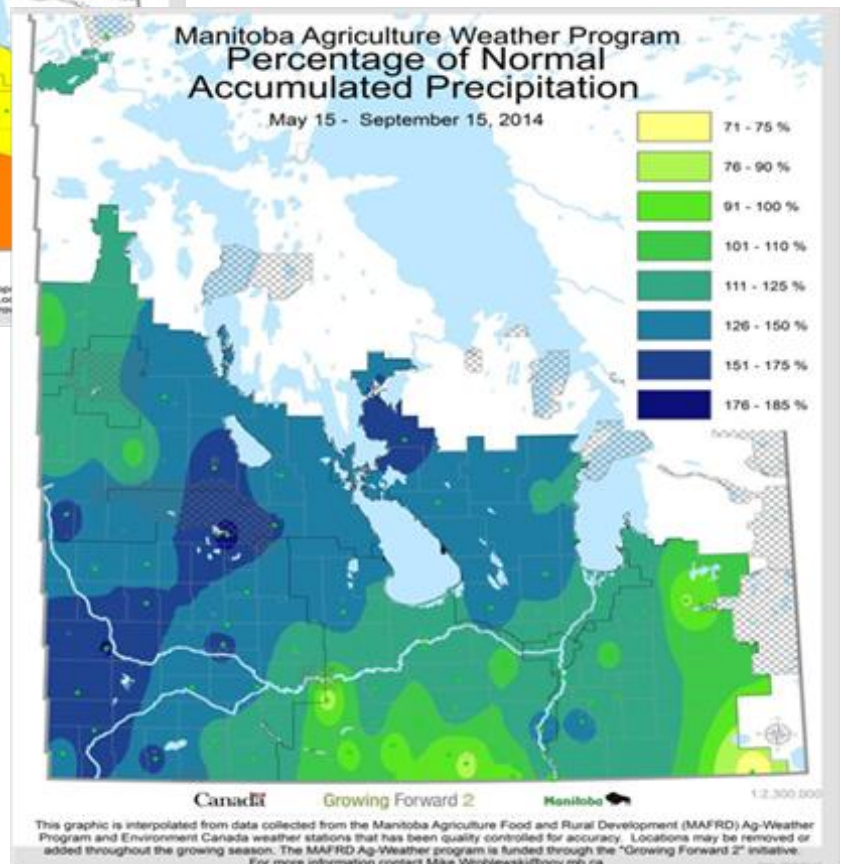
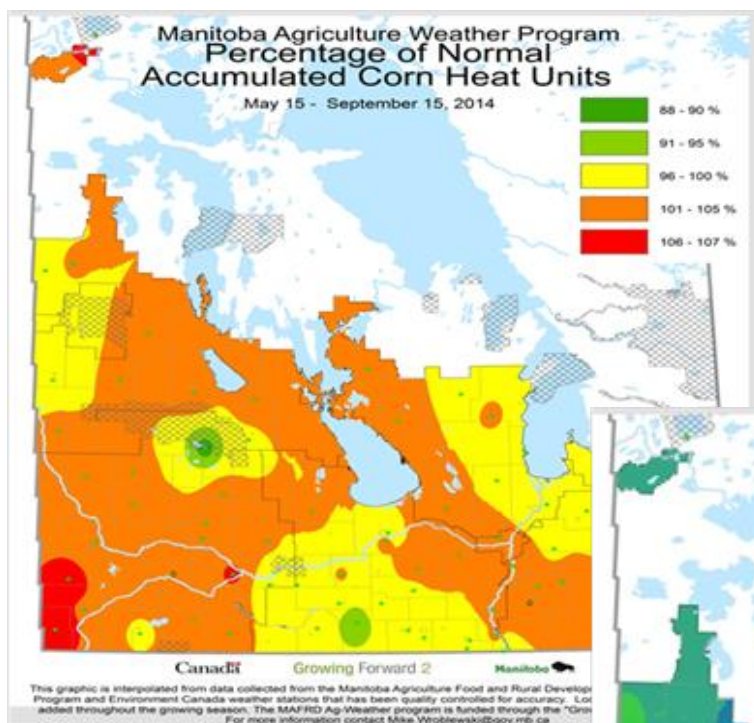
Corn heat units (CHU) are based on a similar principle to growing degree days. CHUs are calculated on a daily basis, using the maximum and minimum temperatures; however, the equation that is used is quite different. The CHU model uses separate calculations for maximum and minimum temperatures. The maximum or daytime relationship uses 10°C as the base temperature and 30°C as the ceiling, because warm-season crops do not develop at all when daytime temperatures fall below 10°C, and develop fastest at about 30°C. The minimum or nighttime relationship uses 4.4°C as the base temperature and does not specify an optimum temperature, because nighttime minimum temperatures very seldom exceed 25°C in Canada. The nighttime relationship is considered a linear relationship, while the daytime relationship is considered non-linear because crop development peaks at 30°C and begins to decline at higher temperatures. CHU's is a more accurate crop prediction tool for crops like corn and beans that require heat for proper growth.



WADO continues to operate and draw data from several weather stations in the southwest. These stations include Melita, Hamiota, Wawanesa, and Reston. Continuous real time data recorded every 15 minutes and this can be viewed publicly at the following locations:

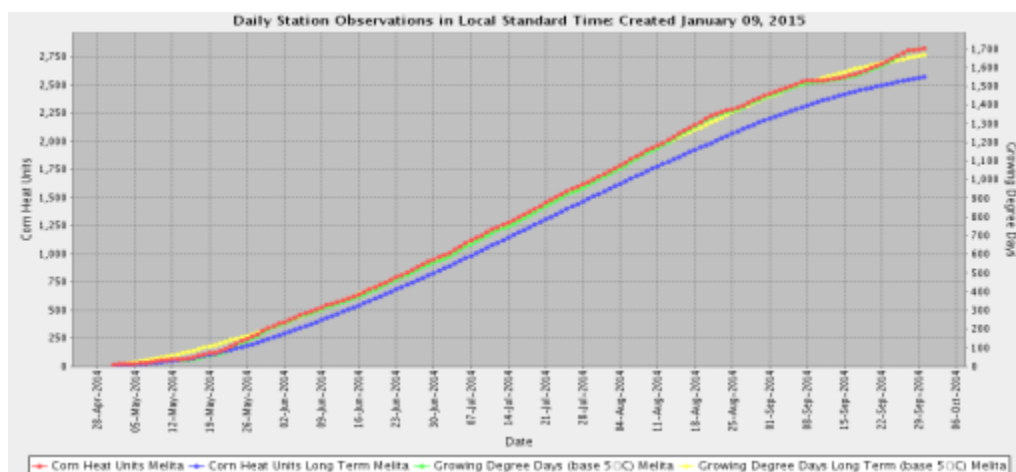
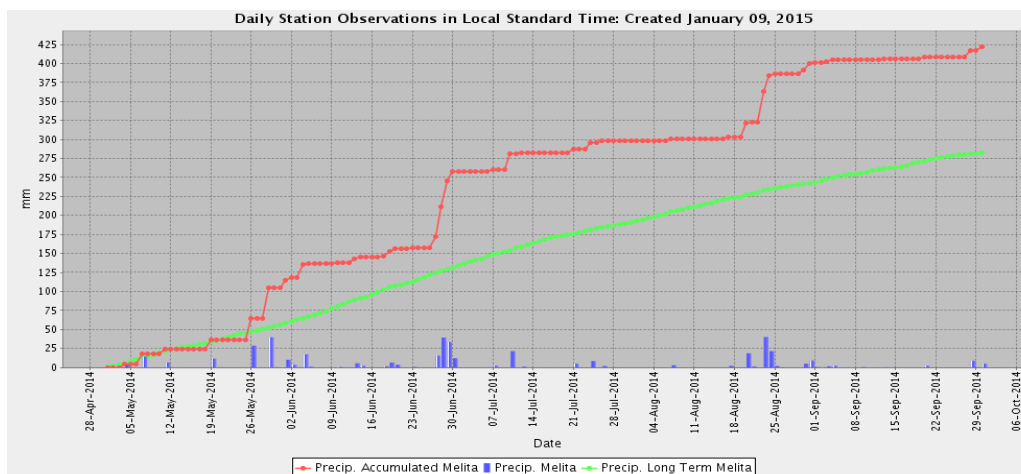
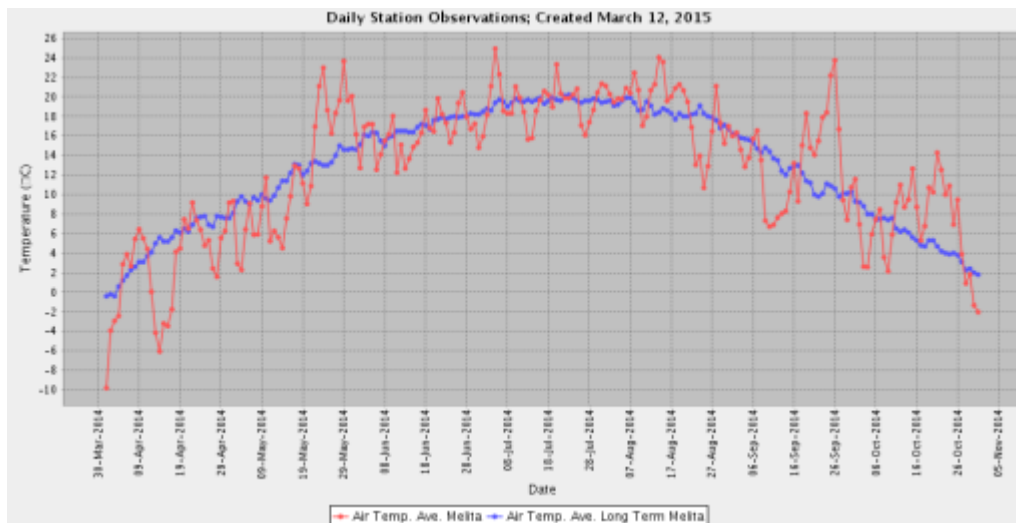
<http://tgs.gov.mb.ca/climate/DisplayImage.aspx?StationID=bede253>  
<http://tgs.gov.mb.ca/climate/DisplayImage.aspx?StationID=hamiotaWADO>  
<http://tgs.gov.mb.ca/climate/DisplayImage.aspx?StationID=reston245>  
<http://tgs.gov.mb.ca/climate/DisplayImage.aspx?StationID=wawane240>

## 2014 % of Normal Precipitation Map and Corn Heat Unit Map



## 2014 Weather Data Comparison Charts

[agriculture.alberta.ca/acis/weather-data-viewer](http://agriculture.alberta.ca/acis/weather-data-viewer)



## WADO Tours and Special Events



Ag Days, held January in Brandon, was the largest event WADO was involved in for 2014 (picture left). WADO attended the show with the rest of Manitoba's Diversification Centres featuring a booth showcasing new farming opportunities and possibilities. Over 60,000 people were in attendance.



WADO sponsored a field tour of the Hamiota plots in August which hosted about 50 in attendance. Plots including the MCVET variety trials and the Western Feed Grain Cooperative trial were showcased.

## Understanding Plot Statistics

There are two types of plots at WADO. The first type is replicated research plots and the other is demonstration plots. Demonstration plots are not used to determine statistical differences between data. They are typically used only for show and tell, and observation.

Replicated plots are scientific experiments in which various treatments (ex. varieties, rates, seed treatments, etc.) are subject to a replicated assessment to determine if there are differences or similarities between them. Many designs of replicated trials include randomized complete block designs (most common), split plot design, split-split plot design and lattice designs. Since these types of trials are replicated, statistical differences can be derived from the data using statistical analysis tools.

The analysis of variance (ANOVA) is the most common of these calculations. From those calculations, we can determine several important numbers such as coefficient of variation (CV), least significant difference (LSD) and R-squared. CV indicates how well we performed the trial in the field which is a value of trial variation; variability of the treatment average as a whole of the trial. Typically CV's greater than 15% are an indication of poor data in which a trial is usually rejected from further use. LSD is a measure of allowable significant differences between any two treatments. Ex: Consider two treatments, 1 and 2. The first treatment has a mean yield of 24 bu/ac. The second treatment has a yield of 39 bu/ac. The LSD was found to be 8 bu/ac. The difference between the treatments is 15. Since the difference was greater than the LSD value 8, these treatments are significantly different from each other. In other words, you can expect the one treatment (variety or fertilizer amount, etc.) to consistently produce yields higher than the other treatment in field conditions. If "means" (averages) do not fall within this minimal difference, they are considered not significantly different from each other. Sometimes letters of the alphabet are used to distinguish similarity (same letter in common) between varieties or differences between them (when letters are different representing them).

R-squared is the coefficient of determination and is a value of how "sound" the data really is. In regression models such as ANOVA it is determined by a value that approaches the value of 1, which represents perfect data in a straight line. In most plot research, R-squared varies between 0.80 and 0.99 indicating good data.

Grand mean is the average of the entire data set. Quite often, it helps gauge the overall yield of a site or trial location.

Sometimes 'checks' are used to reference a familiar variety to new varieties and may be highlighted in grey or simply referred to as 'check' in the results table or summary for the readers convenience.

Data in all replicated trials at WADO has been analyzed by statistical software from either Agrobase Gen II version 16.2.1 software, or Analyze-it version 2.03 software. Coefficient of variation and least significant difference at the 0.05 level of significance was used to determine trial variation and mean differences respectively. At this level of significance, there is less than 5% chance that this data is a fluke when considered significant. For differences among treatments to be significant, the p-value must be less than 0.05. A p-value of 0.001 would be considered highly significant.

## MCVET Variety Evaluation Trials

The Westman Agricultural Diversification Organization is one of many sites that are part of the Manitoba Crop Variety Evaluation Team (MCVET) which facilitates variety evaluations of many different crop types in this province.

The purpose of the MCVET variety evaluation trials is to grow both familiar (checks or reference) and new varieties side by side in a replicated manner in order to compare and contrast various variety characteristics such as yield, maturity, protein content, disease tolerance and many others. From each MCVET site across the province, yearly data is created, combined, and summarized in the 'Seed Manitoba 2015 Guide'. Hard copies can be found at most MAFRI and Ag Industry Offices. The suite of Seed Manitoba products — the Seed Manitoba Guide and the websites [www.seedinteractive.ca](http://www.seedinteractive.ca) and [www.seedmb.ca](http://www.seedmb.ca) — provides valuable variety performance information for Manitoba farmers. Look for Seed Manitoba 2015 mailed out with the Manitoba Cooperator or on the web.

## Winter Wheat Variety Trials

### Cooperators

- Ducks Unlimited Canada
- MCVET & Seed Manitoba
- Winter Cereals Canada

### Introduction

Farmers select winter wheat varieties based on yield potential, disease resistance, height, standability and maturity. Another selection point that is becoming increasingly important is selecting a variety on planned end-use or marketing considerations. Is the harvested product for milling? For ethanol production? As an ingredient in feed rations? Knowing the answers to these questions will help farmers select not only a variety that will perform on their farm, but one that will also be suitable for the planned end-use.

The Canadian Grain Commission moved CDC Falcon, Manitoba's most popular variety, from the Canada Western Red Winter (CWRW) class to the Canada Western General Purpose (CWGP) class as of August 1, 2014.

The variety Emerson is rated 'resistant' (R) to Fusarium Head Blight. Depending on the level of disease pressure, varieties that are rated as resistant could still be infected to some degree. If disease pressure is high, yield and/or quality loss due to FHB can still occur in R-rated varieties.

### *Updated Long-Term Data*

To assist with variety decisions, MCVET publishes variety data in Seed Manitoba's 2015 Variety Selection & Growers Source Guide available at [www.seedmb.ca](http://www.seedmb.ca).

Farmers should look at long-term data and select those varieties which perform well not only in their area but across locations and over multiple years. Long-term data can be found in the 2015 Winter Wheat Variety Descriptions Table. The "Yield % Check" column provides an indication of how the listed varieties performed compared to the check, CDC Falcon. Remember that only direct comparisons can be made between CDC Falcon and the variety chosen to compare it to. The more site-years, the more dependable the data. If farmers want to choose their own check, the website [www.seedinteractive.ca](http://www.seedinteractive.ca) gives them that ability.

Flourish and Moats, possible CWRW replacements for CDC Falcon, have now been tested for a fourth year so additional data is available. New CWGP entries in 2014 including 1603-137-1 and 1303-132-1 from the University of Manitoba (Dept. Plant Sciences) have been supported for registration. Caution must be exercised when evaluating the performance of these two varieties as the data only represents two or three years of data.

### *Multi-site Data for 2014*

Multi-site data can be found in the Yield Comparisons Table. Although yields are expressed as bushels per acre compared to CDC Falcon, comparisons are not restricted to only CDC Falcon. Comparisons can be made between other varieties.

For example, you may want to compare the performance of CDC Buteo and Sunrise at Isabella. The first step will be to look at the "Sign Diff" value — a "yes" or "no" will indicate if a real difference exists between varieties. At Isabella, there is a significant difference between the varieties tested. You then need to look at the "LSD %" value. LSD stands for Least Significant Difference and it shows the yield that individual varieties must differ by to be considered significantly different. At the Isabella location, varieties must differ by 5 bu/ac to be significant. Since yields of CDC Buteo and Sunrise differ by 4 bushel per acre, statistically, Sunrise did not yield more or less than CDC Buteo at Isabella.

The next step would be to determine if that yield potential is consistent across all sites. Out of the 5 locations, Sunrise yielded significantly more than Buteo at 1 location, but at the remaining locations the performance of CDC Buteo and Sunrise is similar. Therefore, by looking only at the 2014 data, farmers can see that yield potential of Sunrise and Buteo is fairly similar.

Keep in mind that data accumulated over several sites in a single year must always be viewed with caution. Varieties that excel under one set of environmental conditions may not perform as well under the next year's conditions.



Farmers can also go to [www.seedinteractive.ca](http://www.seedinteractive.ca) where they can select multiple varieties, locations and years that are most compatible with their farm, while still offering the ability to choose their own check variety.

### *Fusarium Head Blight Ratings*

A concerted effort to improve fusarium head blight (FHB) resistance in winter wheat varieties is being undertaken by breeders. In past editions of the seed guide, there has been limited data available to publish ratings for many varieties. However, official FHB evaluations have started for winter wheat entries tested in both the Central and Western winter wheat co-operative registration trials. Combined with previous testing, done by Dr. Anita Brulé-Babel at the University of Manitoba, enough data exists to assign and in one case change, ratings to some of the varieties.

The rating for CDC Buteo has been changed to moderately resistant or MR from the intermediate (I) rating received prior to 2014. Data for CDC Ptarmigan and Peregrine shows both at an intermediate (I) rating. Emerson is now the only resistant (R) rated variety. All other varieties are either susceptible (S) or moderately susceptible (MS), or not enough data exists yet to give a rating.

It is important to note that with future testing, more changes to the ratings may occur in order to provide the most accurate information to farmers. But the data released is a great first step and subsequently a great planning tool for farmers as FHB can be an issue in winter wheat production.

### *Trial Objectives*

- To evaluate yield and qualities of different varieties of winter wheat for use in food, fuel and feed markets.
- To expand the current industry for value-added processing opportunities.
- To grow winter wheat in several locations across SW Manitoba to assess the impact of climate and soil type differences among variety yields.

### *Methods*

This trial consisted of 12 varieties of winter wheat in plots that were 1.44 m wide by 9 m long. Varieties were organized in a randomized complete block design. Variety plots were replicated three times. Soil tests were taken prior to seeding (Table 1). Plots were established in two locations in southwest Manitoba (Melita and Crandall) by WADO in accordance to their agronomic specifications (Table 2). Due to harvest management issues at Melita, only the Crandall location will be presented in this report. A plot air seeder equipped with SeedHawk dual knife openers was used to seed plots. Herbicides Achieve

and Buctril M were applied at 10 gal/ac water volume at recommended application rates. Plots were combined with a Wintersteiger plot combine. Samples were measured for moisture and test weight.

**Table 1:** Site locations and the previous crop type and soil tests

Site	Legal Land Location	Previous Crop	Depth	N	P	K	S	OM
				lbs/ac	ppm Olsen	ppm	lbs/ac	
Melita	SW 1-4-27 W1	Canola	0-6"	9	12	410	14	3%
			6-24"	5			36	
Crandall	NE 26-13-25	Canola	0-6"	18	11	318	120+	5%
			6-24"	30			360+	

**Table 2:** Specific site location information

Site	Seed Date	Applied Fertility NPKS (lbs/ac)	Spring 50 lbs N/ac Topdress	Herbicides	Dessication	Harvest
Melita	20-Sep	65-30-0-0	06-May	Achieve + Buctril M	19-Aug	30-Aug
Crandall	20-Sep	65-30-0-0	09-May	Achieve + Buctril M	14-Aug	12-Sep

## Results

There were significant differences among varieties (Table 3). CDC Chase and '1303-132-2' were the top yielding varieties of the trial. The variety Emerson was highest protein variety for the trial.

**Table 3:** Varieties of winter wheat and their corresponding yield and protein content in 2014 (Crandall).

Variety	Class	Mean (kg/ha)	%
CDC Chase	CWRW	6101.5	11.5
1303-132-2	CWGP	5538.1	11.3
Sunrise	CWGP	5498.5	10.8
AAC Gateway	CWRW	5417.7	12.2
Swainson	CWGP	5381.9	10.6
Emerson	CWRW	5370.6	12.0
1603-137-1	CWGP	5216.8	11.1
Moats	CWRW	5162.8	11.4
CDC Buteo	CWRW	5119.7	11.5
Broadview	CWGP	4919.0	11.8
Flourish	CWRW	4452.7	11.8
CDC Falcon	CWGP	4087.3	11.5
Coefficient of Variation		6.9	
LSD (p<0.05)		597.2	
P value		<0.0001	
Grand Mean		5136	
R-Square		0.84	

CWRW – Canada Western Red Winter

CWGP – Canada Western General Purpose

## Spring Wheat

### Cooperators

- MCVET
- Seed Manitoba

**Research Site:** Melita, MB

**Location:** SW 1-4-27 W1

**Land Cooperator:** Jim Anderson

**Previous Crop:** Canola

**Soil Texture:** Waskada Loamy Fine Sand

**Soil Test:**

Depth	pH	N ppm	P ppm Olsen	K ppm	S lbs/ac	Organic Matter %
0-6"	7.4	4.5	12	410	12	3.4
6-24"		2.5			19	

### Objective

Evaluate and demonstrate different varieties of Canada Western Red Spring, Canada Prairie Spring Red, Canada Western Extra Strong, and Canada Western Hard White wheat for yield potential and protein content. This will provide producers with information to help them select the appropriate variety in order to meet their target market's specifications whether it is the food sector, feed wheat, or ethanol industry. This variety data is used to support the province wide data set published in Manitoba's Seed Guide for 2015.

### Methods

The evaluation consisted of two trials, one with 17 Canada Western Red Spring (CWRS) varieties and the other with 14 varieties of Canada Western General Purpose (CWGP), Canada Prairie Spring Red (CPSR), and Canada Western Hard White Spring (CWHWS). Each trial had a CWRS check (Glenn). Plot dimensions were 1.44 m wide x 9 m long. Varieties were organized in a randomized complete block design and replicated three times. Plots were direct seeded May 15<sup>th</sup> and 16<sup>th</sup> at a depth of 0.5" using a dual knife SeedHawk air seeder. Fertilizer was side band at 118 lbs/ac nitrogen and 35 lbs/ac phosphorous, 30 lbs/ac potassium, and 15 lbs/ac sulfur, using liquid 28-0-0 UAN and granular 11-52-0 MAP, 0-0-60, and 21-0-0-24 granular. Plots were maintained weed free using Tundra Herbicide at a rate of 0.8 L/a. Plots were desiccated with Roundup 1 L/ac, Heat 10 g/ac and Merge 0.5% v/v on August 26. Plots were harvested at full maturity on September 2<sup>nd</sup>. Data collected included yield and test weight. Yield and protein data are summarized.

### Results

There were significant differences among spring wheat varieties in Melita (Table 1).

**Table 1:** Varieties of spring wheat, wheat classes and their corresponding grain yield, bushel weight and protein content in Melita.

<b>Wheat Trial 1</b>		Yield		Bushel Weight	Protein
Variety	Class	kg/ha	bu/ac	lbs/bu	%
AAC Whitefox	CWHWS	3738	55	60.4	13.9
PT584	CWHWS	3597	53	60.6	14.7
CDC Whitewood	CWHWS	2587	39	58.6	14.2
PT765	CWRS	3639	54	59.7	13.6
AAC Elie	CWRS	3526	53	59.1	14.2
AAC Brandon	CWRS	3503	53	59.3	14.1
AAC Prevail	CWRS	3384	51	59.3	14.2
5605HR CL	CWRS	3378	50	60.0	14.8
CDC Utmost VB	CWRS	3333	51	58.7	14.5
CDC VR Morris	CWRS	3274	49	59.8	14.1
AAC Redwater	CWRS	3219	50	57.9	14.8
CDC Plentiful	CWRS	3198	48	59.6	14.9
Glenn	CWRS	3176	46	61.1	15.2
Cardale	CWRS	2963	45	58.3	15.2
AAC Bailey	CWRS	2938	44	59.2	14.7
Carberry	CWRS	2805	42	59.0	14.6
AAC Iceberg	CWRS	2698	42	57.8	13.8
Coefficient of Variation		5.2		0.91	
LSD (p<0.05)		283	4	0.9	
P value		<0.001		<0.001	
Grand Mean		3249	49	59.3	
R-Square		0.85		0.84	

<b>Wheat Trial 2</b>		Yield		Bushel Weight	Protein
Variety	Class	kg/ha	bu/ac	lbs/bu	%
AAC Chiffon	CWSWS	4113	65	56.3	11.5
AAC Innova	CWGP	3578	59	54.3	12.0
AAC Proclaim	CWGP	3877	58	59.1	12.5
AAC Ryley	CPRS	3452	56	55.0	13.6
AAC Tenacious	CPSR	4104	61	60.1	12.7
Enchant VB	CPSR	3703	56	58.6	13.1
Glenn	CWRS	2928	43	60.4	15.2
GP097	CWGP	3753	56	59.3	12.5
HY1319	CPSR	3436	54	56.8	14.1
HY1603	CPSR	3180	49	58.2	13.6
HY1610	CPSR	3659	56	57.9	13.1
SY087	CWGP	3664	57	57.5	13.5
SY995	CPSR	3539	57	55.7	13.0
Coefficient of Variation		3.7		1.2	
LSD (p<0.05)		221.5	3	1.2	
P value		<0.001		<0.001	
Grand Mean		3593	55	58	
R-Square		0.91		0.93	

## Oats

### Cooperators

- MCVET
- Seed Manitoba

**Research Site:** Melita, MB

**Location:** SW 1-4-27 W1

**Cooperator:** Jim Anderson

**Previous Crop:** Canola

**Soil Texture:** Waskada Loamy Fine Sand

**Soil Test:**

Depth	pH	N ppm	P ppm Olsen	K ppm	S lbs/ac	Organic Matter %
0-6"	6.9	1	9	256	7	2.2
6-24"		2			7	

### Objective

To evaluate and demonstrate varieties of oats for yield and protein for milling, food processing and expand the current industry for value-added processing opportunities.

### Methods

This trial consisted of 7 varieties of hulled oats in plots that were 1.44 m wide by 9 m long. Varieties were organized in a randomized complete block design and replicated three times. Plots were direct seeded May 15<sup>th</sup> at a depth of 0.5". Fertilizer was side band at 85 lbs/ac nitrogen and 30 lbs/ac phosphorous using liquid 28-0-0 UAN and granular 11-52-0 MAP. Plots were maintained weed free using Stampede herbicide and MCPA Ester 500 herbicides at rates of 1.25 lbs/ac and 0.4 L/ac respectively, applied with a 20 gal/ac water volume on June 16<sup>th</sup>. Plots were desiccated with an application of 1 L/ac Roundup, 10 g/ac Heat and 0.5% v/v Merge) on August 26. Plots were harvested at full maturity September 6<sup>th</sup>. Protein samples were analyzed from composite samples of each variety. Data collected included: leaf disease, height, lodging, maturity, and grain yield and bushel weight. Agronomic characteristic data can be made available upon request or from [www.seedmb.ca](http://www.seedmb.ca). Composite samples were not provided by the Melita site in time for protein testing.

### Results

There were significant differences in oat plant height and grain bushel weight. There were no differences in leaf disease and yield (Table 1).

**Table 1:** Yield Comparisons of oat varieties in Melita, 2014

Variety	Height cm	Leaf Disease 1-11 (11=severe)	Yield		Bushel Weight lbs/bu
			kg/ha	bu/ac	
AAC Justice	115	4	5793	146	35.2
Bia	111	5	4574	128	31.9
CDC Haymaker	111	4	3489	101	30.9
CDC Ruffian	104	2	6654	155	38.2
Leggett	112	1	6021	136	39.5
Nice	116	6	3830	107	32.0
Souris	107	3	5644	134	37.6
Coefficient of Variation	3.7	51.0	25.7		9.0
LSD (p<0.05)	7	3	NS	NS	5.6
P value	<b>0.041</b>	0.125	0.100		<b>0.028</b>
R-squared	0.71	0.53	0.59		0.67
Grand Mean	111	4	5143	131	35

## Durum

### Cooperators

- MCVET
- Seed Manitoba

**Research Site:** Melita, MB

**Location:** SW 1-4-27 W1

**Cooperator:** Jim Anderson

**Previous Crop:** Canola

**Soil Texture:** Liege Sandy Loamy

**Soil Test:**

Depth	pH	N	P	K	S	Organic Matter
		ppm	ppm Olsen	ppm	lbs/ac	%
0-6"	7.7	28	8	280	24	3.1
6-24"		72			78	

## Background

Manitoba Durum production has been minimal as of late due to its higher susceptibility to Fusarium head blight (FHB) and leaf diseases linked to southern Manitoba's unique climate. FHB not only affects final yield potential by shriveling kernels, it also produces deoxynivalenol (DON) toxins. Durum is also easily downgraded because of other fungal diseases so this has limited its acreage in Manitoba.

## Objectives

To test varieties of durum registered in Canada for yield, protein and food quality characteristics.



## Methods

This trial consisted of 13 varieties (photo right shows one variety) in plots that were 1.44 m wide x 9 m long. Varieties were organized in a randomized complete block design. Variety plots were replicated three times. Plots were direct seeded May 16 at a depth of 0.5". Fertilizer was applied at 118 lbs/ac nitrogen, 35 lbs/ac phosphorous, 30 lbs/ac potassium, and 15 lbs/ac sulfur. Plots were maintained weed free using Tundra herbicide at 0.8 L/ac, applied June 16<sup>th</sup>. Plots were desiccated on August 26<sup>th</sup> with an application of 1 L/ac Roundup, 10 g/ac Heat and 0.5% v/v Merge. Plots were harvested at full maturity on September 3<sup>rd</sup>. A composite sample of each variety was analyzed for protein content.



## Results

There were significant differences among variety yields and bushel weights of durum in Melita (Table 1). There were no differences in height or leaf diseases.

**Table 1:** Crop height, leaf disease, grain yield, grain protein content and bushel weight of durum in Melita, 2014.

Variety	Height cm	Leaf Disease 1-11 (11=severe)	Grain Yield		Protein %	Bushel Weight lbs/bu
			kg/ha	bu/ac		
Transcend	96	9.0	3606	58	13.5	55.1
Brigade	97	8.0	3554	58	13.4	54.1
Eurostar	100	7.0	3430	56	13.3	54.7
AAC Cabri	102	7.3	3403	56	13.6	53.7
AAC Raymore	99	7.3	3245	52	14.1	56.0
DT575	100	9.0	3192	53	-	53.7
CDC Carbide	100	7.0	3100	52	13.7	53.3
AAC Marchwell	98	8.3	3060	52	13.4	52.6
Strongfield	98	8.3	2862	48	14.3	53.1
CDC Fortitude	100	7.7	2594	44	14.3	51.9
CDC Vivid	102	8.3	2478	42	15.0	52.3
AAC Current	99	7.7	2439	44	14.7	49.6
AAC Spitfire	101	7.0	2268	40	15.3	50.8
Coefficient of Variation	4.8	16	9.4			2.8
LSD (p<0.05)	8.1	2.1	479	8		2.5
P value	0.927	0.454	<b>&lt;0.001</b>			<b>&lt;0.001</b>
Significant?	No	No	Yes	Yes	n/a	Yes
Grand Mean	99	7.8	3018	51		53.1
R-Square	0.48	0.37	0.80			0.79

## Discussion

Durum is highly susceptible to FHB and if grown in Manitoba, strict production management practices should be exercised.

These measures may include:

- Crop rotation cycles and field stubble selection
- Timely use of fungicides and seed treatments
- Attention to weather patterns, humidity and temperature

Varieties used in this trial and others found in the Manitoba Seed Guide are rated as poor or very poorly resistant to FHB, therefore these management practices are a must to follow. However, it goes without saying that these practices must also make economic sense.

The varieties AAC Marchwell VB, and CDC Carbide VB are midge tolerant durum varieties registered for production in Canada. They are grown as a varietal blend to protect the Sm1 gene. AAC Raymore is the first solid stemmed variety for production in Canada.

Varieties AAC Raymore, CDC Fortitude, and AAC Cabri have solid stem with resistance to the wheat stem sawfly.

## Lentils

### Cooperators

- Seed Manitoba
- WADO
- Manitoba Pulse Growers Association

**Research Site:** Melita

**Location:** NE 26-3-27 W1

**Cooperator:** Larry Kirkup

**Previous Crop:** Winter Wheat

**Soil Texture:** Newstead Loamy Sand

**Soil Test:**

Depth	pH	N ppm	P ppm Olsen	K ppm	S lbs/ac	Organic Matter %
0-6"	7.4	2.5	4	424	7	3.1
6-24"		4.5			46	

## Background

Lentils are a cool season crop with a restricted root system that is only somewhat resistant to high temperatures and drought. They cannot withstand flooding, water-logging or soils with high salinity. Lentils work well in rotation with cereals such as spring and durum wheat. They have the ability to fix nitrogen from the air which can then be used by other crops in following years. Lentils are vulnerable to Ascochyta blight as well as anthracnose. To reduce the risk of these blights, lentils should be seeded in the same field only once every four years. (AAFC)

Lentil production has been limited in Manitoba due to several factors such as:

- Disease incidence
- Limited processing companies
- The limited need to grow such a specialty crop in regions better suited for other crop production such as wheat, barley and canola.

The pulse industry in Manitoba has adopted peas, edible beans, and soybeans as pulses rather than the lentil which is more suitable for the cooler, drier, brown and light brown soil zones of Saskatchewan.

Despite all these factors, large yields in certain areas are not impossible. As seen in this trial in 2009, yields were reaching near 58 bu/ac. Yields like this could be very competitive and profitable compared to a market dominated by Saskatchewan farms typically reaching 30 bu/ac on average. With new varieties and weed control options becoming available, producers in Manitoba may be able to capitalize on some serious returns.

## Methods

The trial consisted of 12 varieties in plots that were 1.44 m wide x 9 m long. Varieties were organized in a 3 x 4 rectangular lattice design and replicated three times. A pre-seed application of Credit 1 L/ac, Rival 0.5 L/ac and Aim 30 ml/ac was applied on May 14 for pre-emergence weed control. Plots were direct seeded at a depth of 1" on May 14<sup>th</sup>. The plots were in a low spot in the field and the soil contained excessive amounts of moisture at the time of seeding. Rep 2 also sustained major flooding July long weekend with some standing water for a couple days.

Seed was inoculated with granular pea/lentil Rhizobia (BeckerUnderwood) and a granular fertilizer blend of 12-17-15-10 was applied at 200 lbs/ac. Plots were maintained weed-free with Centurion applied at a rate of 100 mL/ac and Amigo applied June 17<sup>th</sup>. Plots were desiccated August 29<sup>th</sup> with Roundup 1 l/ac, Heat 10 g/ac, Mextrol 0.2L/ac and Merge at a rate of 0.2% v/v and were harvested August 29<sup>th</sup>.

Data collected included plant emergence, height, lodging, and days to maturity. Plots were harvested for grain yield with a Hege plot combine. Test weight, sample moisture, and total plot weight were collected.

## Results

There were significant differences in yield in Melita (Table 1).

**Table 1:** Variety descriptions of lentils and their respective characteristics and yields in Melita, 2014.

Market Class	Variety	Yield %	Site Years	Maturity <sup>1</sup>	Resistance Level:		Seed Wt (TKW)	Cotyledon Colour	2014 Yield: % of CDC Maxim			
		Check	Tested	Rating	Asochyta	Anthrachnose <sup>1</sup>			Melita			
Small green	CDC Asterix	91	3	Early	G	F	26	Yellow	78			
	CDC Invincible CL	76	12	Early	G	G	35	Yellow	68			
	CDC Milestone	80	10	Early	G	VP	37	Yellow	—			
	Eston	82	7	Early	VP	VP	33	Yellow	—			
Medium green	CDC Imigreen CL	63	11	Medium	G	F	63	Yellow	—			
	CDC Impress CL	68	11	Medium	G	P	52	Yellow	—			
	CDC Richlea	76	7	Medium	VP	VP	51	Yellow	—			
Large green	CDC Greenland	63	10	Med/Late	G	VP	64	Yellow	—			
	CDC Greenstar	101	1	Med/Late	G	F	73	Yellow	101			
	CDC Impower CL	65	5	Medium	G	P	74	Yellow	68			
	CDC Improve CL	70	11	Medium	F	VP	67	Yellow	—			
	CDC Plato	61	11	Med/Late	G	P	62	Yellow	—			
	Laird	54	7	Very Late	VP	VP	67	Yellow	—			
French green	CDC Peridot CL	78	11	Early	G	P	40	Yellow	—			
	CDC Marble	109	3	Early/Med	F	G	32	Yellow	113			
	CDC QG-2	67	1	Early/Med	F	G	33	Yellow	67			
Extra small red	CDC Robin	78	10	Early	G	G	30	Red	—			
	CDC Impala CL	81	11	Early	G	G	31	Red	—			
	CDC Imperial CL	77	11	Early	G	G	30	Red	—			
	CDC Redbow	84	8	Early/Med	G	G	42	Red	—			
	CDC Rosebud	87	10	Early	G	G	29	Red	—			
	CDC Rosie	91	3	Early/Med	G	G	30	Red	83			
	CDC Rosetown	88	11	Early	G	G	31	Red	—			
	CDC Ruby	92	2	Early	G	G	29	Red	—			
Small red	CDC Dazil	94	4	Early/Med	G	F	35	Red	85			
	CDC Imax CL	81	12	Medium	G	G	50	Red	71			
	CDC Impact CL	78	10	Early	G	P	34	Red	—			
	CDC Maxim CL	100	14	Early/Med	G	G	40	Red	100			
	CDC Red Rider	83	2	Early/Med	G	F	45	Red	—			
	CDC Redberry	97	11	Early/Med	G	G	42	Red	—			
	CDC Redcoat	78	8	Early	G	G	40	Red	—			
	CDC Scarlet	106	3	Early/Med	G	F	36	Red	105			
Large red	CDC KR-1	79	9	Medium	G	G	56	Red	115			
CHECK CHARACTERISTICS							CDC Maxim (lb/ac)		2148			
CDC Maxim		3329	13				CV%		14.7			
		lb/ac	site years				LSD (%)		29			
							Sign Diff		Yes			
							Seeding Date		13-May			
							Harvest Date		03-Sep			

<sup>1</sup> Ratings determined in Saskatchewan and may not be accurate under wetter growing conditions present in Manitoba.

## Discussion

Lentils are not a crop typically grown in Manitoba due to the high precipitation region that our agriculture sector lies within. Normally, the plot would be infected with Ascochyta and Anthracnose fungi that typically infest lentils where rain is abundant. Stereotypically, lentils are grown in regions such as the Brown and Dark Brown soil zones of Saskatchewan. The 2014 growing season would not have been optimal for lentil production in Melita as precipitation was above normal, favoring disease development.

## MCVET Trials Lost to Excessive Moisture or Seeding & Establishment Issues

### *Cereals*

1. Western Manitoba Grain Corn Variety Trial (seeding issues)

### *Pulses*

1. Pea Variety Trial (excessive moisture)
2. Western Manitoba Soybean Adaptation Variety Trial (excessive moisture)
3. Narrow Row Dry Bean Variety Trial (excessive moisture)

### *Oilseeds*

1. Confectionary & Oilseed Sunflower Variety Trials (excessive moisture)
2. Canola Performance Variety Trial (100% hail)

Photo: Massive Hail storm in May pummelled cereal plot site just west of Melita. Hail turned stubble into little bits; soil filled in furrows and covered crowns of plants. All cereal plots recovered because the growing point of the plant was safe below ground at this stage.



# Western Feed Grains Development Cooperative Variety Trial

## Cooperators

- Westman Agricultural Diversification Organization – Melita & Hamiota, MB
- Prairies East Sustainable Agriculture Initiative – Arborg, MB
- Parkland Crop Diversification Foundation – Roblin, MB
- Ag-Quest Inc. – Minto MB – Matthew Yau, Dana Rourke

## *Introduction (Taken from WFGDC website: <http://www.wfgd.ca>)*

The Western Feed Grain Development Co-op Ltd. is a farmer directed breeding program established in December 2005; created by farmers, for farmers, to benefit farms, livestock production operations, ethanol facilities, and local communities across Western Canada. Since the initiation of the Co-op there have been many significant changes that have occurred within Canadian agriculture including changes to grain classes and requirements, grain marketing, changes in priorities for federal funding, etc. The WFGD Co-op has continued to operate the farmer directed spring wheat breeding program to meet the changing needs of Western Canadian grain producers, the livestock industry as well as the ethanol industry. This small, dedicated organization was formed by three founding Directors with a dream to develop “feed wheat” varieties that they could use on their own farms for livestock feed instead of relying on “feed wheat” by default due to negative impacts of disease and weather.

WFGD Co-op is a unique concept in that farmers can invest and participate in the development of varieties that they can use on their own farm. Grain produced from WFGD seed can be utilized to feed livestock on farm or market to a variety of different markets. The Co-op is focused on developing general purpose class wheat that can be utilized in many markets providing many marketing options for farmers.

The Co-op is incorporated in Manitoba and is also registered in Saskatchewan and Alberta. The Co-op is governed by a Board of Directors consisting of six grain and livestock producers representing Manitoba, Saskatchewan, and Alberta.

## *Research & Development*

The Co-op is focusing on two areas, quality varieties and a dependable feed stock for end users. WFGDC is not only trying to develop varieties that are beneficial for farmers by having disease resistance and high yield to achieve higher returns on farm, but is also focused on providing end users with a dependable feed stock. Very few breeding programs/companies are focused on primary producers as well as domestic feed end users but WFGDC believes that it is important to address the concerns of both parties and attempt to breed lines that meet their needs.



The size of this breeding program allows for the flexibility of realigning priorities as the needs of primary producers and end users change. WFGDC feels that this is another characteristic that provides an advantage over larger competing breeding programs as modifications to the breeding activities can be made in a timely manner to adapt to the needs of the industries. The Co-op program is unlike other wheat breeding programs as it is not limited by class and quality. The Co-op is combining materials that “class-specific breeders” would not consider as parents and is conducting germplasm development in a traditional, cost effective manner. The advantage to the traditional approach taken by the Co-op is that funds are spent on large nurseries instead of spending dollars on expensive technologies such as double haploid thus creating a greater chance of finding unique individuals within the nurseries.

WFGD Co-op has recently assessed the breeding objectives of the program and has concluded that a breeding program focused on a short term objective of developing high yielding (40% higher than the best Hard Red Spring varieties), fusarium head blight resistant general purpose wheat varieties is still needed in Western Canada to compete with corn, as a lower risk, lower production cost alternative for feed in the Canadian Prairies. The long term objective of the Co-op is to increase yield to 10 MT/hectare by 2020. This objective will be achieved through breeding and the addition of agronomic optimization trials which will test agronomic interactions of advanced lines by various fertilizer rates, seeding rates, seeding dates, and fungicide applications.

Small adjustments to the program have been made, increasing the emphasis on yield, while still emphasizing disease resistance levels required by the PGDC for variety registration. The program’s emphasis shifts from stringent disease screening to screening for yield and disease equally, meeting the requirement for registration for disease with an optimum yield on new varieties. The WFGD Co-op is also screening lines in numerous trial locations throughout the Prairies to gain agronomic data to assist the Co-op in selecting wheat lines adapted to specific areas. This will allow WFGDC to identify varieties that are high yield in different environments, with different maturity levels, to provide varieties to more farmers. Starch content will also be screened for. Combining this approach could result in high starch wheat lines that can be grown in the areas around ethanol production facilities, as starch content is an important factor in ethanol production and would be attractive for contracting by ethanol production facilities.

The WFGD Co-op is developing general purpose spring wheat lines to directly benefit Western Canadian Grain Producers and the Canadian Grain and Feed Industries. The Co-op has made significant gains to yield and disease resistance in the past eight years and will continue to in the future.

What sets the Co-op apart from other breeding programs is that the WFGDC has been able to achieve their objectives in genetic advancement on a very modest budget by optimizing resources much like our farmer members. The Co-op’s breeding program may be a small program in size but their accomplishments to date can match some larger competing companies in that support from the PRCWRT was received on one general purpose wheat class variety in February 2013. WFT 603 Breeder seed was available for distribution to seed growers in 2014 and will be accessible for commercial distribution in the spring of 2015. The WFGD Co-op has two more advanced lines: WFT 736 and WFT

805, which are in the second year General Co-op Testing trials and a request for support will be submitted to the PRCWRT in February 2015 with distribution of seed to Seed Growers in 2015 and commercial distribution in the spring of 2016.

The research and development for this project will be conducted by Ag-Quest Inc. ([www.agquest.com](http://www.agquest.com)). Ag-Quest Inc., a contract agricultural research company, will be hired to conduct all research for this wheat breeding project. Ag-Quest will be subcontracted to lower costs, eliminating the need for full-time R&D employees and purchasing specialized equipment for this project. Ag-Quest has completed all research and development to date for WFGD Co-op, and their experience and expertise will prove to be beneficial throughout this project. Ag-Quest has four research stations across Canada: Minto and Elm Creek Manitoba, Saskatoon, Saskatchewan and Taber, Alberta. Research trials can be conducted at these four locations with additional sites locally at each station. Ag-Quest is contracted by the WFGDC Board of Directors. No long term contract exists between WFGD Co-op and Ag-Quest and it is at the Board's discretion how best to conduct the research in the most cost-effective manner.

A partnership has been underway for several years between the Co-op and the Manitoba Diversification Centres. Regional variety trials have offered insight into variety strengths and weaknesses over a variety of years, sites, climatic conditions, and soil types.

**Photo (right):** Trials in Melita in 2014.



## Methods

The variety trials were located at four sites in Manitoba: Melita, Roblin, Crandall, and Arborg. Plots were arranged in a randomized complete block design replicated three times. This report is concerned with the Crandall and Melita sites specifically. The Crandall site was planted on June 3<sup>rd</sup> into a Newdale clay loam, which was previously sowed to spring wheat. The stubble was burned prior to seeding. The Melita site was planted in a Waskada loamy fine sand formerly seeded to canola. This site was treated with Buctril M and Credit, 0.2 L/ac and 1 L/ac in the fall of 2013 to control volunteer canola and green and yellow foxtail. Moisture conditions at the time of seeding were perfect in Crandall; however, the Melita site contained excessive moisture. The seeding dates, seeding fertility, weed control, and harvest dates for Crandall and Melita are listed in Table 1.

**Table 1:** Seeding date, fertility regime, herbicide use and harvest dates for Crandall and Melita.

Location	Seed Date	Fertilizer Applied	Herbicides	Harvest Date
Crandall	03-Jun	106 lbs/ac from 28-0-0 UA 35 lbs/ac from 11-52-0 M 30 lbs/ac from 0-0-60 20 lbs/ac from 21-2-24	No pretreatment required  Tundra, incrop @ 0.8 L/ac	08-Oct No dessication, harvested after frost
Melita	16-May	111 lbs/ac from 28-0-0 UA 35 lbs/ac from 11-52-0 M 30 lbs/ac from 0-0-60 20 lbs/ac from 21-0-24	Tundra, incrop @0.8 L/ac 23°C, PC, Breeze	06-Sep Dessicated on 03-Sep

Soil tests were taken prior to seeding (Table 2 and 3).

**Table 2:** Soil fertility levels prior to seeding of the trial at Crandall.

Parameter	pH	N	P	K	S	Organic Matter
Depth		ppm	ppm Olsen	ppm	lbs/ac	%
0-6"	7	7	16	337	10	4.7
6-24"		11			19	
0-24"	7			337		

**Table 3:** Soil fertility levels and to seeding of the trial at Melita.

Parameter	pH	N	P	K	S	Organic Matter
Depth		ppm	ppm Olsen	ppm	lbs/ac	%
0-6"	6.9	1	9	256	7	2.2
6-24"		2			7	
0-24"		3			14	

Data collected included: plant stand, heading dates, lodging, plant height, leaf disease, shatter loss, test weight, maturity, grain yield and moisture. Data was analyzed with an analysis of variance using Agrobases Gen II statistical software at the 0.05 level of significance. Site precipitation is summarized in Table 4 according to each site collected from May 1 to August 31. Data taken from the AgroClimatic Information Service (ACIS) available online at: <http://agriculture.alberta.ca/acis/>

**Table 4:** Site precipitation May 1 – August 31

Site	Actual Precip. (mm)	Normal Precip. (mm)	% of Normal
Crandall	353	254	139
Melita	400	242	165

## Results

There were significant height, leaf disease, test weight, and yield differences among both sites (Table 5). There were no significant differences in leaf disease between varieties in Crandall. Varieties WFT 914, WFT603 and Unity appear to be some of the top yielding varieties, which was consistent in both sites. WFT 914 was significantly later in maturity according to Melita than any other variety. This may have contributed to greater yield with the late summer season Melita experienced in 2014.

**Table 5:** Mean disease incidence, days to maturity, height (HT), test weight, and yield of each variety in Crandall and Melita. Variety yield was average for both sites and are listed from greatest to least yield.

Treatment	Variety	Crandall				Melita				Average Yield
		Height cm	Leaf Disease* 1-11(11 severe)	Test Wt kg/hL	Yield kg/ha	Leaf Disease* 1-11(11 severe)	DTM days	Test Wt kg/hL	Yield kg/ha	kg/ha
14	WFT 914	116.7	7.0	57.5	4999	7	88	55.7	5833	5416
29	WFT 603	98.0	5.0	54.6	4644	7	87	54.5	4927	4786
3	Unity	102.7	7.0	58.3	4394	8	85	54.7	5153	4774
20	PYT13-58	84.7	6.0	56.0	4219	8	85	53.8	5237	4728
27	PYT13-6	84.7	4.0	55.7	3972	6	85	55.2	5243	4608
28	PYT13-15	85.0	4.0	55.4	4105	7	86	54.4	5090	4598
15	Sadash	89.3	6.0	53.5	4344	9	86	51.2	4850	4597
2	AC Andrew	92.7	4.0	54.2	4415	7	86	50.7	4590	4502
23	PYT13-103	86.7	3.0	56.0	3895	7	86	55.6	4996	4445
24	PYT13-97	85.3	6.0	55.9	4130	8	85	54.5	4599	4364
1	PYT13-86	90.7	6.0	55.4	3400	7	86	54.6	5322	4361
10	WFT 805	91.0	5.0	53.2	4153	8	86	50.9	4521	4337
9	WFT 921	92.3	5.0	56.2	3788	9	85	52.5	4853	4321
18	PYT13-5	87.0	5.0	55.6	3722	6	84	54.1	4911	4317
7	Pasteur	94.7	4.0	53.5	3990	7	88	54.3	4534	4262
11	PYT13-44	83.0	6.0	56.4	3617	10	85	54.2	4877	4247
22	WFT 409	83.3	5.0	53.2	3841	7	86	53.9	4419	4130
26	PYT13-41	82.0	6.0	54.9	3432	10	85	53.7	4789	4111
16	PYT13-65	82.3	5.0	54.7	3513	9	85	50.4	4704	4109
21	PYT13-75	85.0	5.0	54.1	3842	8	85	50.0	4287	4065
5	PYT13-42	84.7	4.0	55.7	3549	8	85	53.0	4425	3987
12	PYT13-56	84.3	5.0	55.5	3271	10	86	52.2	4647	3959
25	PYT13-88	82.0	5.0	54.0	3566	7	85	51.7	4116	3841
19	PYT13-4	92.7	4.0	55.1	3746	7	85	50.4	3925	3836
8	PYT13-39	85.0	5.0	54.4	2871	10	85	53.5	4687	3779
4	PYT13-20	89.7	6.0	54.4	3576	8	85	51.7	3837	3706
17	5702PR	88.7	6.0	54.1	3269	10	85	51.4	4138	3704
13	PYT13-17	80.7	7.0	54.5	2444	11	85	54.9	4379	3412
6	PYT13-96	87.0	4.0	51.5	2759	7	87	55.0	4056	3408
30	PYT13-85	86.0	5.0	53.6	2704	6	86	52.6	3739	3222
LSD (p<0.05)		7.0	NS	1.5	340.8	1.6	1.5	2.0	424.0	
R-Square		0.8	0.5	0.8	0.9	0.7	0.7	0.8	0.8	
P value		0.0001	0.0645	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	
Grand Mean		88.6	5.2	54.9	3739.0	8.0	85.7	53.2	4656.2	
CV%		4.9	27.7	1.7	5.6	12.1	1.1	2.3	5.6	
Significant?		Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	

\* McFadden Scale

## *Comments*

Producers interested in participating in the coop are encouraged to contact the cooperative headquarters directly at:

Ag Quest  
c/o: Haylee Hargreaves  
Box 144 Minto, Manitoba R0K 1M0

Phone: 204-776-5558  
Toll Free: 1-877-250-1552  
Fax: 204-776-2250  
Email: [info@wfgd.ca](mailto:info@wfgd.ca)  
Website: <http://www.wfgd.ca>

## **Canadian International Grains Institute Canada Western Red Spring Wheat Trial**

### *Site Information*

<b>Location:</b>	Melita, Manitoba
<b>Legal Land Location:</b>	SW 1-4-27 W1
<b>Soil Type:</b>	Waskada Loamy Fine Sand
<b>Cooperator:</b>	Canadian International Grains Institute Dale Alderson- Independent Seed Consultant

### *Objective*

To study the impact of fungicide application and wheat variety on gluten strength.

### *Background*

The Canadian International Grains Institute (CIGI) is an independent market development institute established in 1972, based out of Winnipeg, Manitoba. They provide technical expertise, support, applied research and customized agricultural training to the field crop industry including farmers, researchers, marketers, processors and end-product manufacturers. Throughout the past 40 years, CIGI has delivered 1,430 programs and has continued to expand its expertise in processing and testing capabilities for wheat, durum, pulses, barley, oilseeds and special crops.

CIGI's work in specific markets has given them an in-depth understanding of customer and consumer preferences with respect to specific end-product applications. For example, the different textural and color requirements for Asian noodles in Japan, China, Indonesia, Thailand and Taiwan; how pasta processing requirements and products differ in markets like Italy and Venezuela and the significant

range of processing conditions and formulations that exist in bakeries producing bread and other products in the United Kingdom, Peru and Colombia. (Canadian International Grains Institute 2013)

China's state-owned company, COFCO has raised concerns about the poor baking quality of Canadian wheat. COFCO is concerned about weak gluten strength in some Canadian wheat. Gluten protein is important for keeping the shape of baking goods through the baking process. Part of the issue could be related to the many different varieties of wheat grown by Canadian farmers. CIGI is conducting field research in hopes to address the issue and produce wheat with proper gluten levels for the Asian markets. (Nickel 2013)

This year at WADO, CIGI conducted a trial to study the impact of fungicide and variety on gluten strength for the Asian market for producing pasta, noodles and other baking products. This is the second year of this trial for WADO. There were multiple research sites across the Prairie Provinces that are also partnered with the trial.

### ***Design, Materials & Operation***

Treatments:	18: 6 varieties, 3 fungicide treatments (Table 1)
Replication:	2
Plot size:	1.44 m x 9m
Test design:	Split Plot Design: Main Plot- Fungicide, Split Plot- Variety
Seeding date:	May 16
Seed Rate:	100 lbs/ac
Seed Varieties:	Sourced from Dale Alderson
Fertilizer applied:	80 lbs/ac N using 28-0-0 UAN, 35 lbs/ac P, 30 lbs/ac K, 20 lbs/ac S using side band 11-52-0 MAP, 0-0-60 (Potash), 21-0-0-24 (ammonium sulfate) applied as a blend of 12-17-15-10 at 200 lbs/ac
Pesticide applied:	June 16- Tundra @ 0.8 L/ac Group 3 Fungicide: Stratego 250EC @ 202 ml/ac applied July 8 Group 11 Fungicide: Folicur 432F @ 118 mL/ac applied July 17
Desiccation:	Roundup Transorb and Heat tank mixed at 1 L/ac and 10 g/ac applied Aug 26
Harvest date:	September 3
Product handling:	Each individual plot harvested with weight and moisture recorded

Plots were direct seeded into canola stubble using a Seedhawk dual knife opener. Fertilizer was side band. Fungicide applications were applied accordingly; a no fungicide application (control), a group 3 fungicide at flowering and a group 3 and 11 combination where a group 11 fungicide was applied at flag leaf and group 3 fungicide at flowering.



All plots were harvested with a small plot combine. Each treatment was individually bagged , weighed and moisture were recorded. A 2 kilogram sample from each plot was then sent to CIGI in Winnipeg for further quality analysis.

**Table 1:** 2014 CIGI Canada Western Red Spring Wheat Trial Treatments at Melita, MB

Fungicide Treatment	Seed Variety	Fungicide Treatment	Seed Variety	Fungicide Treatment	Seed Variety
None	AC Barrie	Group 3 @ Flower	AC Barrie	Group 11 @ Flag, Group 3 @ Flower	AC Barrie
	Carberry		Carberry		Carberry
	Harvest		Harvest		Harvest
	Kane		Kane		Kane
	Lillian		Lillian		Lillian
	Unity VB		Unity VB		Unity VB

**Table 2:** 2014 Spring Soil Nutrient Analysis from 0-24” Depth at the Melita, MB Site \*\*

	Estimated Available Nutrients	Fertilizer Applied (actual lbs)
N*	6 lbs/acre (low)	102
P*	9 ppm (low)	35
K*	256 ppm (high)	30
S*	14 lbs/acre (low)	20

\* N- Nitrate

\* P- Phosphorus (Olsen)

\* K- Potassium

\*S- Sulphate

\*\* Analysis by Agvise Laboratories (Northwood, ND)

## Results

There were no significant differences in grain yield or test weight among treatments (Table 3).



**Table 3:** Variety grain yield and test weights and their fungicide responses to group 3 and group 11 timings of applications in Melita, 2014.

Variety	Fungicide and Stage	Grain Yield kg/ha	Test Weight kg/hL
Glenn		4016.8	73.1
AC Barrie		3466.6	73.2
Carberry		3631.9	73.7
Unity VB		3781.1	74.0
Lillian		3131.1	69.2
Harvest		3936.6	72.3
	Control	3477.5	71.3
	Grp3-Fung@flwr	3579.5	72.8
	Grp3+11-Fung@flag+3@Flwr	3925.0	73.5
Glenn	Control	3783.4	70.2
	Grp3-Fung@flwr	4262.3	75.7
	Grp3+11-Fung@flag+3@Flwr	4004.8	73.3
AC Barrie	Control	3503.6	73.0
	Grp3-Fung@flwr	3178.2	72.8
	Grp3+11-Fung@flag+3@Flwr	3717.9	73.7
Carberry	Control	3454.4	72.1
	Grp3-Fung@flwr	3404.7	73.7
	Grp3+11-Fung@flag+3@Flwr	4036.6	75.3
Unity VB	Control	3510.0	73.5
	Grp3-Fung@flwr	3820.2	73.8
	Grp3+11-Fung@flag+3@Flwr	4013.2	74.6
Lillian	Control	2881.1	68.5
	Grp3-Fung@flwr	3164.9	68.6
	Grp3+11-Fung@flag+3@Flwr	3347.4	70.6
Harvest	Control	3732.7	70.7
	Grp3-Fung@flwr	3647.0	72.4
	Grp3+11-Fung@flag+3@Flwr	4430.1	73.7
CV%		8.3	1.7
LSD (p<0.05)		NS	NS
P value		0.47	0.18
Significant?		No	No
Grand Mean		3660.7	72.6
R-Square		0.90	0.89

CIGI is performing gluten quality tests. For more information the results of the research, please contact CIGI.

## References

1. Canadian International Grains Institute. *CIGI Knowledge at Work for You*. 2013. [http://CIGI.ca/wp-content/uploads/2013/03/CIGI-Knowledge-at-work-for-you\\_Brochure\\_130114011.pdf](http://CIGI.ca/wp-content/uploads/2013/03/CIGI-Knowledge-at-work-for-you_Brochure_130114011.pdf) (accessed November 6, 2013).
2. Nickel, Rod. "China complains about Canadian wheat's gluten strength." *Grainews*. Grainews. April 2, 2013. <http://www.grainews.ca/news/china-complains-about-canadian-wheats-gluten-strength/1002194705/> (accessed November 6, 2013).

# Field Performance of Farmer-selected Wheat Populations in Western Canada

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## Background

Organic farming presents unique challenges that include limitations in available soil nutrients and interference from weeds. Due to the unique stresses found under organic management, selecting crop cultivars for organic crop production under organic production systems is recommended. Previous research conducted at the University of Manitoba has demonstrated that performance of spring wheat (*Triticum aestivum* L.) in organic systems is improved if the plant breeding process occurs under actual organic field conditions.

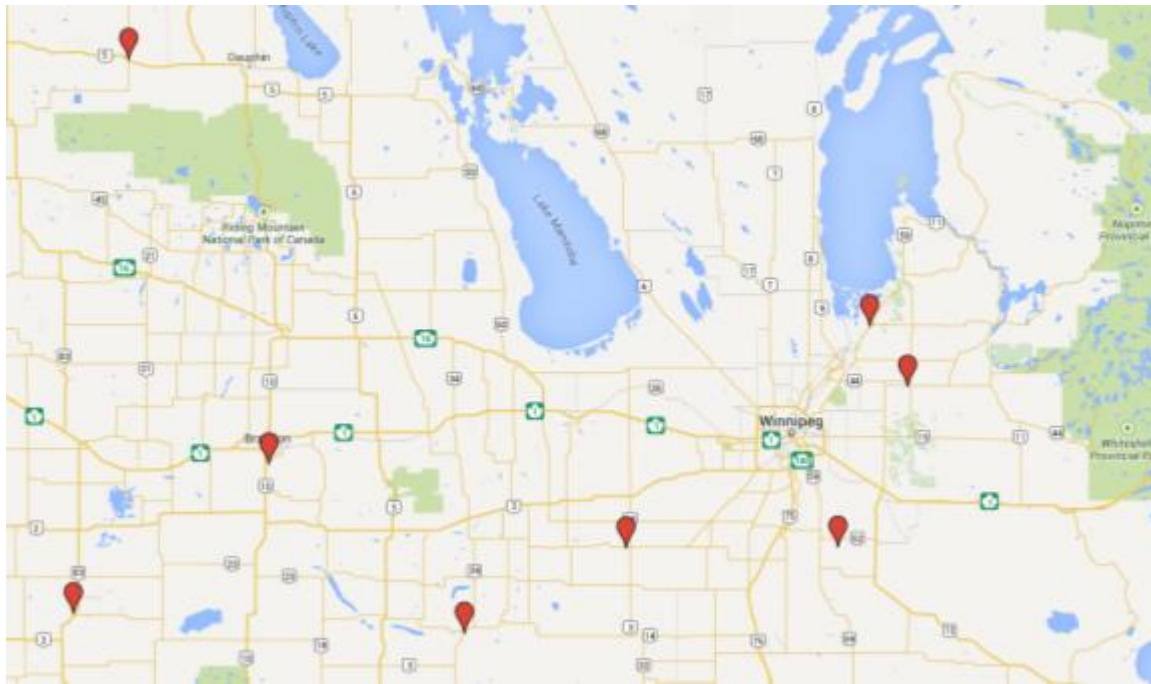
A further step in developing crop cultivars adapted to organic production systems is to involve farmers directly in the selection process through participatory plant breeding (PPB). PPB is collaboration between researchers and farmers that aims to restore the place of farmers in the plant breeding process. In Canada the majority of cultivar development occurs under conventional management in environments that have been made homogeneous through the use of chemicals and fertilizer. Due to the more diverse nature of organic farms, involving farmers in the plant breeding process by having them conduct selection on-farm may be particularly beneficial to organic farmers.

A PPB program for spring wheat was initiated by the University of Manitoba in collaboration with Agriculture and Agri-Food Canada (AAFC) in 2011. A plant breeder made the cross and provided early generation populations to farmers located in Manitoba. After three years of on-farm selection, the farmer-selected wheat populations were returned to the University of Manitoba for further testing. In 2014, we tested all of the farmer selected populations in a common study at the Carman research station. The objective was to test field performance and quality of farmer selected wheat populations and compare them with some registered varieties. The plots were grown on the long-term organic land at Carman.

## Methods

Early generation (F3 or 3<sup>rd</sup> generation) wheat populations from the organic wheat breeding program at the University of Manitoba were distributed to eight farmers located in Manitoba in 2011 (Figure 1). With input from the plant breeder and coordinator, the participating farmers chose wheat populations based on the known characteristics of the parental lines. Each farmer chose three populations and was given 5,000 seeds of each population in order to seed a 20m<sup>2</sup> area. Plots were seeded on farm using a garden seeder or by hand and selections occurred throughout the growing season based on the farmer's preferences.

Selections were made throughout the growing season by removing undesirable plants from the populations, with final selections being made at harvest. At harvest, farmers selected approximately 300 spikes per population to move forward to the next generation; with the exception of one of the participating farmers who bulk harvested the plots. The selected spikes were sent to the University of Manitoba for threshing and cleaning and returned to the farmers the following spring. This process was repeated for 3 consecutive years: 2011, 2012 and 2013. In 2013, the F6, or 6<sup>th</sup> generation, was harvested by the participating farmers.



**Figure 1:** Location of the farms in the participatory wheat breeding program in 2011.

### *The Research Trial*

To evaluate the field performance and quality of the farmer-selected populations the F6 (6<sup>th</sup> generation) farmer selections were seeded in a replicated field experiment at the University of Manitoba research farm near Carman, Manitoba. Check cultivars were included in the study for comparison purposes. A complete treatment list can be found in Table 1.

The field experiment was replicated four times and the plot size was 2 m<sup>2</sup>. Data was collected throughout the growing season on plant density, early season vigour, growth stage, leaf diseases, leaf and stem rust, fusarium head blight, crop and weed biomass, height, days to maturity, lodging, spike density, yield and harvest index. Thousand kernel weight was measured post-harvest, and a subsample of seed was analyzed for macro and micronutrients.

**Table 1:** Treatment name and pedigree (female parent/male parent) of the treatments included in the study. Farmer selected populations were selected under organic crop production as part of the participatory plant breeding (PPB) project. Check cultivars were selected under conventional crop production.

Treatment <sup>1</sup>	Pedigree
<b><i>Farmer selected populations</i></b>	
BJ08-IG	BW430/BW897
BJ22-IG	3X1-134*FA0067/BW880
BJ23-IG	BD94B*D0371/BW880
BJ26-KS	ND04/3-21/BA51*B92
BJ32-KS	BD92A*D0621/BW410
BJ18-KS	BW429/BW880
BJ11-CG	ACS 54608/Waskada
BJ08-CG	BW430/BW897
BJ10-SC	ACS 54608/BW342
BJ11-SC	ACS 54608/Waskada
BJ25-SC	ND04/3-21/BW874
BJ28-MW	SD3948/BW880
BJ27-MW	SD3948/97B64-F9A3
BJ03-HRE	HW341/BW342
BJ13-HRE	BW433/BW430
BJ2-HRE	3X1-134*FA0067/BW875
BJ11-KB	ACS 54608/Waskada
BJ04A-KB	HW341/Vesper
BJ10A-KB	ACS 54608/BW342
BJ05-GM	HW341/Waskada
BJ15-GM	BW425/BW430
BJ43-GM	3X1-134*FA0067/BW342
PA00-KB-AL	Red Fife/5602 HR
<b><i>Check cultivars</i></b>	
AC Cadillac	Pacific*3/BW553
Glenn	ND2831/Steele-ND
AAC Brandon	Superb/CDC Osler//ND744
Carberry	Alsen/Superb
Unity	McKenzie*3//BW174*2/Clark
AC Vesper	A/HWA//*3ACBarrie/6/BW150*2//Tp/Tm/3/2*BW252/4/98A190/5/Sup
PT245	Somerset/BW865

<sup>1</sup>The initials of the farmer that selected the population have been added to the population name. In some cases more than one farmer received the same population

## Results

### Agronomic Characteristics

Days to maturity (DTM), height, lodging, yield and thousand kernel weight results for all treatments included in the field study are presented in Table 2.

**Table 2:** Days to maturity (DTM), height (cm), lodging index, yield (kg ha<sup>-1</sup>), thousand kernel weight (TKW) and protein of all treatments included in the study.

Treatment	DTM	Height (cm)	Lodging <sup>1</sup>	Yield (kg ha <sup>-1</sup> )	TKW (g)
BJ08-IG	98	102	3.7	4658	35.0
BJ22-IG	99	103	1.5	4983	35.2
BJ23-IG	98	100	3.0	4928	33.6
BJ26-KS	94	101	3.5	4622	31.2
BJ32-KS	96	99	3.8	4027	32.4
BJ18-KS	100	103	4.5	5318	32.1
BJ11-CG	105	103	5.3	4788	34.0
BJ08-CG	103	103	3.3	5095	33.0
BJ10-SC	100	92	2.8	4750	32.2
BJ11-SC	104	103	3.8	4740	32.6
BJ25-SC	103	91	4.5	4536	32.5
BJ28-MW	98	100	1.8	4834	33.0
BJ27-MW	95	96	3.3	5102	34.6
BJ03-HRE	98	93	3.0	4457	33.1
BJ13-HRE	99	104	4.0	4635	36.2
BJ21-HRE	99	94	1.8	4856	34.7
BJ11-KB	103	103	3.3	5081	35.6
BJ04-KB	99	100	2.8	4311	35.5
BJ10-KB	101	109	2.8	4716	34.8
BJ05-GM	100	99	2.5	4184	35.0
BJ15-GM	100	103	3.3	4332	35.6
BJ43-GM	102	96	2.5	4041	34.9
PA00-KB-AL	101	108	4.5	4453	35.0
AC Cadillac	96	102	4.5	4437	36.2
Glenn	99	91	1.3	4834	32.6
AAC Brandon	97	83	2.5	4272	37.2
Carberry	97	81	1.8	3315	33.8
Unity	98	98	3.5	5108	37.4
AC Vesper	94	93	2.0	5050	36.4
PT245	93	91	1.0	3591	34.5
<i>Pr &gt; F</i>	<i>&lt;.0001</i>	<i>&lt;.0001</i>	<i>&lt;.0001</i>	<i>&lt;.0001</i>	<i>0.0449</i>
<i>LSD</i>	<i>4.23</i>	<i>3.60</i>	<i>1.01</i>	<i>505</i>	<i>4.9</i>

<sup>1</sup>1-9 rating scale, with 1 given to plots with erect stems and 9 given to plots with plants that are flat on the ground.

To compare the farmer selected populations to the conventionally selected checks treatments were combined and analyzed as two groups: farmer selected populations and conventionally selected checks.

### ***Early Season Vigour***

Early season vigour was visually rated and took into account the general health and appearance of the plants, row cover and tolerance to harrowing (Figure 1). There were significant differences in early vigour across treatments, and as a group the farmer selected populations displayed significantly greater early vigour than the conventionally selected varieties (Figure 2A).



**Figure 1:** A treatment with poor early season vigour (left) compared to a treatment with good early season vigour (right).

### ***Leaf Disease***

Leaf disease was measured at heading and plant maturity by visually estimating the percent of the flag leaf surface area that showed symptoms of disease. There were significant differences between treatments at maturity, but not at heading. When analyzed as a group there were no significant differences between the farmer selected populations and the conventionally selected check varieties (Figure 2B).

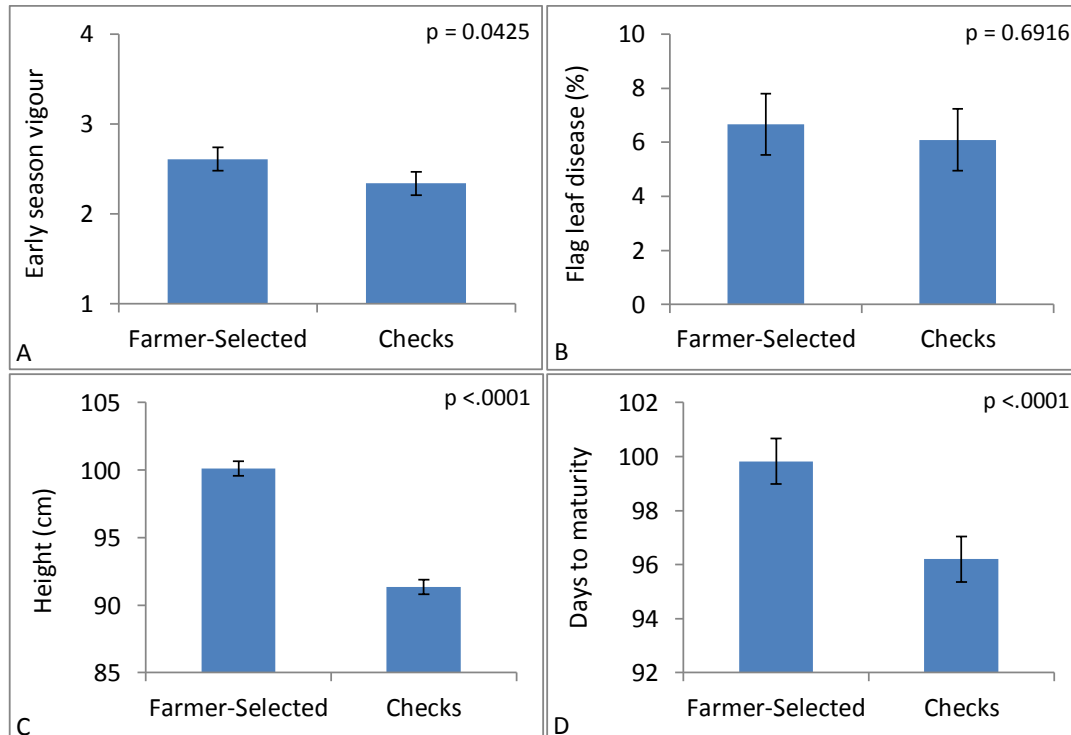
### ***Plant height***

As a group the farmer selected populations were significantly taller than the conventionally selected check varieties. The average height of the farmer selected populations was 9 cm taller than the conventionally selected check varieties (Figure 2C).



### Days to maturity

There were significant differences across treatments for days to maturity. As a group the farmer selected populations matured four days later than the conventionally selected check varieties (Figure 2D); however, there were large differences in days to maturity between treatments.



**Figure 2:** Farmer selected populations compared to the conventionally selected check varieties for: **A)** early season vigour (visually rated with a 1-4 rating scale with 4 being the most vigorous), **B)** percent of flag leaf showing symptoms of leaf disease, **C)** plant height, and **D)** days to maturity. A P value of <0.05 indicates a significant difference between the farmer-selected populations and conventionally selected check varieties.

### Lodging

Lodging was rated using a 1-9 rating scale with a rating of 1 given to plots with completely erect stems and 9 to plots with plants that are flat on the ground. There were significant treatment differences in lodging and as a group the farmer selected populations lodged more than the conventionally selected checks (Figure 3A). On average, the farmer selected populations received a lodging rating of 3, while the conventionally selected checks were rated as a 2.

## ***Yield***

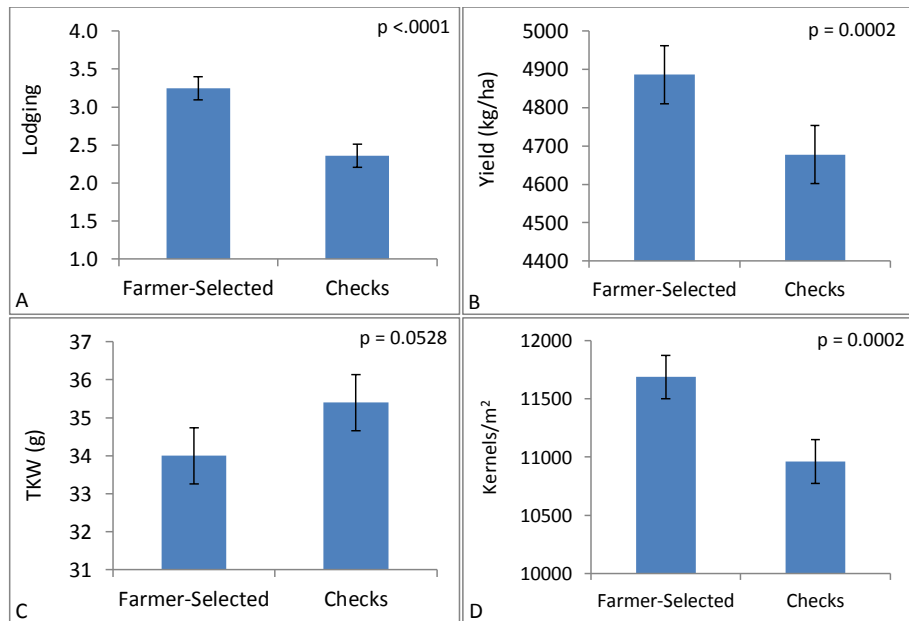
There were significant yield differences between treatments. As a group the farmer selected populations yielded significantly higher than the conventionally selected checks (Figure 3B). On average the farmer selections yielded 3 bu ac<sup>-1</sup> greater than the conventionally selected check varieties.

## ***Thousand kernel weight***

There were significant differences in thousand kernel weight across treatments, but there was no significant difference between the farmer selected populations and the conventionally selected checks (Figure 3C).

## ***Kernel number per unit area of land***

Kernel number per unit of land is a measure used by plant breeders and crop physiologists to better understand the yield potential of cereal crops. It is generally accepted that yield of cereal crops like rice, wheat, and oats are limited by the seed number per unit area of land. Results of this work show that there were significant differences in kernel number per unit area of land across treatments. On average, the farmer selected populations had 700 more kernels m<sup>-2</sup> than the conventionally selected checks (Figure 3D). This result demonstrates that farmers were indeed increasing the yield potential compared to the conventionally bred varieties – an exciting development.



**Figure 3:** Farmer selected populations compared to the conventionally selected check varieties for: **A)** lodging (1-9 rating scale with a higher number indicating more lodging), **B)** yield (kg/ha), **C)** thousand kernel weight (TKW), and **D)** kernel number per unit area. A P value of <0.05 indicates a significant difference between the farmer-selected and conventionally selected check varieties.

### How do farmer selections shape a population?

Having more than one farmer make selections in the same population provides a unique opportunity to see how the person making the selections in their particular selection environment influences the population. While the populations started out the same, the characteristics of these populations shifted over the three year period of on-farm selection.

There were three populations that were distributed to more than one farmer. Results showed that these populations were similar in terms of yield and amount of leaf disease. There were, however, differences in early season vigour, height, days to maturity, and lodging (Figure 4).

#### ***Early season vigour***

There were significant differences in early season vigour in the population BJ11, with BJ11 selected by farmer SC (BJ11-SC) having greater early season vigour than BJ11 selected by farmer KB (BJ11-KB) (Figure 4A). Differences in early season vigour between the same population selected by two different farmers are likely due to the selection environment since this is a characteristic that has not been directly selected for. Farmer-selected populations with greater early season vigour may have had greater weed competition early in the growing season during the on-farm selection period, which would have resulted in collecting seed from the most vigorous plants. The treatment with greater early season vigour may have also been a better quality seed sample which may have resulted in faster germination, or the population may have been more tolerant to harrowing.

#### ***Height***

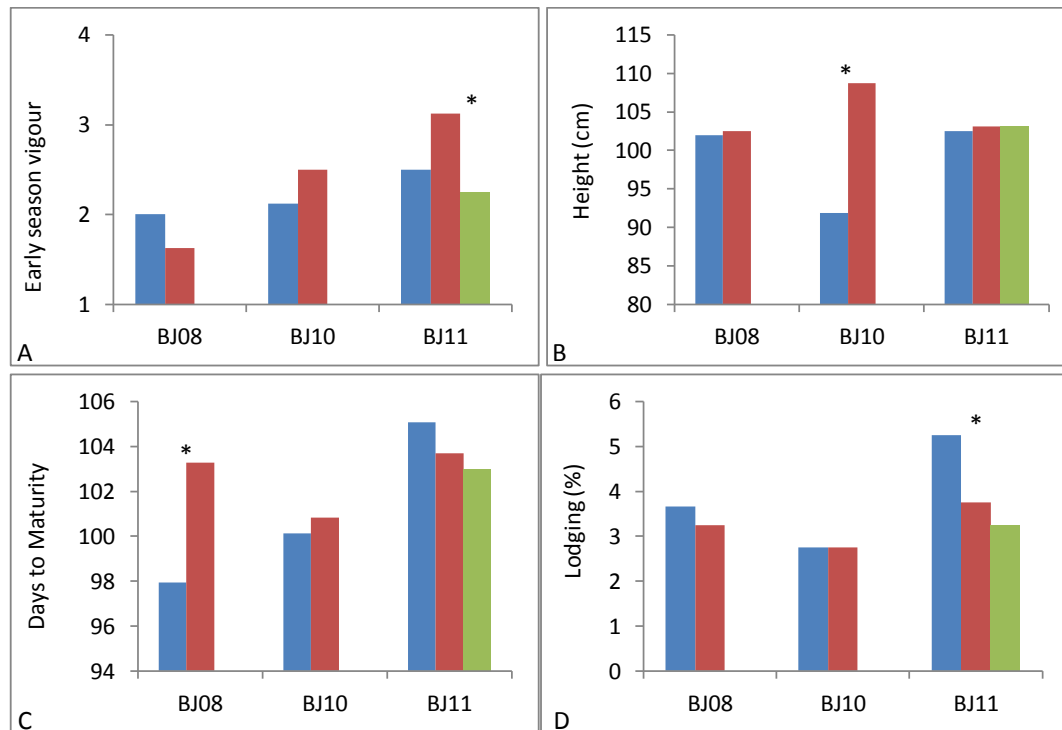
The population BJ10 had significant height differences between treatments selected by two different farmers (Figure 4B), with BJ10 selected by farmer KB (BJ10-KB) measuring 17 cm taller than BJ10 selected by farmer SC (BJ10-SC). In general, the farmer selected populations were taller than the conventionally selected check varieties, but comparing the individual farmer selections shows how much of an influence the person making selections has on a population in just three years. The height difference between the farmer selections is likely due to the farmers' preference for taller or shorter wheat.

#### ***Days to maturity***

There was a significant difference in days to maturity in the population BJ08 (Figure 4C), with BJ08 selected by farmer IG (BJ08-IG) reaching maturity in 98 days, while BJ08 selected by farmer CG (BJ08-CG) reached maturity in 103 days (Figure 6). The five day difference in days to maturity between these two populations may be explained by the selection environment. BJ08-IG was selected in the Brandon area, which on average has a 10 day shorter frost free period than Carman, Manitoba where BJ08-CG was selected. What happened in this case is that the farmer from the shorter season region actually produced a wheat "variety" that reaches maturity faster than the farmer from the longer season region. This is a good example of how genetically diverse populations can be tailored to the environment where they will be grown, and the importance of farmer involvement in the early plant breeding process.

## Lodging

There were significant differences in the amount of lodging in population BJ11 (Figure 4D), with BJ11 selected by farmer CG (BJ11-CG) lodging more than BJ11 selected by farmers SC (BJ11-SC) and KB (BJ11-KB). Differences in the amount of lodging between farmer selections may be due to a combination of the selection environment and the person making the selections. Soils that are very high in fertility tend to result in greater issues with lodging, and when the entire population is lodged it is difficult to make selections. If some lodging occurs within a population during the three years of on-farm selection the person making selections may be able to select spikes from plants that have stronger stems.



**Figure 4:** Comparison of populations selected by different farmers for: **A)** early season vigour (visually rated with a 1-4 rating scale with 4 being the most vigorous), **B)** height (cm), **C)** days to maturity, **D)** lodging (1-9 rating scale with a higher number indicating more lodging). From left to right the populations shown in each figure are BJ08-IG, BJ08-CG, BJ10-SC, BJ10A-KB, BJ11-CG, BJ11-SC, and BJ11-KB. An asterisk (\*) over bars within the same population indicates that there is a significant difference between treatments within that population.

## Grain nutrient analysis

After harvest, all farmer-selected and commercial check varieties were analyzed for macro and micronutrients. Grain nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), zinc (Zn), iron (Fe), manganese (Mn), and boron (B) concentrations for all treatments can be found in Table 3.

There were no significant differences among varieties for sulfur (S) and copper (Cu) concentrations. It was interesting to observe that wherever differences were detected, the farmer selected populations that had significantly greater concentrations of nutrients than the commercial varieties (eg., Ca, Zn, Fe and Mn) (Table 4).

Greater concentrations of Ca, Zn, Fe and Mn in the farmer-selected populations may be due to the selection environment, the genetics of the populations, or a combination of both. Conducting selections on organically managed land may have resulted in an improved ability of the root to uptake mineral nutrients, or improved the ability of the plant to allocate mineral nutrients to the grain. Conducting selections in an environment with lower levels of available phosphorus may have improved the ability of these populations to form a symbiotic relationship with arbuscular mycorrhizal fungi (AMF), which not only improves uptake of P, but also of Cu and Zn.



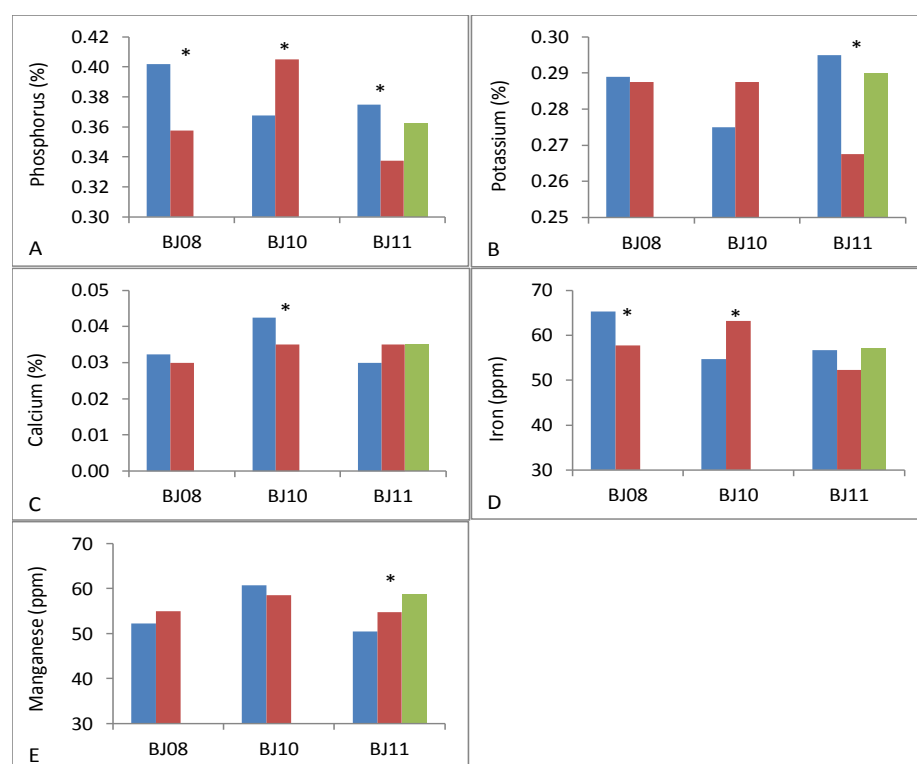
**Table 3:** Total nitrogen (N), protein, phosphorus (P), potassium (K), calcium (Mg), zinc (Zn), iron (Fe), manganese (Mn), and boron (B) grain concentration of all treatments included in the study.

Treatment	Total N	Protein <sup>1</sup>	P	K	Ca	Mg	Zn	Fe	Mn	B
	----- % -----					----- ppm -----				
BJ08A-N-IG	3.11	17.1	0.40	0.289	0.032	0.191	45.1	65.3	52.3	0.29
BJ22A-N-IG	2.72	14.9	0.37	0.306	0.028	0.181	39.2	56.9	58.7	0.31
BJ23A-N-IG	2.90	15.9	0.42	0.311	0.028	0.196	41.2	62.4	55.2	0.31
BJ26A-N-KS	3.02	16.6	0.38	0.305	0.038	0.190	43.8	57.0	55.3	0.31
BJ32A-N-KS	3.10	17.0	0.38	0.275	0.035	0.198	43.0	60.8	56.8	0.28
BJ18A-N-KS	2.93	16.1	0.41	0.303	0.033	0.195	41.3	62.0	58.0	0.30
BJ11A-N-CG	3.06	16.8	0.38	0.295	0.030	0.188	40.3	56.8	50.5	0.30
BJ08A-N-CG	3.06	16.8	0.36	0.288	0.030	0.180	41.0	57.8	55.0	0.29
BJ10A-N-SC	3.04	16.7	0.37	0.275	0.043	0.205	48.3	54.8	60.8	0.28
BJ11A-N-SC	2.87	15.8	0.34	0.268	0.035	0.185	39.5	52.3	54.8	0.27
BJ25A-N-SC	3.07	16.9	0.38	0.280	0.040	0.198	46.8	56.0	61.8	0.28
BJ28A-N-MW	2.68	14.7	0.38	0.305	0.038	0.193	41.5	59.0	59.0	0.31
BJ27A-N-MW	2.98	16.4	0.36	0.280	0.033	0.195	39.3	55.0	51.0	0.28
BJ03A-N-HRE	3.08	16.9	0.38	0.263	0.033	0.198	45.8	50.3	59.8	0.26
BJ13A-N-HRE	3.11	17.1	0.38	0.288	0.035	0.193	41.3	54.3	52.8	0.29
BJ21-N-HRE	3.12	17.1	0.39	0.318	0.038	0.203	39.8	57.5	59.5	0.32
BJ11A-N-KB	2.86	15.7	0.36	0.290	0.035	0.193	42.3	57.0	58.8	0.29
BJ04A-N-KB	3.08	16.9	0.38	0.288	0.025	0.188	42.5	52.8	56.5	0.29
BJ10A-N-KB	2.93	16.1	0.41	0.288	0.035	0.198	45.5	63.3	58.5	0.29
BJ05-N-GM	3.10	17.0	0.39	0.278	0.028	0.185	42.5	52.3	57.3	0.28
BJ15A-N-GM	3.01	16.5	0.39	0.283	0.033	0.190	44.8	57.0	55.0	0.28
BJ43A-N-GM	3.10	17.0	0.37	0.285	0.033	0.190	40.5	54.0	57.5	0.29
PA00-KB-AL	2.86	15.7	0.39	0.318	0.035	0.193	47.3	61.0	57.3	0.32
Cadillac	3.04	16.7	0.39	0.300	0.030	0.185	43.8	50.5	52.3	0.30
BW487	3.04	16.7	0.35	0.283	0.030	0.183	36.3	55.8	47.3	0.28
Red Fife	2.62	14.4	0.37	0.328	0.035	0.175	42.0	58.0	47.0	0.33
Glenn	2.96	16.3	0.41	0.295	0.033	0.213	46.3	56.8	58.8	0.30
AAC Brandon	2.89	15.9	0.33	0.283	0.033	0.183	34.8	52.5	48.5	0.28
Carberry	3.06	16.8	0.38	0.288	0.035	0.195	37.3	56.5	50.8	0.29
Unity	2.94	16.1	0.36	0.268	0.025	0.183	38.5	54.3	47.3	0.27
Vesper	2.87	15.8	0.39	0.283	0.033	0.193	46.3	58.3	66.0	0.28
PT245	3.02	16.6	0.40	0.333	0.023	0.180	42.5	48.8	50.8	0.33
<i>Pr&gt;F</i>	0.0013	0.0013	0.0001	<.0001	<.0001	0.0076	<.0001	<.0001	<.0001	<.0001
<i>LSD</i>	0.2456	1.348	0.0331	0.0266	0.007	0.0164	4.1205	4.9559	6.5236	0.03

**Table 4:** Ranges and mean seed mineral nutrient concentrations of the 32 treatments. Means and contrasts of the farmer selected populations and conventionally selected check cultivars for seed mineral nutrient concentrations.

	Total N	P	K	S	Ca	Mg	Zn	Fe	Mn	Cu	B
	%						ppm				
Range	2.62 - 3.12	0.33 - 0.42	0.26-0.33	0.16-0.18	0.02-0.04	0.18-0.21	34.8-48.3	48.8-65.3	47-66	3.3-4.8	0.26-0.33
Mean	2.98	0.38	0.29	0.17	0.03	0.19	42.20	56.40	55.30	3.87	0.29
<b>Means</b>											
Farmer-selected	2.99	0.38	0.29	0.17	0.033	0.19	42.7	57.2	56.6	3.8	0.29
Conventional checks	2.97	0.38	0.29	0.17	0.030	0.19	41.3	53.9	53.5	4.0	0.29
Difference between farmer selections and conventional checks?	no	no	no	no	yes	no	yes	yes	yes	no	no

Populations that were distributed to more than one farmer were compared to see if the different selection environments resulted in differences in the grain nutrient concentration. There were no significant differences in total grain N, Mg, Zn, and B concentrations between populations selected by different farmers. There were, however, differences in grain P, K, Ca, Fe and Mn concentrations (Fig. 5).



**Figure 5:** Comparison of populations selected by different farmers for: **A)** phosphorus (P), **B)** potassium (K), **C)** calcium (Ca), **D)** iron (Fe), and **E)** manganese (Mn) concentration in the grain. From left to right the populations shown in each figure are BJ08-IG, BJ08-CG, BJ10-SC, BJ10A-KB, BJ11-CG, BJ11-SC, and BJ11-KB. An asterisk (\*) over bars within the same population indicates that there is a significant difference between treatments within that population.



### *What can we take away from this study?*

The results of this study indicate that farmer selected populations are better adapted to organic crop production than conventionally selected varieties. As a group the farmer selected populations displayed greater early vigour, higher yield, and increased concentrations of Ca, Zn, Fe and Mn in the grain than the conventionally selected checks. There was no difference in leaf disease between the farmer selected populations and the conventionally selected checks indicating that the farmer selected populations have a good level of disease resistance. As a group the farmer selected populations were significantly taller than the conventionally selected checks and matured later.

This study highlights the large influence that the individual farmer and the selection environment have on shaping a population. Three years of on-farm selection had a significant impact on agronomically important characteristics such as days to maturity, lodging and height, as well as the nutrient density of the grain. The characteristics of the populations changed depending on the selection environment and the preferences of the person making selections, showing that a population can be tailored to the growing environment and needs of an individual farmer.

The fact that grain P status varied among farmer selected populations indicates that there is potential to select for organic wheat types that are able to capture soil P, even when soil available P levels appear low. This will be a focus on a new research project.

Since the start of the participatory wheat breeding program the on-farm breeding project has expanded to include oat and potato and takes place on farms across Canada. The results of this project show the positive impact of involving farmers in plant breeding and the gains that can be made by just three years of on-farm selection.

### *Acknowledgements*

We gratefully acknowledge funding from the Governments of Manitoba (through the ARDI program) and Canada (through AAFC) who supported this program at the outset, as well as Organic Alberta for recent funding. We also gratefully acknowledge the Bauta Family Initiative on Canadian Seed Security for recent and ongoing funding. Thanks to all who helped carry out the work including Keith Bamford. A very special thanks to all the farmers who participated in the program. We could not have done this without your hard work, enthusiasm and dedication. You are Canada's newest plant breeders!

# Effect of Seeding Rate, Seed Treatment and Fertility on the Performance of Winter Wheat – 2014 Interim Report

<b>Principal Investigators:</b>	Ducks Unlimited Canada. Westman Agriculture Diversification Organization (WADO) Canada-Manitoba Crop Diversification Centre (CMCDC) Parkland Crop Diversification Foundation (PCDF)
<b>Support:</b>	Ducks Unlimited Canada; Growing Forward 2
<b>Progress:</b>	Year 1 of 3
<b>Objective:</b>	Evaluate the effect of inputs on winter wheat variety performance in western Manitoba.
<b>Contact Information:</b>	Ken Gross ( <a href="mailto:k_gross@ducks.ca">k_gross@ducks.ca</a> ) Craig Linde ( <a href="mailto:Craig.Linde@gov.mb.ca">Craig.Linde@gov.mb.ca</a> ) Scott Chalmers ( <a href="mailto:scott.chalmers@gov.mb.ca">scott.chalmers@gov.mb.ca</a> )

## Background

Winter wheat is a crop with one of the highest potential returns to growers in Manitoba due to typically high yields and relatively low inputs. Planting winter wheat also spreads out labor during the fall and reduces planting requirements during the spring. Despite the prospect of high returns, made even more likely by new high yielding genetics, producers in Manitoba tend to plant winter wheat on their lower quality land and/or restrict input levels relative to other crops.

There are a number of agronomic approaches to improving yields in winter wheat along with variety selection. Fall establishment is important for ensuring the crop has a high probability of surviving winter and to ensure a suitable plant stand come spring. The use of seed treatments and an increase in seeding rate have been two approaches to improve the likelihood of a healthy stand. Nitrogen fertility is another factor to consider and recommendations can be slightly different depending on the source.

This trial looks at three agronomic components for achieving high winter wheat yield: planting rate, seed treatment and fertility. The locations of the trials are at Roblin, Carberry and Hamiota managed by PCDF, CMCDC, and WADO, respectively. This report is only concerned with the Hamiota location methods, the Carberry and Hamiota results, and the overall yield among the three sites. The Roblin site was canceled due to severe winter kill during the 2014 winter-spring.

## Methods

Plot treatments were seeded into a randomized complete block design and replicated 3 times. Plots were seeded with a Seedhawk dual knife air seeder. Table 1 below outlines the factors of the experiment as well as agronomic operations at Hamiota in 2014.

**Table 1:** WADO field operations for 2014 high yielding winter wheat.

Operation	Date/Rate
Variety	Flourish
Seeding Rates	Target: 250 plants/m <sup>2</sup> or 450 plants/m <sup>2</sup>
Seeding Date	September 20, 2013
Harvest Date	August 19, 2014
Fertility Treatments Available (fall soil test): 48 lbs/ac	LOW: 60 lbs/ac side banded at seeding; 20lbs/ac spring broadcast. Total Available N: 128 lbs/ac MED: 60 lbs side banded at seeding; 40lbs/ac Spring broadcast. Total Available N: 148 lbs/ac HIGH: 60 lbs/ac side banded at seeding; 60 lb/ac Spring Broadcast. Total Available N: 168 lbs/ac
Herbicide	Achieve (0.2L/ac) and Basagran (0.9L/ac) June 24.
Fungicide	Not applied

Data Measured: Fall and spring plant emergence, grain yield, test weight, grain moisture, Fusarium damaged kernels, grain protein content.

Plots were harvested with a Wintersteiger Classic plot combine. Grain samples were measured and composites were sent to BioVision laboratories (Winnipeg, MB) for quality testing.

Site data was analyzed with an analysis of variance (ANOVA) using Agrobase Gen II statistical software. Site data was combined and a REML analysis was performed to calculate variable means and determine their least significant differences (LSD) and probabilities among the factors investigated.

## Results

### *Hamiota*

Winter wheat establishment was excellent following planting in September, 2013 with no visible differences among seed treatments. Spring counts (data not shown) confirmed very low winter mortality and those with higher seeding rates resulted in a denser stand (Table 5).

There were significant differences among fall and spring seeding rates indicating that increasing seeding rates increases seedling emergence. There were no differences in grain yield or test weight. There was

an interaction between nitrogen rate and seed treatment as well as between all factors (ST x SR x N) but this appears to be a coincidence.

Fusarium (*Fusarium graminearum*) infection was very high in winter wheat throughout Manitoba in 2014<sup>(1)</sup> and Hamiota was no exception. Grade results for composite samples revealed levels of Fusarium damaged kernels ranging between 5-10% (Table 2) for which yield was most likely compromised. There was no significant connection between factors tested and final grade (Table 3) based on a 1-way analysis of variance (ANOVA) of quality data.

**Table 2:** Test Percent Fusarium Damaged Kernels (FDK) and percent protein in composite samples taken from high yield winter wheat trial at Hamiota, 2014.

Seed Rate	Seed Treatment	N Rate	%FDK	Protein
250 pl/m2	Raxil WW	80N	8.58	11.4
250 pl/m2	Raxil WW	100N	10.38	11.6
250 pl/m2	Raxil WW	120N	7.6	11.8
250 pl/m2	Untreated	80N	8.43	11.6
250 pl/m2	Untreated	100N	7.8	11.2
250 pl/m2	Untreated	120N	8.44	11.6
450 pl/m2	Raxil WW	80N	9.6	11.4
450 pl/m2	Raxil WW	100N	4.58	11.8
450 pl/m2	Raxil WW	120N	11.5	11.5
450 pl/m2	Untreated	80N	6.16	11.5
450 pl/m2	Untreated	100N	10.8	11.4
450 pl/m2	Untreated	120N	9.92	11.4

**Table 3:** Probabilities between factors investigated and final grade values based on composite sample data generated from laboratory grades.

Factor	Variable	
	%FDK	%Protein
Seed Rate	0.856	0.758
Seed Treatment	0.925	0.200
N Rate	0.710	0.741

Despite any differences in FDK content between plots treated with or without a seed treatment, this did not translate into a yield increase overall; however, there was a significant ( $p < 0.1$ ) interaction between seed treatment and fertilizer rate with the yield being significantly greater with seed treatment at the lowest fertilizer rate as compared to when no seed treatment was used. Since seed treatment has been shown to increase tillering this may be an explanation, but more investigation is required.

Fertilizer was the only factor that significantly increased yield (Figure 2). Additional fertilizer translated into 5bu/ac for every 20lbs/ac of actual N added. Any yield increase was counteracted by overall Fusarium levels in the crop.

As this was the first of potentially 3 years of study it will be repeated in 2015. Planting of the 2015 trial occurred September 26 and stand establishment was once again excellent heading into winter. The only modification relative to 2014 was that all fertilizer was banded in the fall. This is not always recommended as there is a chance of having too much growth heading into winter which can compromise survival, but given the delayed planting it was decided this risk was low.

### **Carberry**

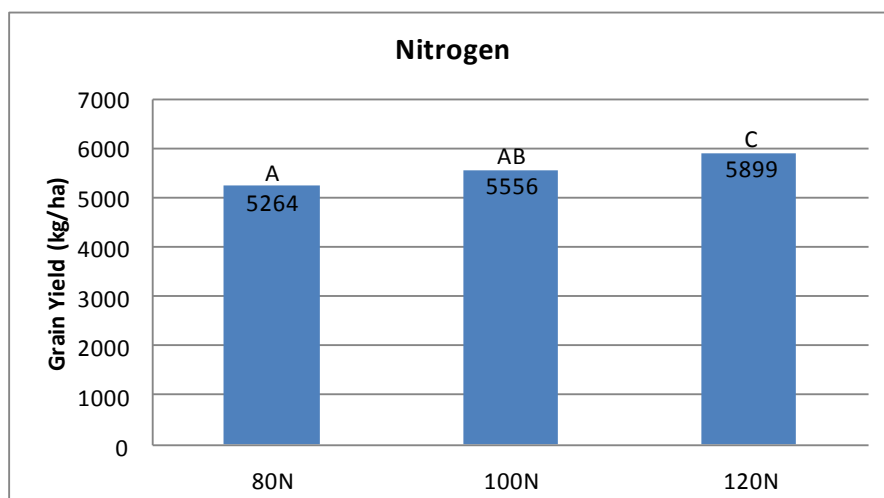
*Fusarium (Fusarium graminearum)* infection was very high in winter wheat throughout Manitoba in 2014<sup>(1)</sup> and Carberry was no exception. Grade results for composite samples revealed levels of *Fusarium* damaged kernels ranging between 9-15% (Table 4) for which yield was most likely compromised. The lower seeding rate had higher rates of FDK than the higher seeding (sig T-Test  $p < 0.1$ ). This is possibly related to a slightly reduced flowering period that has been shown to be associated with higher planting rates in Ontario<sup>(2)</sup>. Seed treatment was also significant ( $p = 0.1$ ) in showing reductions in FDK, although levels were still very high. Studies in Guelph have shown both an increase and a decrease<sup>(3)</sup> in FHB levels relative to the use of seed treatment so this is very possibly a coincidence in this case.

**Table 4:** Test weight, Percent *Fusarium* Damaged Kernels (FDK) and vomitoxin (VOM) in parts per million (ppm) of composite samples taken from high yield winter wheat trial at CMCDC, Carberry 2014.

Seeding Rate	Seed Treatment	Fertility	TW (g/0.5l)	FDK (%)	VOM (ppm)
250 pl/m <sup>2</sup>	Raxil WW	HIGH	364	12.8	6.0
250 pl/m <sup>2</sup>	Raxil WW	LOW	361	11.7	10.5
250 pl/m <sup>2</sup>	Raxil WW	MEDIUM	364	13.0	10.0
250 pl/m <sup>2</sup>	Untreated	HIGH	363	13.8	7.0
250 pl/m <sup>2</sup>	Untreated	LOW	362	10.0	7.0
250 pl/m <sup>2</sup>	Untreated	MEDIUM	362	15.6	13.0
450 pl/m <sup>2</sup>	Raxil WW	HIGH	362	10.2	6.0
450 pl/m <sup>2</sup>	Raxil WW	LOW	364	10.8	7.5
450 pl/m <sup>2</sup>	Raxil WW	MEDIUM	364	7.5	5.0
450 pl/m <sup>2</sup>	Untreated	HIGH	365	12.6	5.0
450 pl/m <sup>2</sup>	Untreated	LOW	364	9.8	9.0
450 pl/m <sup>2</sup>	Untreated	MEDIUM	363	14.5	6.0

Despite any differences in FDK content between plots treated with or without a seed treatment, this did not translate into a yield increase overall; however, there was a significant ( $p < 0.1$ ) interaction between seed treatment and fertilizer rate with the yield being significantly greater with seed treatment at the lowest fertilizer rate as compared to when no seed treatment was used. Since seed treatment has been shown to increase tillering this may be an explanation, but more investigation is required.

Fertilizer was the only factor that significantly increased yield (figure 1). Additional fertilizer translated into 5 bu/ac for every 20 lbs/ac of actual N added. Any yield increase was counteracted by overall *Fusarium* levels in the crop.

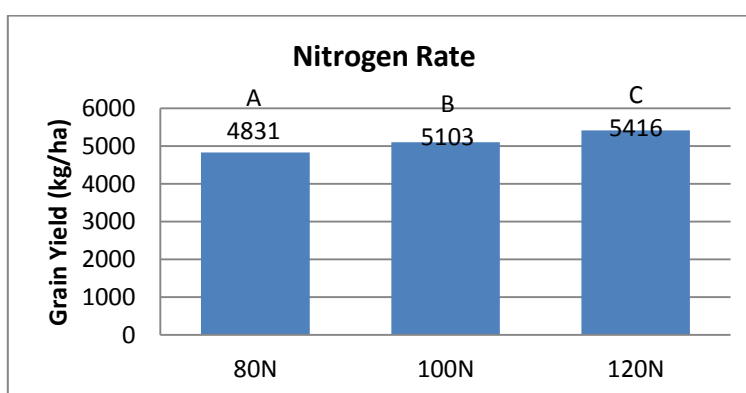


**Figure 1:** Winter Wheat grain yield (kg/ha) for three different fertilizer regimes at CMCDC, Carberry 2014.

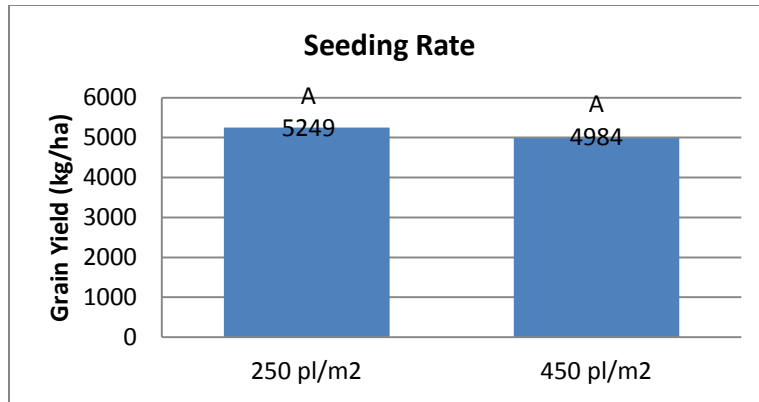
As this was the first of potentially 3 years of study it will be repeated in 2015. Planting of the 2015 trial occurred September 26 and stand establishment was once again excellent heading into winter. The only modification relative to 2014 was that all fertilizer was banded in the fall. This is not always recommended as there is a chance of having too much growth heading into winter which can compromise survival, but given the delayed planting it was decided this risk was low.

#### ***Hamiota and Carberry REML Analysis on Grain Yield***

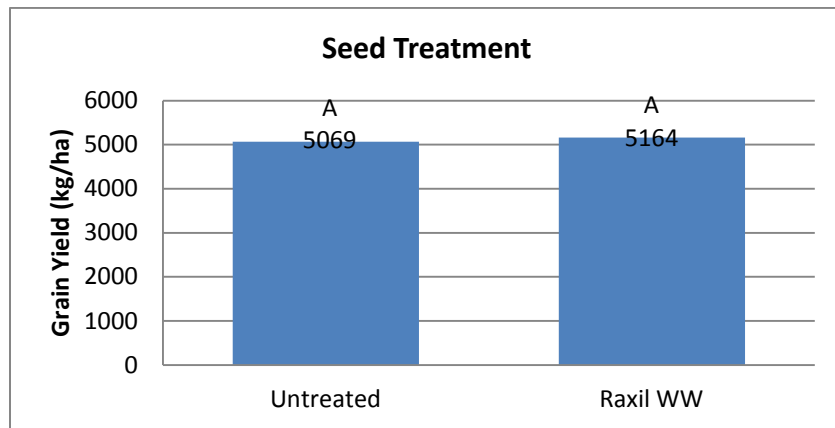
There were significant differences among both sites only in nitrogen applications and not from the use of seed treatments or seeding rates (Table 5). Higher application rates of nitrogen (Figure 2) resulted in significantly ( $p < 0.001$ ) higher grain yield. There were no interactions between using seeding rates, seed treatments or nitrogen application in combination.



**Figure 2:** Effect of nitrogen rate on grain yield in Carberry and Hamiota in 2014.



**Figure3:** Effect of seeding rate on grain yield in Carberry and Hamiota in 2014.



**Figure 4:** Effect of seed treatment on grain yield in Carberry and Hamiota in 2014.

### *Discussion and Recommendations*

Based on the preliminary results of one year, it appears obvious that nitrogen application is foremost the most important factor (in this project compared to seed treatment and seeding rates used) in winter wheat production. Carberry resulted in significant responses to nitrogen application and Hamiota was significant at the 0.1 level of significance. Overall, both sites combined resulted in significant nitrogen response.

Further site years of testing may warrant the use of seeding rate and seed treatments to be significant agronomic factors producers can adjust to reach the potential of high yielding winter wheat.



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- (3) A. H. Teich, and J. R. Hamilton. June 1985. Effect of cultural practices, soil phosphorus, potassium, and pH on the incidence of Fusarium Head Blight and deoxynivalenol levels in wheat. Applied and Environmental Microbiology. 49, no. 6: 1429-1431.

**Table 5:** Effects of seeding rate, seed treatment and nitrogen fertilizer applications on fall and spring plant emergence, test weight, and grain yield in winter wheat near Hamiota and overall between Hamiota and Carberry, MB in 2014.

Effect	Seed Rate	Seed Treatment	Nitrogen Rate	HAMIOOTA				Overall	
				Emergence (plants/m2)		% Change	Test Weight	Yield	Yield
				fall	spring				
Seed Rate (SR)	250 pl/m2			177.5	169.4	4.6	70.9	4788.6	5249
	450 pl/m2			217.7	208.5	4.2	70.7	4531.6	4984
Seed Treatment (ST)		Untreated		192.5	182.6	5.1	70.6	4538.8	5069
		Raxil WW		202.7	195.4	3.6	71.0	4781.3	5164
Nitrogen Rate (N)			80N	207.6	199.3	4.0	70.5	4397.8	4831
			100N	192.0	183.2	4.6	70.7	4650.2	5103
			120N	193.2	184.4	4.6	71.2	4932.2	5416
SR x ST	250 pl/m2	Untreated		172.9	163.2	5.6	70.8	4769.6	5202
		Raxil WW		182.1	175.7	3.5	71.0	4807.5	5296
	450 pl/m2	Untreated		212.1	201.9	4.8	70.5	4308.0	4935
		Raxil WW		223.3	215.0	3.7	71.0	4755.1	5032
SR x N	250 pl/m2		80N	193.7	185.8	4.1	70.7	4547.4	5014
			100N	174.1	165.8	4.8	70.5	4664.1	5171
			120N	164.7	156.8	4.8	71.6	5154.1	5563
	450 pl/m2		80N	221.4	212.8	3.9	70.3	4248.2	4648
			100N	210.0	200.6	4.5	71.0	4636.2	5035
			120N	221.7	212.1	4.3	70.9	4710.3	5269
N x ST		Untreated	80N	184.1	174.1	5.4	70.0	4223.3	4634
			100N	206.2	196.5	4.7	69.8	4489.6	5106
			120N	187.2	177.2	5.3	72.1	4903.5	5465
ST x SR x N		Raxil WW	80N	231.0	224.5	2.8	70.9	4572.3	5027
			100N	177.9	169.9	4.5	71.6	4810.7	5100
			120N	199.3	191.7	3.8	70.4	4961.0	5367
	Coefficient Variance (%)			13.8	14.8		2.6	11.5	10
	R-Square			0.71	0.72		0.33	0.43	1
	Grand Mean			197.6	189.0		70.8	4660.1	5117
LSD	Seed Rate (SR)			18.9	19.3		1.3	370.9	469
	Seed Treatment (ST)			18.9	19.3		1.3	370.9	469
	Nitrogen Rate (N)			23.1	23.6		1.6	454.3	266
	SR x ST			26.7	27.3		1.8	525.5	663
	SR x N			32.7	33.4		2.2	642.4	684
	N x ST			32.7	33.4		2.2	642.4	684
	ST x SR x N			-	-		-	-	967
P values	Seed Rate (SR)			0.0002	0.0004		0.793	0.165	0.165
	Seed Treatment (ST)			0.273	0.183		0.593	0.189	0.612
	Nitrogen Rate (N)			0.319	0.310		0.606	0.072	<0.001
	SR x ST			0.912	0.972		0.727	0.265	0.907
	SR x N			0.413	0.453		0.688	0.634	0.701
	N x ST			0.010	0.010		0.081	0.766	0.106
	ST x SR x N			0.001	0.001		0.576	0.515	0.442

## Pepsico (Quaker) Oats Variety Trial

### Cooperators

- PepsiCo-Fritolay-Quaker-Gatorade Company

### *Background (taken from Wikipedia)*

Oat bran is the outer casing of the oat. Its consumption is believed to lower LDL ("bad") cholesterol, and possibly to reduce the risk of heart disease. Oats contain more soluble fibre than any other grain. One type of soluble fibre, *beta-glucans*, has proven to help lower cholesterol.

After reports of research finding that dietary oats can help lower cholesterol, an "oat bran craze" swept the U.S. in the late 1980s, peaking in 1989, when potato chips with added oat bran were marketed. The food fad was short-lived and faded by the early 1990s. The popularity of oatmeal and other oat products again increased after a January 1998 decision by the Food and Drug Administration (FDA), when it issued a final rule that allows food companies to make health claims on food labels of foods that contain soluble fibre from whole oats (oat bran, oat flour and rolled oats), noting that 3.0 grams of soluble fibre daily from these foods may reduce the risk of heart disease. To qualify for the health claim, the whole oat-containing food must provide at least 0.75 grams of soluble fibre per serving. A class of polysaccharides known as beta-D-glucans comprise the soluble fibre in whole oats.

Beta-D-glucans, usually referred to as beta-glucans, comprise a class of indigestible polysaccharides widely found in nature in sources such as grains, barley, yeast, bacteria, algae and mushrooms. In oats, barley and other cereal grains, they are located primarily in the endosperm cell wall.

Oat beta-glucan is a soluble fibre. In comparison, the indigestible polysaccharide cellulose is also a beta-glucan, but is not soluble. The percentages of beta-glucan in the various whole oat products are: oat bran, greater than 5.5% and up to 23.0%, rolled oats, about 4% and whole oat flour about 4%.

The food and beverage company PepsiCo has partnered with Secan Seeds to evaluate varieties of oats keeping these beta-glucans in mind, while evaluating growth characteristics, yield and milling quality. The purpose being to find the best milling oat, with the best marketable beta-glucan content, that farmers will want to grow.

Trials were set up around the Prairies by Secan and Pepsico with cooperation of research groups like WADO, to evaluate some classic and some new varieties of oats available, and assess the geographical/environmental parameters that affect the quality and quantity of the oats being grown. One of these trial sites was grown in Melita by WADO. This was year three of this partnership.

## Methods

Twenty-one varieties were arranged in a randomized complete block design and replicated three times. The trial area was not treated with pre-emergent herbicides prior to seeding. However, this site was treated with Buctril M and Credit, 0.2 L/ac and 1 L/ac in the fall of 2013 to control volunteer canola and green & yellow foxtail. Plots were direct seeded into canola stubble at a depth of ½" using a SeedHawk dual knife opener. Fertilizer was side band at a rate of 85 lbs/ac actual nitrogen using 28-0-0 UAN and a granular blend 12-17-15-10 applied at 200 lbs/ac. Plots were kept weed free by spraying in crop with Stampede EDF herbicide, tank mixed with MCPA ester 500 at a rate of 1.25 lbs/ac and 0.5 L/ac, respectively. Herbicides were tank mixed and applied June 16 with a water volume of 20 gal/ac at the five leaf stage. Plots were not sprayed with fungicide.

### Spring Soil Test:

Legal Land Location	Depth	pH	N ppm	P ppm Olsen	K ppm	S lbs/ac	Organic Matter %
SW 1-4-27 W1	0-6"	6.9	1	9	256	7	2.2
	6-24"		2			7	

Plots were desiccated with glyphosate at full maturity using Roundup Transorb and Heat (with 0.5% v/v Merge adjuvant) at a rate of 1 L/ac and 10 g/ac, respectively, on August 26<sup>th</sup>. Plots were harvested September 6<sup>th</sup> with a Hege 140 plot combine. Data collected throughout the season included: heading date, days to maturity, crop height, lodging, test weight, sample moisture, seed weight and grain yield. Plot samples were combined by variety and sent to PepsiCo for milling and beta-glucan content analysis (results confidential).

Data was analyzed with a two-way analysis of variance (ANOVA) using Agrobases Gen. II statistical software (Microsoft). Coefficient of variation (CV), least significant difference (unprotected), grand mean, and R-squared were calculated.

## Results

There were significant differences among all characteristics measured (Table 1). Varieties are sorted in order from highest yield to lowest yield.

**Table 1:** Variety, test weight, maturity, heading, lodging, height, and disease rating of various oat varieties grown in Melita in 2014.

Variety	Days to Heading days	Crop Height cm	Maturity days	Test Weight g/0.5L	Grain Yield kg/ha	Seed Weight g/500
Triactor	63	117	99	217	6451	17.5
OT3080	63	113	97	239	5980	19.2
OT3083	61	117	95	233	5962	20.4
Leggett	62	112	101	240	5857	17.5
OA1286-1	62	113	94	242	5794	18.6
OA1357-2	62	117	98	222	5790	18.5
CFA 1112	61	105	95	214	5763	17.8
ND 090011	60	113	95	233	5752	16.8
Souris	61	107	94	237	5662	15.1
OT3081	61	115	99	227	5642	17.6
OA1331-5-4	64	118	95	210	5612	14.6
ND 080375	60	122	94	242	5474	16.4
OA1306-1	64	123	101	225	5427	17.1
OA1331-5-5	62	118	95	209	5403	15.6
CDC Morrison	60	115	94	235	5378	17.1
BetaGene	60	110	94	226	5370	18.8
ND 080012	60	107	93	243	5177	14.7
CDC Dancer	62	125	93	225	5096	14.2
OT3071	64	118	101	213	4946	17.8
Dieter	62	125	94	200	3660	15.6
AC Morgan	62	115	95	170	2767	14.3
CV%	1.1	3.8	1.8	2.5	8.2	5.2
LSD (p<0.05)	1	7	3	9	731	1.5
R-Square	0.86	0.71	0.80	0.94	0.84	0.85
P value	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
Significant	Yes	Yes	Yes	Yes	Yes	Yes
Grand Mean	61.7	115.5	96.1	223.9	5379	16.9

## Discussion

Testing varieties of oats over many locations over several years can be beneficial not only for the producer, but also for the processors. Processors could choose varieties that are outstanding in a certain region and also choose varieties with exceptional quality parameters such as high beta-glucan. PepsiCo-Quaker plans to use the composite samples to assess milling quality and beta-glucan content. The processor would then be in a position to advise producers what varieties would be valuable to grow and market in their region.

## Soybean Inoculant Trial

**Cooperators:** Manitoba Pulse Growers Association  
Becker Underwood (BASF Canada)  
Novozymes

**Location:** Melita, MB

**Year:** 2014

**Soil Type:** Newstead Loamy Sand

### Objectives

1. To test granular and liquid inoculants in soybean in sole form and in combination from Novozyme and Becker Underwood.
2. To test alternative inoculant forms of “biofertility” treatments in conjunction with liquid or granular inoculants such as Jumpstart, Optimize and Tag Team, and Biostacked

### Methods

A trial location was picked from a field that had no history of soybean production located near Melita on NE 26-3-27 W1. A soil test was taken prior to seeding the plots to determine background nutrient profiles (Table 1). Plots were direct seeded into winter wheat stubble with significant volunteer growth. That day, after seeding, an herbicide application of glyphosate (Roundup Transorb) was applied at a rate of 1 L/ac to control volunteer winter wheat and weeds. Plot area was also rolled with a land roller to pack stones into the soil.

**Table 1:** Spring soil test on trial area prior to seeding plots in Melita, MB.

	N	P	K	S	Salts	Organic Matter	
Depth	ppm	ppm Olsen	ppm	lbs/ac	mmhos/cm	%	pH
0-6"	2.5	4	424	7	0.23	3.1	7.4
6-24"	4.5			46			

Eleven inoculation treatments (listed in Table 2) were seeded into plots arranged in a randomized complete block design and replicated three times. Plots were air seeded June 11, 2014 at a depth of 1" using a Seedhawk dual knife system. Variety 'McLeod' (Secan) was seeded at a target rate of 210,000 plants/acre. Final plot dimension was 1.44 m wide by 9 m long with six rows on 9.5" spacing. Seed was not inoculated until the day of seeding. The seeding components were not sterilized between inoculation treatments because of impending rain at seeding. Fertilizer was side band as a granular blend of 12-17-15-10 at a rate of 138 lbs/ac using 11-52-0 MAP, 0-0-60 (potash), 21-0-0-24 (ammonium

sulfate). An application of glyphosate (Roundup Transorb) was applied July 23 at a rate of 0.4 L/acre to control weeds in crop.

**Table 2:** Inoculation treatment products used in trial, the company that distributes the product, formulation of the product, target purpose (N, P, NT, LCO), and the corresponding rates used.

Treatment	Description	Product 1	Product 2	Company	Formulation	Purpose	Rate 1	Rate 2
1	Untreated							
2	Liquid	Cell-Tech		Novozymes	L	N	75 ml/27 kg	
3	2 x liquid N	Cell-Tech	Cell-Tech	Novozymes	L	N	150 ml/27 kg	
4	Liquid + Granular	Cell-Tech		Novozymes	L + G	N	75 ml/27 kg	4.5 lbs/ac
5	Granular N	Cell-Tech		Novozymes	G	N	4.5 lbs/ac	
6	Liquid + P inoc.	Cell-Tech	Jumpstart	Novozymes	L + WP	N, P	75 ml/27 kg	80g/1630 kg
7	Liquid N + LCO	Cell-Tech	Optimize	Novozymes	L + L	N, LCO	75 ml/27 kg	125 ml/45.4 kg
8	Granular N + P	TagTeam		Novozymes	G	N, P	4.7 lbs/ac	
9	Granular	Nodulator		Becker Underwood	G	N	5 lbs/ac	
10	Liquid N + NT	Nodulator N/T		Becker Underwood	L	N, NT	77 ml/27.2 kg	
11	Liquid N+ NT + Granular	Nodulator N/T	Nodulator	Becker Underwood	L + G	N, NT	77 ml/27.2 kg	5 lbs/ac
L = liquid G = Granular WP = wettable powder N = Nitrogen P = Phosphorous LCO = lipo-chitooligosaccharide technology NT = double stacked								

Data collected included: nodule counts, plant biomass, grain moisture, grain yield, seed size, seed protein, and seed oil content. Ten random plants per plot were dug up and carefully washed prior to nodule counting. The number of nodules was recorded for each plant and an average for the plot was determined. The plot growth stage during nodule counts was at an average of R3 (beginning of pod, July 25). Plant biomass was taken at the R5 stage (full pod, August 25) by harvesting 2 random lengths of 1m of row. Plants were dried and weighed. Plots were harvested for seed yield on October 14th with a Hege 140 plot combine. Grain moisture was measured using a Labtronics model 919 moisture meter and values were used to correct grain yields to 14% moisture for all plots. Five hundred seeds were counted with a Seedburo 801 Count-a-pak (Seedburo Inc.) and weights were doubled to determine the thousand kernel weight (TKWT) of the plot sample. A 1 kg composite seed sample of each treatment was sent to BioVision Laboratories (Winnipeg, MB) for percent protein and percent oil content.

Data was analyzed with a two-way analysis of variance (ANOVA) Microsoft Analyze-it v2.03 statistical software with using a Fishers unprotected LSD if there was a significant difference among treatment means. Coefficient of variation was calculated using grand mean and residual mean square error.

Average nodule counts, plant biomass, grain yield and seed weight were tested to determine the strength of their relationship to each other using a Pearson correlation analysis to test for their correlation coefficient (r) and the significance of their relationship. If significant, a linear regression analysis was also performed to test for the strength of their association (R-squared) and their equation describing their relationship ( $y = mx + b$ ) also using Microsoft Analyze-it v2.03 statistical software.

## Results

There were significant differences in nodule counts, plant biomass, seed weight, and grain yield (Table 3). Generally most inoculants provided a positive response to all parameters measured. However, in treatments from Novozymes containing a phosphorous inoculant there seemed to be short fall in all parameters measured compared to those focusing on solely nitrogen fixation. Also, Novozyme inoculants solely used in fixing nitrogen performed better on most parameters except yield than did those sourced from Becker Underwood (Figure 1).

Seed oil contents were generally similar; however, protein contents were rather low in the untreated check which was to be expected. Oddly the protein contents were low in treatment 6 (containing JumpStart) which also supports the low grain yield response of that treatment, similar to the untreated check as well.

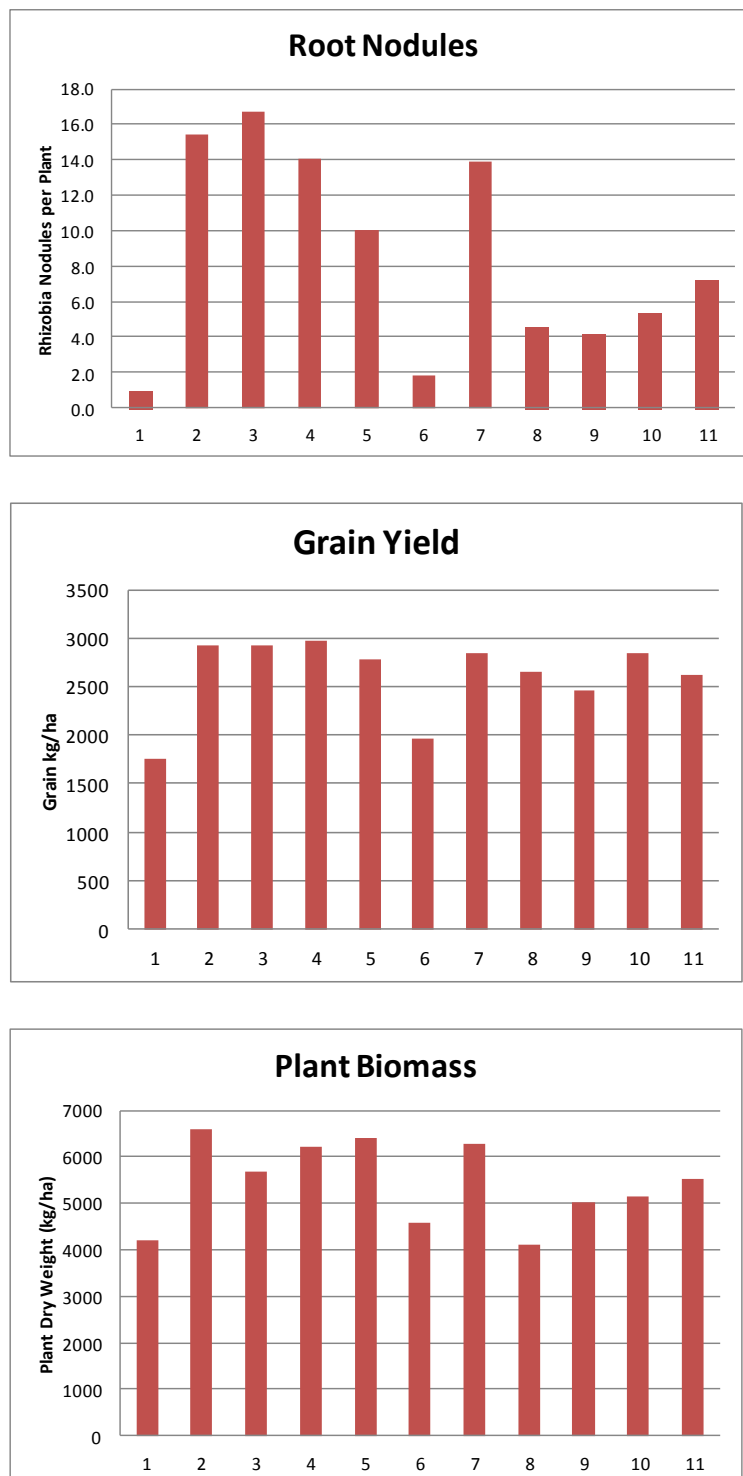
Double inoculating whether with double rate (trt 3), or with multiple formulations (trt 11) did not improve any of the parameters measured.

**Table 3:** Mean nodule counts, plant biomass, seed weight (TKWT), grain yield and seed oil and protein values for all treatments. Grand Mean, coefficient of variation (CV%), least significant difference (LSD), R-squared and probability values of all parameters are summarized below means.

Treatment No.	Inoculant Formulation	Brand	Company	Nodules nodules/plant	logNodules/pl ant	Plant Biomass kg/ha	TKWT g/1000 seeds	Yield kg/ha	Oil %	Protein %
1	Untreated			0.9	-0.09	4201	169	1757	17	31.2
2	Liquid	Cell-Tech	Novozymes	15.5	1.19	6609	188	2926	16	36.2
3	2 xLiquid N	Cell-Tech	Novozymes	16.7	1.22	5667	186	2926	15	36.8
4	Liquid + Granular	Cell-Tech	Novozymes	14.1	1.15	6209	188	2979	16	36.6
5	Granular N	Cell-Tech	Novozymes	10.0	0.98	6415	188	2778	15	36.6
6	Liquid + P inoculant	Jumpstart	Novozymes	1.8	0.24	4585	169	1957	17	32.4
7	Liquid N + LCO	Optimize	Novozymes	13.9	1.11	6288	191	2844	15	36.8
8	Granular N + P	TagTeam	Novozymes	4.6	0.62	4112	187	2658	15	35.6
9	Granular	Nodulator	Becker Underwood	4.2	0.60	5035	180	2459	16	34.7
10	Liquid N + NT	Nodulator N/T	Becker Underwood	5.4	0.70	5157	179	2843	16	34.9
11	Liquid N+ NT + Granular	Nodulator	Becker Underwood	7.2	0.77	5513	187	2620	16	35.3
Grand Mean				8.6	0.77	5436	183	2613		
CV%				37.1	24.9	18.3	2.2	9.5		
LSD (p<0.05)				5.4	0.33	1693	7	422		
R-squared				0.83	0.88	0.55	0.84	0.84		
P value				<0.0001	<0.0001	0.04	<0.0001	<0.0001		
Significant?				Yes	Yes	Yes	Yes	Yes		

There were significant linear correlations and regressions between nodules and plant biomass and biomass and yield (Table 4). Relationships between nodules and yield and seed weight existed but were not linear until a log to the base 10 was applied to the nodule means (Figure 2). In doing so, their relationship became highly significant and explained 54% and 60% of the association to yield and seed weight, respectively. Greater nodulation success translated to larger plant biomass, more grain yield and larger seed weights.

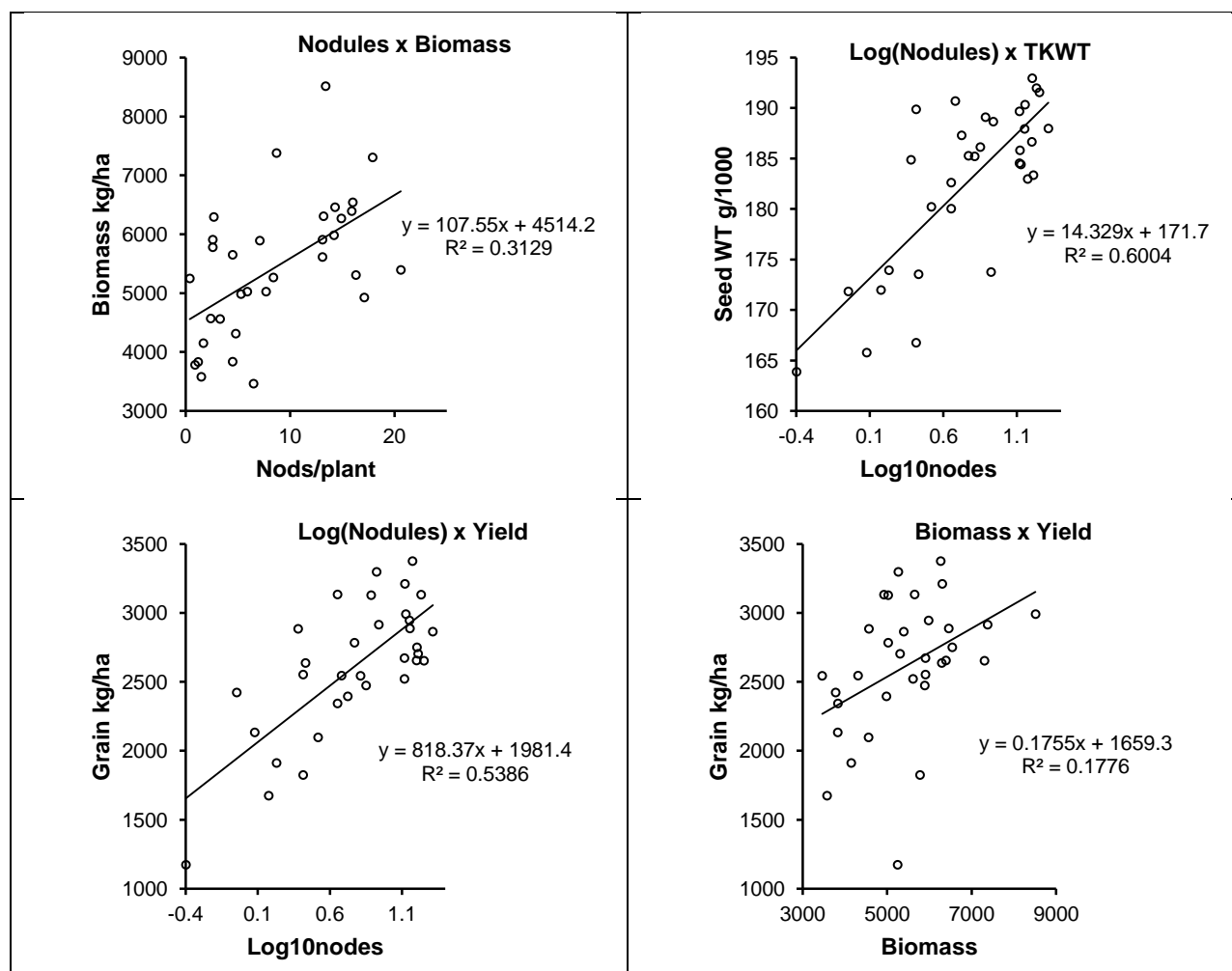




**Figure 1:** Root nodules, plant biomass and grain yield among all inoculation treatments in Melita, 2014.

**Table 4:** Correlation and Linear Regression of root nodules, biomass, yield and seed weight relationships indicating the strength of their relationship and the significance of that relationship.

Relationship	Pearson Correlation			Linear Regression		
	r	P Value	Significant?	R <sup>2</sup>	St.Err.	Linear Equation of Best Fit
Nodules x Biomass	0.56	0.001	Yes	0.31	985	Biomass= 107.55(Nodules)+ 4514.2
Biomass x Yield	0.42	0.015	Yes	0.18	449	Yield= 0.1755(Biomass) + 1659.3
log(Nodules) x Yield	0.73	<0.0001	Yes	0.54	336	Yield = 818.37log(Nodules) + 1981.4



**Figure 2:** Correlation of root nodules to biomass, grain yield, seed weight (TKWT) and biomass and yield and the corresponding best fit linear equations and regression values.

## *Discussion*

This trial indicated that seed yield, seed size and plant biomass were highly dependent on the success or amount of nodulation in soybean stands. This experiment also indicated that secondary inoculants that attempt to improve phosphorous uptake (JumpStart or TagTeam) may cause negative consequences on the formation of nitrogen fixing nodules on soybean roots thus negatively affecting final plant biomass, grain yields, and seed protein contents. This conclusion should be taken with caution as this trial was only tested for one site year. Multiple site years would assist with improving the precision and accuracy of the data conclusions. The possibility of improper application of inoculants at the time of seeding could contribute to this conclusion.

**Photo:** Visual differences among plots on August 11<sup>th</sup>. Untreated checks denoted by an arrow.



# Phosphorus Fertilization Beneficial Management Practices for Soybeans in Manitoba (2014 Progress Report)

## Cooperators

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## Abstract

Very little research has been conducted to determine the best rate, source, placement, and timing of P fertilizer for modern soybean cultivars grown in the Canadian Prairies. Preliminary results of the two years of field studies at 10 locations in Manitoba showed that typical agronomic rates of seed row P did not decrease plant stand and seed yield at any sites; nor was seed yield increased at any site, even with Olsen P concentrations as low as 3 ppm.

## Introduction

Soybeans areas are expanding northerly across the Great Plains region of North America. Over the last 15 years in Manitoba, Canada, soybean acreage has increased from 18,000 acres in 1998 to over 1.3 million acres in 2014 (Statistics Canada, 2014). This increase in soybean acreage is due to a variety of factors, including the development of new varieties that are adapted to Manitoba's relatively short (95-135 frost-free days) and cool (2100-2500 crop heat units) growing season. Although Manitoba's soybean producers are proficient at inoculating their soybeans for maximum biological fixation of N, they have many questions about P fertilization and placement under Manitoba conditions. Most Prairie Canadian crops such as wheat, barley and canola respond more to banded (seed placed and side banded) P fertilizer than to broadcast applications. However, seed placed P is known to cause stand injury with some crops, including soybeans, at high rates of application.

Very little research has been conducted on P fertilization of soybeans in the Canadian Prairies and the results of that limited amount of research are inconsistent. As a result, little is known about the right source, right rate, right placement and right timing (4Rs) for P fertilization of modern soybean cultivars in this environment. For example, in field and growth chamber studies with Manitoba soils testing 2-5 ppm Olsen P, Bullen et al. (1983) measured very large soybean dry matter and seed yield responses to P fertilizer, especially when the P fertilizer was banded underneath the seed row. However, in unpublished field studies conducted in 2005 and 2006 near Brandon, Manitoba, soybean dry matter and seed yield were not increased by P fertilization, regardless of fertilizer source or placement method (C. Grant, pers. communication). In both of these previous sets of studies, the seed yields of soybeans were much smaller than those typically harvested from current cultivars. Moreover, many areas of soybean

production are depleting soil P reserves, because there is a large amount of P removed by the crop and a relatively small amount of P fertilizer being applied.

As a result of these questions, the following study was initiated in 2013 to assess soybean response to rates and placements of P fertilizer, using a contemporary cultivar in a Manitoba environment. Preliminary results from the first and second year of the study are presented as follows.

### ***Materials and Methods***

Field studies were conducted at 10 locations across southern Manitoba; Olsen extractable P concentrations at these sites varied between 3 and 44 ppm. Seeding equipment varied by site, with row spacings between 7 and 12"; openers were disk, knife or hoe and 7 sites had side band capability. Soybeans (Dekalb 24-10RY) were planted for a target stand of 210,000 plants/acre. All sites were planted between May 22 and June 3 in 2013 and between May 24 and June 9 in 2014. P fertilizer was applied as monoammonium phosphate (11-52-0). At 7 of 10 sites, 20, 40 and 80 lb P<sub>2</sub>O<sub>5</sub>/ac was applied in the seed row, as a side band within 2" inches of the seed or surface broadcast prior to seeding and incorporated with seeding operations. At 3 of 10 sites, equipment limitations restricted treatments to seed placed and broadcast placements only. Treatments were replicated either 3 or 4 times. Plant stands were assessed at 4 weeks after planting and at 7 of 10 sites biomass was harvested and analyzed for P uptake at R3 stage. Plant stand, mid-season biomass and seed yield data were measured at all sites and analyzed using ANOVA with SAS Proc Mixed.

### ***Results and Discussion***

Overall growing conditions in Manitoba in 2013 were better than the average for most crops, so soybean yields at most sites were greater than the 10-year provincial average yield of 28 bu/ac (Table 3a, 3b; Appendix 1). Seedrow placement of typical agronomic rates of fertilizer P (20 or 40 lb P<sub>2</sub>O<sub>5</sub> per acre) did not affect soybean plant stands, biomass or seed yields at any site (Tables 1-3; Appendix 1). However, an extremely high rate of seed row P (80 lb P<sub>2</sub>O<sub>5</sub> per acre) decreased plant stand and seed yield at Melita and Carberry, which are located on coarse and medium-textured soils, respectively. None of the fertilizer P rates or placements increased soybean seed or biomass yield, even at the sites with less than 10 ppm Olsen extractable P.

In 2014, seedling stands at Portage and Carberry were reduced by seed-placed P applied at rates of 40 or 80 lb P<sub>2</sub>O<sub>5</sub>/ac (Tables 4a and 4b; Appendix 2). However, seed yield (Tables 6a and 6b; Appendix 2) was not affected by the plant stand reduction as it happened in 2013. At both of these locations, the row spacing was 12", an important factor for increasing the fertilizer salt concentration in the seed row. Large amounts of precipitation occurred at several sites shortly after planting, reducing the risk of seedling toxicity where it might otherwise have been expected. Mid-season biomass and seed yield were not affected by the fertilizer rates and placement in 2014 (Tables 5, 6a and 6b).

## Conclusions

The lack of seed yield response to P and the high tolerance of soybeans to seedrow placed P was surprising. In spite of P rate, placement and soil test P, there was no response to P fertilizer. Therefore, as the study continues, we look forward to learning more about P fertilization for sustainable soybean production systems in Manitoba.

## Acknowledgements

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Table 1a. 2013 Stand Counts (thousand plants/acre)

Treatment	Brandon	Melita	Carberry	Beausejour	Arborg
Control	179 a	250 a	97 a	165 a	186 a
20 SP	172 a	160 a	110 a	170 a	174 a
20 SB	199 a	172 ab	109 a	186 a	180 a
20 BR	169 a	214 ab	112 a	190 a	201 a
40 SP	187 a	163 a	90 ab	180 a	171 a
40 SB	167 a	155 ab	93 ab	168 a	168 a
40 BR	189 a	183 ab	100 a	141 a	162 a
80 SP	189 a	73 b	60 b	178 a	142 a
80 SB	192 a	177 ab	96 a	167 a	201 a
80 BR	177 a	245 a	95 a	197 a	192 a

For each site, means followed by the same letter are not significantly different ( $p=0.05$ ). SP = seed placed P fertilizer; SB = side-banded P fertilizer; BR = broadcast P fertilizer.

Table 1b. 2013 Stand Counts (thousand plants/acre)

Treatment	Roblin	Portage	St Adolphe
Control	263 a	111 a	84 a
20 SP	253 a	107 a	74 a
20 BR	233 a	123 a	67 a
40 SP	202 a	87 a	84 a
40 BR	263 a	122 a	91 a

For each site, means followed by the same letter are not significantly different ( $p=0.05$ ). SP = seed placed P fertilizer; SB = side-banded P fertilizer; BR = broadcast P fertilizer.

Table 2. 2013 Midseason (R3 stage) Biomass Dry Matter (lb/acre)										
Treatment	Brandon		Melita		Carberry		Beausejour		Arborg	
Control	4955	a	6285	Ab	5562	a	5002	a	4412	a
20 SP	5721	a	5104	A	5278	a	4308	ab	4983	a
20 SB	4752	a	4596	Ab	6190	a	4220	ab	4280	a
20 BR	4062	a	5564	Ab	6236	a	4183	ab	4809	a
40 SP	4783	a	5047	Ab	4531	a	4878	a	4753	a
40 SB	4285	a	2968	Ab	5813	a	4535	a	4739	a
40 BR	4757	a	4995	Ab	5990	a	3049	b	4026	a
80 SP	4942	a	2549	B	5387	a	4059	ab	3588	a
80 SB	5041	a	4091	Ab	6599	a	4420	ab	4660	a
80 BR	5533	a	6164	Ab	6134	a	4787	a	3823	a

For each site, means followed by the same letter are not significantly different (p= 0.05). SP = seed placed P fertilizer; SB = side-banded P fertilizer; BR = broadcast P fertilizer.

Table 3a. 2013 Seed Yield (bu/acre)										
Treatment	Brandon		Melita		Carberry		Beausejour		Arborg	
Control	35	a	59	a	52	a	57	a	35	ab
20 SP	32	a	56	a	54	a	60	a	40	ab
20 SB	33	a	48	ab	51	a	56	a	36	ab
20 BR	35	a	53	ab	47	ab	60	a	40	ab
40 SP	33	a	55	a	47	a	62	a	37	ab
40 SB	32	a	51	ab	49	a	59	a	36	ab
40 BR	34	a	56	a	53	a	62	a	39	ab
80 SP	27	a	38	b	37	b	64	a	36	b
80 SB	27	a	55	a	47	a	59	a	39	ab
80 BR	35	a	57	a	47	a	61	a	44	a

For each site, means followed by the same letter are not significantly different (p= 0.05). SP = seed placed P fertilizer; SB = side-banded P fertilizer; BR = broadcast P fertilizer.

Table 3b. 2013 Seed Yield (bu/acre)						
Treatment	Roblin		Portage		St Adolphe	
Control	23	a	47	a	66	a
20 SP	24	a	43	a	69	a
20 BR	25	a	47	a	63	a
40 SP	23	a	45	a	72	a
40 BR	24	a	45	a	67	a
For each site, means followed by the same letter are not significantly different (p= 0.05). SP = seed placed P fertilizer; SB = side-banded P fertilizer; BR = broadcast P fertilizer.						

Table 4a. 2014 Stand Counts (thousand plants/acre)														
Treatment	Arborg		Beausejour		Brandon		Carberry		Carman		Melita		Roseisle	
Control	194	a	170	a	240	ab	163	ab	260	a	117	a	210	bc
20 SP	198	a	164	a	262	a	123	bcd	273	a	136	a	239	abc
20 SB	180	a	188	a	237	ab	201	a	239	a	178	a	198	c
20 BR	219	a	178	a	249	ab	146	bcd	257	a	147	a	235	abc
40 SP	194	a	179	a	233	ab	105	cd	268	a	134	a	244	abc
40 SB	170	a	173	a	245	ab	141	bcd	203	a	136	a	193	c
40 BR	208	a	168	a	233	ab	176	ab	245	a	134	a	238	abc
80 SP	195	a	161	a	187	b	100	d	203	a	136	a	269	ab
80 SB	228	a	161	a	234	ab	159	abc	257	a	159	a	188	c
80 BR	210	a	185	a	225	ab	156	abc	229	a	126	a	280	a

For each site, means followed by the same letter are not significantly different ( $p=0.05$ ). SP = seed placed P fertilizer; SB = side-banded P fertilizer; BR = broadcast P fertilizer.

Table 4b. 2014 Stand Counts (thousand plants/acre)						
Treatment	Roblin		Portage		St Adolphe	
Control	215	A	251	a	127	a
20 SP	194	A	159	abc	151	a
20 BR	193	A	237	ab	166	a
40 SP	216	A	155	bc	132	a
40 BR	169	A	218	abc	126	a
80 SP	194	A	125	c	126	a
80 BR	198	A	247	ab	147	a

For each site, means followed by the same letter are not significantly different ( $p=0.05$ ). SP = seed placed P fertilizer; SB = side-banded P fertilizer; BR = broadcast P fertilizer.

Table 5. 2014 Midseason Biomass (R3 stage) Dry Matter (lb/ac)														
Treatment	Carman		Roseisle		Carberry		Melita		Arborg		Beausejour		Brandon	
Control	3756	a	2114	a	3772	a	2690	a	3174	a	2781	a	2060	a
20 SP	3044	a	2627	a	2725	a	3229	a	3078	a	2598	a	2136	a
20 SB	3503	a	2131	a	4467	a	3529	a	3181	a	3134	a	2183	a
20 BR	3613	a	2341	a	3683	a	3392	a	3909	a	2958	a	2293	a
40 SP	3496	a	2076	a	2931	a	3280	a	3911	a	3158	a	2557	a
40 SB	4029	a	2346	a	3975	a	3254	a	3385	a	3323	a	2171	a
40 BR	3348	a	2171	a	3624	a	2555	a	3514	a	2667	a	2069	a
80 SP	3096	a	2355	a	3266	a	2512	a	3822	a	2190	a	1857	a
80 SB	3895	a	2693	a	3962	a	3238	a	3871	a	3146	a	2601	a
80 BR	4654	a	2511	a	3623	a	2894	a	3460	a	3501	a	2010	a

For each site, means followed by the same letter are not significantly different ( $p=0.05$ ). SP = seed placed P fertilizer; SB = side-banded P fertilizer; BR = broadcast P fertilizer.



Table 6a. 2014 Seed Yield (bu/acre)

2014 Seed Yield (bu/acre)														
Treatment	Carman		Roseisle		Carberry		Brandon		Melita		Arborg		Beausejour	
Control	53	a	32	a	43	A	17	ab	52	a	52	a	36	a
20 SP	53	a	38	a	47	A	19	ab	51	a	53	a	37	a
20 SB	52	a	33	a	50	A	20	ab	56	a	53	a	34	a
20 BR	54	a	35	a	49	A	18	ab	50	a	55	a	35	a
40 SP	52	a	40	a	45	A	18	ab	50	a	54	a	34	a
40 SB	52	a	38	a	51	A	20	ab	54	a	55	a	37	a
40 BR	53	a	37	a	46	A	19	ab	49	a	49	a	35	a
80 SP	49	a	35	a	42	A	14	b	47	a	54	a	34	a
80 SB	54	a	36	a	48	A	21	a	48	a	57	a	36	a
80 BR	50	a	39	a	49	A	20	ab	53	a	51	a	37	a

For each site, means followed by the same letter are not significantly different ( $p=0.05$ ). SP = seed placed P fertilizer; SB = side-banded P fertilizer; BR = broadcast P fertilizer.

Table 6b. 2014 Seed Yield (bu/acre)

2014 Seed Yield (bu/acre)										
Treatment	Portage		St Adolphe		Roblin					
Control	60	a	31	a	35	a				
20 SP	55	a	31	a	30	a				
20 BR	61	a	32	a	33	a				
40 SP	55	a	31	a	32	a				
40 BR	59	a	35	a	30	a				
80 SP	50	a	26	a	28	a				
80 BR	58	a	35	a	31	a				

For each site, means followed by the same letter are not significantly different ( $p=0.05$ ). SP = seed placed P fertilizer; SB = side-banded P fertilizer; BR = broadcast P fertilizer.

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## Appendices

Contact WADO to see copy of Appendices.

# Secan Soybean Variety Trial

## Cooperators

- Secan Seeds – Brad Pinkerton

## Objective

To grow and compare varieties in prospect for distribution by Secan Seeds against industry standard varieties.

## Introduction

The success of soybean varieties during their northwesterly expansion on the prairies is dependent on early maturity, and most importantly, yield potential. This trial focused on maturity and yield potential in comparison to other varieties currently on the market suited for the region. Secan brought several varieties to the trial that were not available in the traditional MCVET trials. Two sites were devoted to this trial, one in the Melita area and another at the Crandall site.

## Methods

Soil tests were taken prior to seeding the plots to determine background nutrient profiles. Trials were air seeded into a Waskada loamy fine sand in Melita and a Newdale Clay Loam in Crandall. Plots were direct seeded into winter wheat stubble in Melita and burned spring wheat stubble in Crandall.

### Soil Test Melita NE 26-3-27 W1

		N	P	K	S	salts
Depth	pH	ppm	Olsen ppm	ppm	#/ac	mmhos/cm
0-6"	7.5	1.5	7	427	14	0.36
6-24"		9			50	

### Soil Test Hamiota SE35-14-25 W1

		N	P	K	S	salts
Depth	pH	ppm	Olsen ppm	ppm	#/ac	mmhos/cm
0-6"	7	7	16	337	10	0.29
6-24"		11			19	

Eight glyphosate tolerant soybean varieties were seeded into plots arranged in a randomized complete block design and replicated three times. A pre-seeding burnoff was required at the Melita site (Heat 10 g, Aim 15 ml, and Credit 1 l/ac). The Hamiota site was burned prior to seeding due to heavy wheat stubble residue. Plots in Melita were seeded May 23<sup>rd</sup> and at Hamiota on June 3<sup>rd</sup>, both at a depth of ½". Final plot dimension was 1.44 m wide by 9 m long. Seed was inoculated with a granular soybean inoculant applied at 5 lbs/ac (Becker Underwood) with the seed furrow. Fertilizer was side band at a

rate of 200 lbs/ac granular blend 12-17-15-10 and granular soybean inoculant (Tag Team Soy, Novozymes) applied at 5 lbs/ac with the seed. Soybean plots were rolled with a land roller just after seeding. The Melita site received applications of Roundup Transorb @.33 L/ac on June 16<sup>th</sup> and June 24<sup>th</sup>, as well as a spot treatment of Basagran Forte on volunteer canola at 0.91 L/ac. On June 24<sup>th</sup> the Hamiota site was sprayed with Roundup Transorb @0.33 L/ac. Plots were harvested for seed yield on October 10<sup>th</sup> at Melita and October 15<sup>th</sup> at Hamiota with a Hege 140 plot combine. Data collected included days to maturity, height, lodging, seed yield, and seed moisture content. Data was analyzed with a two-way analysis of variance (ANOVA) Microsoft Analyze-it v2.03 statistical software with using a Fishers unprotected LSD.

## Results

### Melita

There were significant differences in days to maturity, and seed weight in Melita at the 0.05 level of significance (Table 1). There were significant differences in grain yield at the 0.1 level of significance. There were no differences in green seed as most varieties were able to mature before the first hard fall frost on October 4<sup>th</sup>.

**Table 1:** Varieties of soybean days to maturity (DTM), final yield, percent green seed, and seed weight in Melita, MB.

Variety	DTM days	Yield kg/ha	Green Seed %	Seed Weight g/1000 seeds
004R21	126	3760	0	154
Chadburn R2	128	3103	2	157
Dekalb 23-10RY	122	2992	1	177
Hero R2	125	4001	0	161
McLeod R2	124	3372	1	177
Pekko	125	3355	1	152
SC12-997R2	123	2973	0	158
SC2350R2	125	3265	0	162
R-squared	0.69	0.57	0.43	0.68
CV%	1.4	12.7	153	5.1
LSD (p<0.05)	3	-	-	14
LSD (p<0.10)	-	611	-	-
P value	0.028	0.098	0.305	0.012
Significant? (95% confidence)	Yes	No	No	Yes
Significant? (90% confidence)	Yes	Yes	No	Yes

## Crandall

There were significant differences in plant height, sample moisture, green seed and seed weight in Crandall at the 0.05 level of significance (Table 2). There were significant differences in pod height at the 0.1 level of significance but not grain yield.

**Table 2:** Varieties of soybean height, days to maturity, and final yield in the Secan soybean variety trial in Crandall, MB

Variety	Plant HT cm	Pod HT cm	Moisture %	Yield kg/ha	Green Seed %	Seed Weight g/1000
004R21	79	7	15.8	2405	63	133.3
Chadburn R2	77	8	16.1	2065	57	137.9
Dekalb 23-10RY	70	5	13.0	2521	9	147.7
Hero R2	80	6	15.3	2231	20	113.1
McLeod R2	83	9	15.7	2215	19	147.0
Pekko	80	10	13.2	2198	48	114.7
SC12-997R2	81	9	14.3	2238	3	116.6
SC2350R2	73	8	14.8	2784	9	140.7
R-squared	0.6	0.6	0.8	0.5	0.88	0.86
CV%	6	22	6.7	13	38	6
LSD (p<0.05)	8	NS	1.7	NS	19	13
LSD (p<0.10)	-	2	-	NS	-	-
P value	0.050	0.072	0.011	0.158	<0.0001	<0.0001
Significant? (95% confidence)	Yes	No	Yes	No	Yes	Yes
Significant? (90% confidence)	Yes	Yes	Yes	No	Yes	Yes

## *Discussion*

### Melita

Almost all varieties matured prior to fall frosts in Melita. Some of the later maturing varieties came rather close to the fall frost. Some of the earlier maturing varieties such as Dekalb 23-10RY and SC12-997R2 may not have yielded as well as some of the other later maturing varieties due to their ability to mature prior to the absolute potential of the full season being utilized. That is, the later the maturity the greater the ability of that variety to fully use all of the crop heat units provided to improve yield over early maturing varieties.

A producer picking varieties for the next growing season should still consider an early variety rather than a later higher yielding variety since the final CHU of the season was 106% (from Seed date to Fall frost) above the normal 2498 CHU.

## Crandall

Unfortunately maturities were not taken in Crandall. This site received only 103% of the normal 2121 CHU between the time of seeding and the first fall frost. There were visual differences noted in most varieties prior to the fall frost (October 3<sup>rd</sup>), primarily in early state of maturity (brown pod stages); however, no observation data was recorded. This would have been useful to correlate maturity date with percent green seed.

It is common not to have differences in grain yield among varieties when soybeans are grown in northern climates. (Glenn et al. 2011-2013) Often if varieties are not truly suited in terms of crop heat units for the climate the variety is grown in, they will not reach their full potential. By observation, WADO has only seen yield differences among varieties when the heat unit rating in varieties themselves has been different or when the season has been quite warm.

This trial location in Crandall in comparison to Melita might suggest that only a handful of the varieties might be truly suited for production this far north simply based on percent green seed. Those varieties would include Dekalb 23-10RY, SC12-997R2 and SC2350R2. Most all the varieties in Melita matured properly

## *References*

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**Photo:** Secan variety trial plots at Melita, photo taken August 8, 2014.

# Influence of Planting Date and Soil Temperature on Soybean in Manitoba

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## *Introduction*

As soybean acres have increased dramatically in Manitoba over the past decade, there are many new soybean growers, especially in the western half of the province. Growers in Manitoba face short seeding windows due to late spring thaws and short growing seasons, making it difficult to establish a vigorous plant stand in the spring and then subsequently harvest the crop before a fall frost. Growers currently time their seeding practices based on recommendations from research conducted in the United States or other Canadian provinces such as Ontario. Thus soybean research specific to Manitoba is required to validate optimum seeding practices.

The first objective of this study is to determine the most optimal date and soil temperature to plant soybeans in Manitoba and to confirm if the current recommendations from previous research holds true for Manitoba. Current soybean seeding recommendations for Manitoba indicate that soil temperature must be at least 10°C for 24 hours before planting with the recommended calendar date range from May 15 to May 25 (MAFRD, 2014). The second objective of this study is to determine what challenges and benefits could be expected by seeding earlier or later than the current recommendation for Manitoba. It is hypothesized that (i) later planting dates will result in more rapid emergence and better stand establishment, (ii) earlier planting dates will result in higher yields due to longer growing seasons and seed-filling periods, and (iii) a balance between optimized plant growth and seed yield will be achieved for intermediate soil temperatures at planting. Funding for this project has been provided by the Western Grains Research Foundation (WGRF) and Agriculture and Agri-Food Canada (AAFC) through the AgriInnovation Program. This report summarizes findings from the first year of the experiment. The experiment will continue in 2015.

## *Treatments and Experimental Design*

The sites selected for this experiment are the Westman Agricultural Diversification Organization (WADO) research site in Melita, Manitoba and the Ian N. Morrison Research Farm in Carman, Manitoba for 2014 and 2015. This report represents the results from the Melita site in 2014. The experimental design is a randomized complete block design with four replicates. The experimental treatments (Table 1) consist of one early- (Dekalb 23-10RY) and one late-maturing soybean variety (Dekalb 25-10RY) both of which are commonly grown cultivars in Manitoba. The varieties were seeded at six soil temperatures: 6, 8, 10, 12, 14 and 16°C with the corresponding calendar dates recorded. Soil sensors were planted at a 5 cm depth with soil temperature and moisture information recorded on data loggers (Decagon Devices Inc., Pullman, WA). Soybeans were seeded at the rate of 180,000 seeds per acre, adjusted for seed lot germination, with both granular and liquid inoculants applied at the recommended rate. Heat and

glyphosate were used for pre-emergent weed control, with only glyphosate for post-emergent weed control.

**Table 1:** Actual soil temperatures and seeding dates in 2014 according to target soil temperatures for both early and late-maturing varieties.

Target Soil Temperature (°C)	Actual Soil Temperature (°C)	Seeding Date
6	5.2	May 13
8	8.1	May 21
10	13.6	May 23
12	15.2	May 26
14	15.1	May 28
16	16.3	June 11

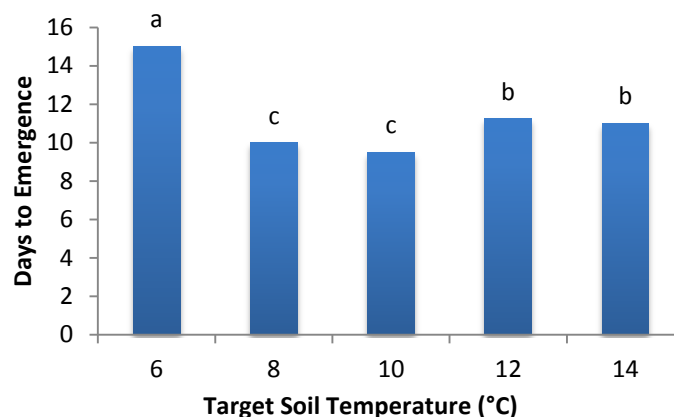
Seeding dates occurred when the target temperature was reached at 10:00 am for at least two consecutive days.

### **Measurements**

Measurements conducted for this study include days to emergence, plant populations, plant branching, biomass, plant and pod height, days to maturity, oil and protein content, seed size, test weight, and yield. Plant populations were determined by counting plants per 1 metre of row for each plot at 2, 3, 4, and 5 weeks after emergence, and at harvest. Soybean branching counts and biomass collection took place at the R5 stage once the plants reached maximum branching and biomass. Plants were cut for biomass from two 1-metre lengths then oven dried and weighed. Plant and pod height measurements took place at the R8 stage after leaf loss just prior to harvest. Heights were measured for 3 plants randomly within each plot. Days to maturity were determined by recording physiological maturity dates. Physiological maturity was reached once 95% of pods were brown on individual plants, and across plot area on average. All plots were harvested on October 17, 2014. Yield data is not available for this study site in 2014. All measurements will be repeated for 2015 with the addition of pod and seed counts per plant prior to harvest.

### **Results**

Statistical analyses were conducted using the mixed model procedure of the SAS package (SAS Institute, 2002-2012). Analysis of variance (ANOVA) was used to compare means of the soil temperature and varietal treatments. Due to cool spring conditions, the earliest seeded treatment (target soil temperature of 6°C) took the longest to emerge compared to other seeding dates (Figure 1). The most rapid emergence occurred for the 8 and 10°C treatments; however, days to emergence increased again for the 12 and 14°C treatments, likely due to a change in weather conditions. Figure 1 shows significant differences in days to emergence between soil temperature treatments for 2014 (Figure 1).



**Figure 1:** Average days to emergence for soybeans seeded on 6 different planting dates at targeted soil temperatures averaged across early- and late-maturing soybean varieties in Melita in 2014.

To compare differences in growth characteristics for soybeans seeded on different dates, plant variables such as main stem branching, plant height and pod height were measured. No significant differences were found for these growth characteristics, which were similar regardless of planting date.

**Table 2:** Protein and oil content for 6 different planting dates at targeted soil temperatures averaged across early- and late-maturing soybean varieties in Melita in 2014.

Target Soil Temperature (°C)	Protein (%)	Oil (%)
6	39.9 cd	20.4 a
8	39.6 d	20.2 a
10	40.2 c	20.1 a
12	40.9 b	19.0 b
14	40.4 bc	18.8 b
16	41.5 a	18.1 c

Means followed by the same letter are not significantly different ( $P = 0.05$ ).

Seed quality variables such as protein and oil content, seed size and test weight were measured in 2014 to detect differences between planting dates and early versus late-maturing varieties. The main determining factor for protein content (%) in this study was soil temperature or planting date. Protein increased with later planting dates and was higher for the later maturing variety, as expected (Table 2). The expected opposite trend can be seen for oil content with a decrease in oil as planting date is delayed (Table 2). Significant varietal differences were also observed for protein and oil, in which the early-maturing variety was higher. Only varietal differences in seed size and test weight occurred for 2014, in which seed size and test weight were both significantly higher for the late-maturing variety. Yield data is not available for this study site in 2014.

Potential outcomes of this research include: 1) identifying the most optimal dates and soil temperatures for planting soybeans in Manitoba, and 2) update extension materials for growers to have access to this



information. Overall, this research is intended to provide growers with current soybean seeding recommendations relevant to Manitoba growing conditions and cultivars, and in turn achieve the best economic return from their soybean crop.



**Photo:** Plots of soybean planted at different soil temperatures (dates) at Melita in 2014. Obvious maturity differences influenced from the various seeding dates and varieties used.

## Effects of Genetic Sclerotinia Tolerance and Foliar Fungicide Applications on the Incidence and Severity of Sclerotinia Stem Rot Infection in Argentine Canola (CARP-SCDC-2013-16)

2014 Annual Project Report for the **SASKATCHEWAN CANOLA DEVELOPMENT COMMISSION (SASKCANOLA)**

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## **Abstract / Executive Summary**

A three year field study was initiated at five locations in 2013 to evaluate the merits of genetic tolerance and foliar fungicide applications for reducing sclerotinia stem rot infection in Argentine canola (*Brassica napus*) under field conditions. A secondary objective was to determine if, and under what conditions, foliar fungicide applications might be required when growing a cultivar with genetic tolerance to this important disease. The locations were Indian Head, Melfort and Outlook in Saskatchewan and Brandon and Melita in Manitoba. Environmental conditions, subsequent disease levels and canola yields varied widely across site-years; however, in general, sclerotinia pressure was low to moderate and treatment effects to date are fairly subtle. Under these conditions, disease levels were frequently lower for the tolerant hybrid 45S54 relative to 45H29. While foliar fungicides tended to provide less consistent benefits with the tolerant hybrid, the results are not necessarily conclusive. At locations where disease was observed, foliar fungicides reduced sclerotinia incidence but only significantly increased seed yields for 45H29 at Melita in 2013 according to the overall F-tests. Similar trends were observed at both Brandon in 2013 and, to a lesser extent, Indian Head in 2013. At Outlook in 2014, fungicides increased yield with 45S54 but, unexpectedly and difficult to explain, not 45H29. There was no evidence of any yield increases with fungicide at Outlook in 2013, Melfort in either year or Indian Head in 2014. The data from Indian Head in 2014 will likely have to be excluded from the final, combined analyses as the plots were severely damaged by flooding in June and, with substantially delayed maturity, fall frost injury. There has been no evidence of any benefits to a dual fungicide application over a single application; however, this may not be the case under extremely higher disease pressure. Field trials will be conducted at all five locations again in 2015, the final growing season of the study.

## **Background / Introduction**

Sclerotinia stem rot causes significant yield loss for canola in western Canada each year; however, the degree to which this disease affects individual fields is highly variable depending on the specific environmental and weather conditions encountered. For example, in 2011 a total of 241 canola fields were surveyed (Dokken-Bouchard et al. 2012) and it was found that 81% of the crops surveyed were affected by sclerotinia; however, the actual percent incidence ranged from 0-91% and averaged 9.4%. In 2012, sclerotinia stem rot was observed in 91% of fields surveyed with incidence ranging from 0-95% but a provincial average of 19.0% (Miller et al. 2013). In 2013, sclerotinia pressure was substantially lower with the disease occurring in 60% of fields surveyed, incidence ranging from 1-8% among regions and 5% province-wide average (Miller et al. 2014). With respect to seed yield, a crude rule of thumb is that approximately 0.5% of yield may be lost for every 1% of infected plants; however, the actual impacts of sclerotinia incidence on yield may vary (Del Rio et al. 2007). At low levels of disease (i.e. 5% or lower), sclerotinia incidence does not generally impact canola yields, likely a result of the plant's ability to compensate provided that the pressure is not too high (Del Rio et al. 2007; Kutcher and Malhi 2010).

Past research on reducing the impacts of sclerotinia in western Canada has looked at many factors with varying levels of success. With the adoption of reduced- and no-tillage systems, many growers have

expressed concerns over higher levels of crop residue resulting in increased disease and have considered burning and/or tillage as potential solutions. However, Kutcher and Malhi (2010) showed that burning could actually increase sclerotinia incidence and tillage had no effect on this disease, concluding that neither of these practices were effective or, considering the negative impacts on soil quality, desirable methods for managing sclerotinia. Similar research conducted at Melfort also concluded that tillage did not impact sclerotinia and, in addition, showed that crop rotation was not effective for reducing sclerotinia or the response to fungicide applications either (Kutcher et al. 2011). With respect to nitrogen fertility and landscape position, it makes sense that higher N rates would produce a denser canopy and greater chance of sclerotinia infection and that lower slope positions would retain more moisture thereby providing a better environment for disease to develop. However, while this can sometimes be the case, actual results are highly dependent on environmental conditions and strong healthy crops are also better able to defend against disease (Kutcher et al. 2005). Under low to moderate disease pressure, Brandt et al. (2007) observed a stronger yield response to fungicide at low seeding rates which, while somewhat counter intuitive, was possibly due to the extended flowering period allowing more time for infection to spread and for the disease to affect the crop. They (Brandt et al. 2007) also detected slightly higher levels with hybrid versus open-pollinated canola (possibly due to a denser canopy) and, as expected, lower disease levels when foliar fungicide was applied. The fact that sclerotinia stem rot, like most crop diseases, is difficult to manage using agronomic practices is largely attributable to the fact that, for the disease to develop, specific combinations of soil (pathogen), weather and crop conditions must be met.

Foliar fungicides have proven to be the most consistent and effective method of controlling sclerotinia stem rot in canola; however, in many regions of the Canadian Prairies, annual applications are unlikely to be economical over the long-term (i.e. Kutcher et al. 2005; Brandt et al. 2007; Kutcher et al. 2011). For example in 2012 at Indian Head, where disease pressure was severe, fungicide applications resulted in average yield increases of 19% in small plot trials; however, field scale trials completed at the same location over the past six seasons, have rarely shown economic benefits (Chris Holzapfel, unpublished data). Consequently, considerable resources have been invested towards developing practical methods of assessing the risk of sclerotinia in canola to help producers determine when and where fungicide applications are likely to be beneficial (McLaren et al. 2004). Petal tests to detect the overall level of inoculum present in a specific field have shown reasonably strong correlations with sclerotinia infection; however, results are affected by the timing of the petal collection and the 3-5 day turnaround for results is somewhat prohibitive (Turkington and Morrall 1993; McLaren et al. 2004). Risk assessment tables and weather-based risk models can also help producers make better informed decisions as to whether or not to spray, but the reliability of such approaches is hampered by our inability to accurately predict upcoming weather patterns on a site-specific basis (McLaren et al. 2004).

While significant variation in the susceptibility of individual cultivars has been previously documented (Bradley and Khot 2006), commercial cultivars that are considered tolerant to sclerotinia stem rot have only recently been introduced (Falak et al. 2011). Under severe disease pressure, these cultivars have exhibited at least a 50% reduction in sclerotinia relative to susceptible cultivars (Falak et al. 2011). It is important to note that sclerotinia tolerant canola hybrids can still be affected by the pathogen

responsible for this disease; however, the expectation is that tolerant hybrids will exhibit fewer symptoms and reduced yield loss compared to susceptible hybrids under the same conditions. When this study was initiated, Dupont-Pioneer had the only commercially available sclerotinia tolerant hybrids; however, since that time, competitive cultivars have been introduced (i.e. L160S, Bayer CropScience). If reliable, genetic sclerotinia tolerance could provide a first line of defense that might appeal both to growers in regions where high disease pressure has made annual fungicide applications commonplace and those in regions where infection levels and response to fungicide are more variable and difficult to predict. Because sclerotinia infection is not eliminated in tolerant cultivars, conditions will likely exist where foliar fungicide applications are still desirable and economically advantageous. In addition, combining tolerant hybrids with foliar fungicides may help minimize the potential for pathogens to develop resistance – experience has shown that relying heavily on any single technology can be risky and unsustainable. This project aims to enhance our current understanding of the benefits and limitations that might be expected with both genetic tolerance and foliar fungicide applications.

## Objectives

The specific objectives of this study are:

- 1) To evaluate the effectiveness of current genetic sclerotinia tolerance and foliar fungicide applications for reducing sclerotinia stem rot infection in Argentine canola under field conditions.
- 2) To determine if, and under what conditions, foliar fungicide applications may be required when growing a hybrid with genetic tolerance to sclerotinia.

## Materials & Methods

Field trials were initiated in 2013 at three locations in Saskatchewan and two in Manitoba. Two of the locations had access to irrigation and all of the locations were considered to be at least a moderate risk for sclerotinia in canola based on their typical climates. The locations were Indian Head, SK (50°33'N 103°39'W), Melfort, SK (52°50' N 104°35'), Melita MB (49°17' N 101°00'), Outlook, SK (51°28' N 107°03') and Brandon, MB (49°52' N 99°58'). The plots at Outlook and Brandon received frequent, light irrigation through flowering to create conditions more favourable for disease development at these locations. Canola at Indian Head, Melfort and Melita did not receive supplemental irrigation and the soil / plants were not inoculated with *Sclerotinia sclerotiorum* at any locations except Brandon in 2014 where the site was inoculated with 107 viable sclerotia m<sup>-2</sup>.

The treatments were a factorial combination of A) two canola hybrids and B) four fungicide treatments for a total eight entries. The hybrids were: 1) 45H29 RR (susceptible) and 2) 45S54 RR (tolerant) and the foliar fungicide treatments were: 1) untreated check, 2) fungicide applied at 20% bloom, 3) fungicide applied at 50% bloom and 4) fungicide applied at both crop stages. The treatments were arranged in a Randomized Complete Block Design (RCBD) with four replicates.

## Canola Hybrid and Foliar Fungicide Treatments

### *A. Canola Hybrid*

1) 45H29 (susceptible)

2) 45S53 (tolerant)

### *B. Foliar Fungicide Treatment*

1) Check (no fungicide)

2) Early (246 g Boscalid ha<sup>-1</sup> at 20% bloom stage)

3) Late (246 g Boscalid ha<sup>-1</sup> at 50% bloom stage)

4) Dual (full rate of fungicide at both stages)

Both hybrids were glyphosate tolerant (Roundup Ready®) and the seeding rates were adjusted for seed size to target 125 viable seeds m<sup>-2</sup>. Seed from the same source was used at all locations with a slightly higher rate chosen to promote dense crop canopies conducive to disease development. Tillage systems and seeding equipment varied across locations with trials established on either fallow or cereal stubble and managed under no-till, reduced tillage or conventional tillage cropping systems (Tables 1 and 2). Row spacing ranged from 20-30 cm and nitrogen (N) fertilizer was either side-banded or broadcast and incorporated prior to seeding (Outlook). In 2014, two sites (Brandon and Outlook) had to be reseeded due to poor initial establishment – no fertilizer was applied during the second seeding operation. Fertilizer sources were granular urea, monoammonium phosphate, potassium chloride and ammonium sulphate and the rates varied with site but were intended to be non-limiting and balanced. Canola was swathed, pushed or straight-combined depending on crop condition and the specific field equipment available at each location. Weed control was achieved with tillage and/or pre-emergent herbicides applications combined with either one or two in crop of glyphosate. Pertinent agronomic details along with dates of field operations and data collection activities are provided in Tables 1 and 2.

The response data collected from each plot included spring plant density (to assess overall stand density and variability), mean disease incidence (% MDI), mean disease severity (0-5 MDS), seed yield, seed weight and percent green seed. Plant densities were determined by counting two separate 1 meter sections of crop row per plot approximately 4 weeks after planting and converting the mean values to plants m<sup>-2</sup>. At the sites where sclerotinia was observed, a total of 100 plants per plot were rated on a scale of 1-5 (Kutcher and Wolf 2006). The values derived from these ratings were percent incidence of infected plants (MDI) and the overall mean disease severity rating for the entire plot (MDS). The rating scale is described in Table 9 of the Appendices. Yields were determined from the harvested seed samples and are expressed as kg ha<sup>-1</sup> on a clean seed basis and corrected to a uniform seed moisture content of 10%. Seed weight was determined by weighing and counting 1000-2000 seeds using automated seed counters and calculating g 1000 seeds<sup>-1</sup> for each plot. Percent green seed was determined by crushing 200-500 seeds per plot and counting the number of distinctly green seeds. Seed size and percent clean seed were not measured at Melfort in 2013 and plant densities were not measured at Melita in 2014.

At this stage of the study, response data were analysed using a separate Mixed model for each location with the effects of hybrid (HYB), fungicide treatment (FUNG) and their interaction (HYB x FUNG)

considered fixed and replicate considered random. Least squares means were separated using Fisher's protected least significant difference (LSD) test. Single degree-of-freedom contrasts were used to more closely evaluate fungicide effects on the individual (susceptible and tolerant) hybrids and to determine whether there were any significant benefits to dual over single foliar fungicide applications. All treatment effects and differences between means were declared significant at  $P \leq 0.05$ .



**Table 1:** Dates of selected field operations and data collection activities completed in SaskCanola sclerotinia study at various locations in 2013.

Field Operation / Data Collection	Indian Head	Melfort	Outlook	Brandon	Melita
Previous Crop / Tillage System	Spring Wheat / Zero-Tillage	Spring Wheat / Zero-Tillage	Spring Wheat / Reduced Tillage	Fallow / Conventional Tillage	Oat / Zero-Tillage
Pre-Emergent Herbicide	May 17	May 22	May 13	May 24 (cultivation only)	n/a
Seeding Date	May 16	May 23	May 16	May 24	May 16
Row Spacing	31 cm	20 cm	25 cm	20 cm	24 cm
Fertility (kg N-P <sub>2</sub> O <sub>5</sub> -K <sub>2</sub> O-S ha <sup>-1</sup> )	130-35-18-18	60-20-10-10	82-20-15-0	0-0-0-0 <sup>z</sup>	113-34-0-0
Emergence Counts	June 27	June 28	June 7	June 7	June 10
In-crop Herbicide 1	June 12 (440 g glyphosate ha <sup>-1</sup> )	June 24 (667 g glyphosate ha <sup>-1</sup> )	June 18 (667 g glyphosate ha <sup>-1</sup> )	June 11 (667 g glyphosate ha <sup>-1</sup> )	June 12 (445 g glyphosate ha <sup>-1</sup> )
In-crop Herbicide 2	June 27 (440 g glyphosate ha <sup>-1</sup> )	n/a	n/a	n/a	n/a
Foliar Fungicide 1	July 4	July 9	July 2	July 2	July 2
Foliar Fungicide 2	July 9	July 12	July 4	July 8	July 8
Sclerotinia Ratings	August 21-22	August 27	August 20	August 27	August 14
Swathing	n/a	n/a	August 27	August 26 <sup>y</sup>	August 15
Combining	September 16	September 12	September 6	October 3	September 3

n/a – not applicable / available

<sup>z</sup> Soil test residual nutrients exceeded estimated crop requirements – fertilizer was not applied at this site

<sup>y</sup> Canola was pushed as opposed to swathed

**Table 2:** Dates of selected field operations and data collection activities completed in SaskCanola sclerotinia study at various locations in 2013.

Field Operation / Data Collection	Indian Head	Melfort	Outlook	Brandon	Melita
Previous Crop / Tillage System	Spring Wheat / Zero-Tillage	Spring Wheat / Zero-Tillage	Spring Wheat / Reduced Tillage	Fallow / Conventional Tillage	Oat / Zero-Tillage
Pre-Emergent Herbicide	May 17	May 22	May 13	May 24 (cultivation only)	n/a
Seeding Date	May 16	May 23	May 16	May 24	May 16
Row Spacing	31 cm	20 cm	25 cm	20 cm	24 cm
Fertility (kg N-P <sub>2</sub> O <sub>5</sub> -K <sub>2</sub> O-S ha <sup>-1</sup> )	130-35-18-18	60-20-10-10	82-20-15-0	0-0-0-0 <sup>z</sup>	113-34-0-0
Emergence Counts	June 27	June 28	June 7	June 7	June 10
In crop Herbicide 1	June 12 (440 g glyphosate ha <sup>-1</sup> )	June 24 (667 g glyphosate ha <sup>-1</sup> )	June 18 (667 g glyphosate ha <sup>-1</sup> )	June 11 (667 g glyphosate ha <sup>-1</sup> )	June 12 (445 g glyphosate ha <sup>-1</sup> )
In crop Herbicide 2	June 27 (440 g glyphosate ha <sup>-1</sup> )	n/a	n/a	n/a	n/a
Foliar Fungicide 1	July 4	July 9	July 2	July 2	July 2
Foliar Fungicide 2	July 9	July 12	July 4	July 8	July 8
Sclerotinia Ratings	August 21-22	August 27	August 20	August 27	August 14
Swathing	n/a	n/a	August 27	August 26 <sup>y</sup>	August 15
Combining	September 16	September 12	September 6	October 3	September 3

n/a – not applicable / available

<sup>z</sup> Soil test residual nutrients exceeded estimated crop requirements – fertilizer was not applied at this site

<sup>y</sup> Canola was pushed as opposed to swathed



**Table 3:** Dates of selected field operations and data collection activities completed in SaskCanola sclerotinia study at various locations in 2014.

Field Operation / Data Collection	Indian Head	Melfort	Outlook	Brandon	Melita
Previous Crop / Tillage System	Spring Wheat / Zero Tillage	Cereal / Zero Tillage	Spring Wheat / Reduced Tillage	Fallow / Conventional Tillage	Winter Wheat / Zero Tillage
Pre-emergent Herbicide	May 18	n/a	May 12	June 9	May 22
Seeding date	May 14	May 21	June 3 <sup>x</sup>	June 10 <sup>x</sup>	May 22
Row spacing	31 cm	20 cm	25 cm	20 cm	24 cm
Fertility (kg N-P <sub>2</sub> O <sub>5</sub> -K <sub>2</sub> O-S ha <sup>-1</sup> )	130-34-17-17	105-35-0-15	135-40-15-12	55-10-0-24	106-35-30-20
Emergence Counts	June 9	June 11	July 7	June 24	n/a
In crop herbicide 1	July 5 (667 g glyphosate ha <sup>-1</sup> )	June 17 (667 g glyphosate ha <sup>-1</sup> )	July 8 (440 g glyphosate ha <sup>-1</sup> )	July 3 (667 g glyphosate ha <sup>-1</sup> )	June 16 (440 g glyphosate ha <sup>-1</sup> )
In crop herbicide 2	n/a	n/a	n/a	n/a	n/a
Foliar fungicide 1	July 9	July 8	July 16	July 26	July 8
Foliar fungicide 2	July 12	July 10	July 20	July 30	July 11
Sclerotinia ratings	August 29 <sup>z</sup>	August 26	September 9	September 17-18	August 18
Swathing	n/a	n/a	September 15	September 26	Aug 29
Combining	October 8 October 19 <sup>y</sup>	September 9	September 24	October 16	September 3-5

n/a – not applicable / available

<sup>z</sup> Ratings only completed on replicate #1 due to delayed maturity and poor establishment in remaining replicates

<sup>y</sup> Replicate #1 combined on October 8 and replicates #3-4 combined on October 19 due to differences in maturity

<sup>x</sup> Reseeded due to poor establishment with initial seeding date

## Results and Discussion

### Weather conditions

Mean monthly temperatures and precipitation amounts for the 2013 and 2014 growing seasons (May-Aug) for each location are presented relative to the long-term averages (1981-2010) in Tables 3 and 4. Relative to the long-term average, temperatures varied widely across months and site-year. July, when sclerotinia stem rot infection is likely to occur, had relatively cool to normal temperatures; however, precipitation levels during this month were extremely variable ranging from 12-248%. When averaged across the four month growing season, mean temperatures ranged from 95-104% of average for the individual site-years while total precipitation ranged from 70-170%. Again, the sites at Outlook and Brandon received supplemental irrigation to maintain a moist crop canopy through flowering and pod filling in order increase potential disease development. Specific details of the irrigation schedule at Brandon are not available.

**Table 4:** Mean monthly temperatures relative to the long-term averages (1981-2010<sup>z</sup>) for the 2013 and 2014 growing season at each trial location.

Month	Year	Indian Head	Melfort	Outlook	Brandon	Melita
----- Mean Temperature (°C) -----						
May	2013	11.9 (110%)	12.0 (112%)	12.9 (109%)	10.8 (96%)	11.2 (105%)
	2014	10.2 (94%)	10.0 (94%)	10.8 (92%)	10.7 (96%)	11.6 (108%)
	LT	10.8	10.7	11.8	11.2	10.7
June	2013	15.3 (97%)	15.4 (97%)	15.9 (97%)	16.9 (102%)	17.0 (106%)
	2014	14.4 (91%)	14.0 (88%)	14.7 90%)	15.8 (96%)	16.6 (103%)
	LT	15.8	15.9	16.4	16.5	16.1
July	2013	16.3 (90%)	16.4 (94%)	17.5 (94%)	17.9 (94%)	18.7 (97%)
	2014	17.3 (95%)	17.5 (99%)	18.4 (99%)	17.9 (94%)	19.4 (101%)
	LT	18.2	17.5	18.6	19.1	19.3
August	2013	17.1 (98%)	17.7 (105%)	18.8 (105%)	18.2 (100%)	19.0 (103%)
	2014	17.4 (100%)	17.6 (105%)	18.2 (102%)	17.9 (98%)	19.2 (104%)
	LT	17.4	16.8	17.9	18.2	18.4
4-Month Average	2013	15.2 (97%)	15.4 (101%)	16.3 (101%)	16.0 (98%)	16.5 (102%)
	2014	14.8 (95%)	14.8 (97%)	15.5 (96%)	15.6% (96%)	16.7 (104%)
	LT	15.6	15.2	16.2	16.3	16.1

<sup>z</sup> Environment Canada 2013

**Table 5:** Mean monthly precipitation amounts relative to the long-term averages (1981-2010<sup>z</sup>) for the 2013 and 2014 growing season at each trial location.

Month	Year	Indian Head	Melfort	Outlook	Brandon	Melita
----- Total Precipitation (mm) -----						
May	2013	17.1 (33%)	18.0 (42%)	12.7 (30%) 0 <sup>y</sup>	58.6 (104%)	51.2 (83%)
	2014	36.0 (70%)	24.4 (57%)	81.2 (191%) 0	114.3 (203%)	104.7 (169%)
	LT	51.8	42.9	42.6	56.4	61.9
June	2013	103.8 (134%)	96.9 (179%)	73.5 (115%) 8	122.9 (156%)	78.4 (103%)
	2014	199.2 (257%)	169.8 (313%)	98.2 (154%) 19	143.5 (182%)	152.6 (200%)
	LT	77.4	54.3	63.9	78.8	76.4
July	2013	50.4 (79%)	100.0 (130%)	28.0 (50%) 75	60.4 (87%)	141.0 (248%)
	2014	7.8 (12%)	94.6 (123%)	28.4 (51%) 38	29.9 (43%)	40.7 (72%)
	LT	63.8	76.7	56.1	69.1	56.9
August	2013	6.1 (12%)	10.6 (20%)	28.8 (67%) 25	70.0 (110%)	24.0 (56%)
	2014	142.2 (277%)	60.4 (115%)	26.5 (62%) 25	69.3 (109%)	102.3 (237%)
	LT	51.2	52.4	42.8	63.4	43.2
4-Month Total	2013	177.4 (78%)	225.5 (100%)	143.0 (70%) 108	311.9 (117%)	294.6 (124%)
	2014	385.2 (170%)	349.2 (154%)	234.3 (114%) 82	357.0 (133%)	400.3 (168%)
	LT	226.3	226.3	205.4	267.7	238.4

<sup>z</sup> Environment Canada 2013

<sup>y</sup> Supplemental irrigation

### Crop Establishment

While fungicide treatments were not expected to affect emergence or plant populations, data were collected for explanatory purposes and were analysed in the same manner as the other response variables (Table 12, Appendices). Again, plant densities were measured in the late spring and therefore are not necessarily representative of the populations at harvest in all cases. Overall average plant densities ranged from as low as 42 plants m<sup>-2</sup> at Indian Head in 2014 to 159 plants m<sup>-2</sup> at Brandon in 2013. In most cases, populations were 40-65 plants m<sup>-2</sup> which was slightly lower than desired but still within the range generally required to reach optimum yield. At Indian Head in 2014, initial populations were relatively low as a result of heavy residues (i.e. poor seedbed conditions) and substantial flea beetle pressure. While the established populations were considered adequate, extensive injury to the

canola occurred as a result of prolonged wet conditions in June, when nearly 200 mm of precipitation was received. While all available results from Indian Head in 2014 are reported at this stage, it is recommended that data from this site be excluded from the final, combined analyses. Plant populations were affected by hybrid ( $P < 0.05$ ) 56% of the time (Table 12) with two cases where populations were higher with 45S54 and three where they were higher with 45H29. As expected, there were no cases where plant populations were affected by fungicide (FUNG) treatment ( $P = 0.289-0.986$ ) and there were no significant HYB  $\times$  FUNG interactions detected ( $P = 0.094-0.926$ ).

#### *Sclerotinia Incidence and Severity*

Again, mean disease incidence (MDI) and severity (MDS) were calculated from ratings (Kutcher and Wolfe 2006) completed on 100 plants per plot prior to maturity. At Outlook in 2013, the check plots for both varieties along with the T1 fungicide treatment for 45H29 were rated; however, disease levels averaged only 0.5-1.25% incidence so no further ratings were completed at this site. At Melita, the canola was inspected prior to swathing, but no disease symptoms were observed therefore detailed ratings were not completed at this site. At Melfort in 2013, ratings were completed for all plots but no disease was observed and, therefore, inferential statistical analyses were not possible or required for this site. At Indian Head in 2014, maturity was delayed, final plant populations were low and the crop was badly lodged. Ratings were completed on one replicate at this site but were not completed in the remaining replicates due to the extremely poor conditions of the remaining plots and subsequent frost injury. The overall tests of fixed effects for MDI (% of infected plants) at the sites where data could be analyzed are presented in Table 5 along with the treatment means. As an indicator of relative disease pressure across sites, MDI of the unsprayed 45H29 plots were 3.8% at Indian Head 2013, 7.0% at Indian Head 2014, 0.0% at Melfort 2013, 4.3% at Melfort 2014, 1.3% at Outlook 2013, 5.3% at Outlook in 2014, 21.5% at Brandon 2013, 5.8% at Brandon 2014 and 4.0% at Melita 2014.

Mean disease incidence was affected by hybrid at Melita in 2014 ( $P = 0.038$ ) but not at any remaining five sites where inferential statistics were possible ( $P = 0.099-0.659$ ). At Melita (2014), disease incidence was extremely low (1.4%) on average; however, at 1.8%, MDI in the tolerant hybrid (45H29) was significantly higher than for the susceptible hybrid (45S54) on average. In all other cases, while not significant at  $P \leq 0.05$ , the tendency was always for slightly lower MDI with the tolerant hybrid 45S54. Fungicide effects on MDI were significant at Indian Head in 2013 ( $P = 0.012$ ) and Melita in 2014 ( $P < 0.001$ ) and marginally significant at Outlook in 2014 ( $P = 0.094$ ). In all cases, incidence was highest in the check and there were none where MDI was significantly lower with a dual application versus a single application. The HYB  $\times$  FUNG interaction was significant at Brandon in 2013 ( $P = 0.039$ ) and, to a lesser extent, 2014 ( $P = 0.074$ ). In both of these cases, the interaction was such that fungicide appeared to be more beneficial for reducing MDI in the susceptible hybrid than with the tolerant hybrid. This was consistent with the contrast results (Table 6) where, averaged across timings, MDI was reduced with fungicides for 45H29 ( $P = 0.006-0.052$ ) but not for 45S54 ( $P = 0.147-0.327$ ) at Indian Head (2013), Outlook (2014) and Brandon (2013 and 2014). At Melita (2014), the contrasts indicated that MDI was reduced with fungicides for both hybrids ( $P < 0.001$ ). There were no cases where MDI was further reduced with a dual relative to a single application ( $P = 0.103-1.000$ ).

Tests of fixed effects for mean disease severity (MDS) are presented with treatment means for each site in Table 7. The results for MDS were largely a function of, and paralleled those for MDI. The overall effect of HYB was significant at Melita ( $P = 0.003$ ) and Brandon ( $P = 0.040$ ) in 2014 but not for any of the other sites where inferential statistics were applied ( $P = 0.093$ - $0.566$ ). Similar to MDI, MDS was higher for the tolerant hybrid 45S54 at Melita (2014); however, the opposite was true at Brandon (2014) and, in general, the trend was for MDS to be higher for 45H29. The main effect of FUNG on MDS was only significant at Indian Head in 2013 ( $P = 0.014$ ) and Melita in 2014 ( $P < 0.001$ ); however, the HYB  $\times$  FUNG interaction was significant at Brandon in both years ( $P = 0.039$ - $0.072$ ) and also at Melita in 2014 ( $P = 0.008$ ). In the cases where the FUNG effect was significant, MDI was higher in the untreated check but did not differ amongst the treatments where fungicide was applied. At Brandon, MDS was reduced with fungicide for 45H29 but not for 45S54. Focussing on the contrasts (Table 8), the overall mean reduction in MDI with fungicide was significant for 45H29 at Indian Head 2013 ( $P = 0.002$ ), Outlook 2014 ( $P = 0.020$ ) Brandon 2013 ( $P = 0.006$ ), Brandon 2014 ( $P = 0.0014$ ) but not for 45S54 at any of these four sites ( $P = 0.173$ - $0.363$ ). At Melita 2014, MDI was reduced with fungicide applications for both hybrids ( $P < 0.001$ ). Similar to percent incidence, there were no further reductions in MDS with a dual relative to the single applications at any sites ( $P = 0.102$ - $0.983$ ).

### Seed Yield

Tests of fixed effects and treatment means for seed yield are presented for each site in Table 9. Averaged across hybrids and fungicide treatments, yields across locations varied widely from as low as  $1039 \text{ kg ha}^{-1}$  at Indian Head in 2014 to as high as  $4424 \text{ kg ha}^{-1}$  at Melita in 2013. Again, the canola at Indian Head in 2014 was damaged by flooding in June and, with subsequently delayed maturity, yields were further reduced by frost in September. Canola HYB affected yield at Brandon in both years ( $P < 0.001$ ) and Melita in 2013 ( $P = 0.046$ ) but not at the remaining seven site-years ( $P = 0.090$ - $0.987$ ). In the cases where a difference was detected, 45H29 yielded 20-21% higher than 45S54 and 14% higher at Melita in 2013. With relatively low disease and/or other factors limiting yield at most sites, foliar fungicide did not affect seed yield in any cases ( $P = 0.150$ - $0.854$ ) when averaged across hybrids and there were no significant HYB  $\times$  FUNG interactions ( $P = 0.111$ - $0.950$ ). Despite the lack of a significant  $F$ -test, the contrast comparisons (Table 10) did detect a significant yield increase with fungicides (averaged across timings) for 45S54 at Outlook in 2014 ( $P = 0.031$ ) but, unexpectedly, no benefit with 45H29 ( $P = 0.560$ ). At Melita in 2013, the opposite occurred in that a yield increase with fungicide was detected for 45H29 ( $P = 0.047$ ) but not 45S54 ( $P = 0.637$ ). To a lesser extent, this also occurred at Brandon in 2013 where  $p$ -values resulting from the contrasts were notably lower for 45H29 ( $P = 0.116$ ) than for 45S54 ( $P = 0.946$ ); however, neither were significant at the desired probability level. Under low to moderate disease pressure, the results at Melita and Brandon in 2013 suggest that higher overall yields were achieved with fungicides for the susceptible hybrid but there was no benefit with the tolerant hybrid. The average yield gain with fungicide for 45H29 was 12% at Brandon and 24% at Melita. At Indian Head, there appeared to be a slight overall yield increase with fungicides ( $P = 0.010$ ); however, it was only 4% on average for 45H29 ( $P = 0.148$ ) and 2.5% for 45S54 ( $P = 0.365$ ). The lack of fungicide response at many of the sites was not necessarily unexpected considering that the observed levels of sclerotinia at the non-responsive sites were typically near or below 5% or yields were limited by factors other than

disease. There was no evidence within the contrasts to suggest that a dual fungicide application provided a yield benefit over a single application at any sites ( $P = 0.222$ - $0.994$ ).

#### Seed Weight and Percent Green Seed

Seed weight (g 1000 seeds<sup>-1</sup>) and percent green seed data were analyzed for all sites except Melfort in 2013 and the results are reported in the Appendices (Tables 13 and 14). Seed weight was affected by HYB at eight of nine site-years where, in all cases, seed weight was significantly higher for 45S54 than for 45H29 ( $P < 0.001$ - $0.004$ ). While not significant at the desired level, the same trend was observed at Melita ( $P = 0.080$ ). Fungicide treatment did not affect seed weight at any sites ( $P = 0.299$ - $0.987$ ) and the HYB x FUNG interaction was not significant in any cases ( $P = 0.067$ - $0.992$ ). While the  $F$ -test for the interaction was not significant ( $P = 0.134$ ), the contrasts did detect a significant increase in seed weight with fungicide for 45S54 at Outlook in 2014 ( $P = 0.035$ ; not shown). This was consistent with the observed effects on seed yield at that location.

Percent green seed was not affected by hybrid at any sites ( $P = 0.347$ - $1.000$ ) and was well below 2% at all except for Indian Head in 2014 where it was extremely high, averaging 23.8% (Table 14). Fungicide affected green seed content at three of nine site-years; Outlook in 2014 ( $P < 0.001$ ) and Brandon in both 2013 ( $P = 0.026$ ) and 2014 ( $P = 0.012$ ) with a HYB x FUNG interaction detected at Outlook in 2014 ( $P = 0.005$ ). In general, fungicide effects on percent green seed were inconsistent, difficult to explain, and of little agronomical consequence. The extremely high green seed content at Indian Head was due to the combination of delayed maturity and fall frost.

**Table 6:** Tests of fixed effects and least squares for mean disease incidence (MDI) in 2013 and 2014 SaskCanola sclerotinia trials. Least squares means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test;  $P < 0.05$ ).

Effect Variable	Indian Head		Melfort		Outlook		Brandon		Melita	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
----- Mean Disease Incidence (n/100) -----										
Hybrid (HYB)	0.230	— <sup>‡</sup>	—	0.659	— <sup>‡</sup>	0.503	0.135	0.099	— <sup>‡</sup>	0.038
Susceptible (S)	1.5 a	10.0	0.00	3.1 a	—	2.9 a	13.2 a	3.3 a	—	1.00 b
Tolerant (T)	0.8 a	3.0	0.00	2.8 a	—	2.3 a	9.7 a	1.9 a	—	1.75 a
Std. Error	0.61	—	—	0.58	—	1.00	4.94	0.73	—	0.24
Fungicide (FUNG)	0.012	—	—	0.660	—	0.094	0.531	0.324	—	<0.001
Untreated (UT)	2.75 a	6.0	0.00	3.3 a	—	4.6 a	13.6 a	3.4 a	—	5.00 a
20% bloom (T1)	1.63 ab	6.5	0.00	2.8 a	—	2.4 a	12.1 a	3.1 a	—	0.00 b
50% bloom (T2)	0.13 b	7.0	0.00	2.3 a	—	2.3 a	10.9 a	2.3 a	—	0.25 b
Dual App. (2X)	0.00 b	6.5	0.00	3.4 a	—	1.3 a	9.1 a	1.5 a	—	0.25 b
Std. Error	0.75	—	—	0.76	—	1.19	5.18	0.90	—	0.34
HYB x FUNG	0.661	—	—	0.446	—	0.638	0.039	0.074	—	0.211
S-UT	3.75	7.0	0.00	4.3	1.25	5.3	21.5 a	5.8 a	—	4.00
S-T1	2.00	10.0	0.00	2.3	0.50	1.8	12.3 ab	2.8 ab	—	0.00
S-T2	0.25	14.0	0.00	2.0	—	2.5	10.3 b	2.3 b	—	0.00
S-2X	0.00	9.0	0.00	3.8	—	2.3	8.8 b	2.3 b	—	0.00
T-UN	1.75	5.0	0.00	2.3	0.50	4.0	5.8 b	1.0 b	—	6.00
T-T1	1.25	3.0	0.00	3.3	—	3.0	12.0 b	3.5 ab	—	0.00
T-T2	0.00	0.0	0.00	2.5	—	2.0	11.5 b	2.5 b	—	0.50
T-2X	0.00	4.0	0.00	3.0	—	0.3	9.5 b	0.8 b	—	0.50
Std. Error	0.96	—	—	1.04	—	1.50	5.64	1.18	—	0.48
AICC	-108.9	—	—	-102.8	—	-87.5	-38.3	-31.1	—	-141.7

<sup>‡</sup>No or minimal symptoms of sclerotinia were observed at Outlook and Melita in 2013 and therefore intensive disease ratings were not completed. At Indian Head in 2014, ratings were only completed on one replicate due to variability in maturity and poor establishment. Disease rating data from Outlook (2013) and Indian Head (2014) was not statistically analyzed.

**Table 7:** Contrasts comparing selected treatment effects on mean disease incidence (n/100) in 2013 and 2014 SaskCanola sclerotinia trials.

Contrast	Indian Head		Melfort		Outlook		Brandon		Melita	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
	----- p-values -----									
UN vs TR (All)	0.006	—	—	0.576	—	0.020	0.255	0.248	—	< 0.001
UN vs TR (S)	0.006	—	—	0.180	—	0.052	0.006	0.014	—	< 0.001
UN vs TR (T)	0.193	—	—	0.566	—	0.147	0.174	0.327	—	< 0.001
1X vs 2X (All)	0.252	—	—	0.319	—	0.355	0.399	0.195	—	0.766
1X vs 2X (S)	0.297	—	—	0.194	—	0.938	0.533	0.852	—	1.000
1X vs 2X (T)	0.558	—	—	0.919	—	0.172	0.566	0.103	—	0.674



**Table 8:** Tests of fixed effects and least squares for mean disease severity (MDS) in 2013 and 2014 SaskCanola sclerotinia trials. Least squares means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test;  $P < 0.05$ ).

Effect Variable	Indian Head		Melfort		Outlook		Brandon		Melita	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
	----- Disease Severity (1-5) -----									
Hybrid (HYB)	0.178	— ‡	—	0.566	— ‡	0.396	0.352	0.040	— ‡	0.003
Susceptible (S)	0.062		0.00	0.033 a	—	0.093 a	0.432 a	0.460 a	—	0.010 a
Tolerant (T)	0.026		0.00	0.029 a	—	0.064 a	0.334 a	0.306 a	—	0.020 b
Std. Error	0.018	—	—	0.006	—	0.034	0.161	0.163	—	0.002
Fungicide (FUNG)	0.014		—	0.657	—	0.085	0.519	0.296 a	—	< 0.001
Untreated (UT)	0.111 a		0.00	0.035 a	—	0.155 a	0.485 a	0.103 a	—	0.055 a
20% bloom (T1)	0.063 ab		0.00	0.028 a	—	0.065 a	0.428 a	0.098 a	—	0.000 b
50% bloom (T2)	0.003 b		0.00	0.025 a	—	0.059 a	0.338 a	0.066 a	—	0.003 b
Dual App. (2X)	0.000 b		0.00	0.036 a	—	0.035 a	0.283 a	0.050 a	—	0.003 b
Std. Error	0.026		—		—	0.041	0.176	0.027	—	0.003
HYB x FUNG	0.437	—	—	0.378	—	0.583	0.039	0.072	—	0.008
S-UT	0.165		0.00	0.048	0.050	0.195	0.813 a	0.175 a	—	0.040 b
S-T1	0.078		0.00	0.023	0.025	0.040	0.408 ab	0.090 ab	—	0.000 c
S-T2	0.005		0.00	0.023	—	0.078	0.263 b	0.068 b	—	0.000 c
S-2X	0.000		0.00	0.040	—	0.058	0.245 b	0.080 b	—	0.000 c
T-UN	0.058		0.00	0.023	0.025	0.115	0.158 b	0.030 b	—	0.070 a
T-T1	0.048		0.00	0.033	—	0.088	0.448 ab	0.105 ab	—	0.000 c
T-T2	0.000		0.00	0.028	—	0.040	0.413 ab	0.065 b	—	0.005 c
T-2X	0.000		0.00	0.033	—	0.013	0.320 b	0.020 b	—	0.005 c
Std. Error	0.036		—	0.011	—	0.053	0.204	0.035	—	0.004
AICC	-44.6	—	—	-99.6	—	-26.4	30.9	-46.2	—	-144.3

‡No or minimal symptoms of sclerotinia were observed at Outlook and Melita in 2013 and therefore intensive disease ratings were not completed. At Indian Head in 2014, ratings were only completed on one replicate due to variability in maturity and poor establishment. Disease rating data from Outlook (2013) and Indian Head (2014) was not statistically analyzed.

**Table 9:** Contrasts comparing selected treatment effects on mean disease severity (1-5) in 2013 and 2014 SaskCanola sclerotinia trials.

Contrast	Indian Head		Melfort		Outlook		Brandon		Melita	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
	----- p-values -----									
UN vs TR (All)	0.003	—	—	0.538	—	0.014	0.264	0.231	—	< 0.001
UN vs TR (S)	0.002	—	—	0.132	—	0.020	0.006	0.014	—	< 0.001
UN vs TR (T)	0.281	—	—	0.504	—	0.221	0.173	0.363	—	< 0.001
1X vs 2X (All)	0.263	—	—	0.288	—	0.525	0.435	0.249	—	0.736
1X vs 2X (S)	0.314	—	—	0.192	—	0.983	0.617	0.974	—	1.000
1X vs 2X (T)	0.559	—	—	0.849	—	0.383	0.542	0.102	—	0.634

**Table 10:** Tests of fixed effects and least squares for seed yield at various locations in 2013 and 2014 SaskCanola sclerotinia trials. Least squares means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test;  $P < 0.05$ ).

Effect Variable	Indian Head		Melfort		Outlook		Brandon		Melita	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
	----- Seed Yield (kg ha <sup>-1</sup> ) -----									
Hybrid (HYB)	0.987	0.971	0.293	0.726	0.706	0.090	< 0.001	<0.001	0.046	0.998
Susceptible (S)	3596 a	1040 a	2241 a	1988 a	3885 a	2907 a	2346 a	4429 a	4717 a	1893 a
Tolerant (T)	3596 a	1037 a	2101 a	2016 a	3836 a	2791 a	1932 b	3684 b	4130 b	1893 a
Std. Error	67.1	320.0	247.1	55.2	90.3	68.5	168.1	246.6	208.5	163.8
Fungicide (FUNG)	0.413	0.626	0.551	0.860	0.854	0.344	0.150	0.632	0.693	0.765
Untreated (UT)	3510 a	1088 a	2245 a	1979 a	3836 a	2780 a	2044 a	4082 a	4150 a	1806 a
20% bloom (T1)	3619 a	1060 a	2060 a	2035 a	3856 a	2855 a	2012 a	3972 a	4478 a	1888 a
50% bloom (T2)	3635 a	1028 a	2285 a	2036 a	3803 a	2944 a	2311 a	4227 a	4603 a	1951 a
Dual App. (2X)	3620 a	979 a	2094 a	1960 a	3949 a	2816 a	2188 a	3943 a	4464 a	1927 a
Std. Error	78.5	322.9	263.7	78.1	127.7	82.7	182.1	272.6	286.8	178.9
HYB x FUNG	0.950	0.587	0.481	0.590	0.995	0.210	0.572	0.489	0.111	0.712
S-UT	3491	1033	2472	2047	3841	2954	2148	4371	4005	1806
S-T1	3609	1123	2005	2035	3905	2835	2313	4175	4554	1846
S-T2	3659	1012	2304	1959	3842	2966	2511	4696	5034	1901
S-2X	3627	991	2185	1914	3960	2872	2411	4472	5273	2019
T-UN	3530	1143	2018	1911	3838	2605	1940	3794	4294	1806
T-T1	3629	998	2115	2034	3813	2877	1710	3769	4367	1930
T-T2	3610	1043	2266	2114	3763	2923	2112	3758	4172	2000
T-2X	3614	966	2004	2006	3938	2760	1966	3414	3655	1835
Std. Error	97.4	328.6	294.1	110.4	180.3	105.4	207.1	318.5	400.0	204.9
AICC	332.7	345.1	375.2	340.4	332.5	338.0	316.7	352.2	387.2	300.1

**Table 11:** Contrasts comparing selected treatment effects on seed yield ( $\text{kg ha}^{-1}$ ) in 2013 and 2014 SaskCanola sclerotinia trials.

Contrast	Indian Head		Melfort		Outlook		Brandon		Melita	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
	----- p-values -----									
UN vs TR (All)	0.101	0.361	0.521	0.734	0.829	0.236	0.279	0.853	0.265	0.326
UN vs TR (S)	0.148	0.928	0.163	0.549	0.775	0.560	0.116	0.769	0.047	0.501
UN vs TR (T)	0.365	0.172	0.608	0.285	0.975	0.031	0.946	0.589	0.637	0.468
1X vs 2X (All)	0.925	0.392	0.630	0.436	0.441	0.306	0.826	0.459	0.826	0.948
1X vs 2X (S)	0.937	0.476	0.893	0.544	0.687	0.806	0.994	0.895	0.324	0.384
1X vs 2X (T)	0.957	0.614	0.418	0.618	0.488	0.231	0.750	0.274	0.222	0.461

## *Summary and Conclusions*

Overall, sclerotinia stem rot pressure in canola has been considered low to moderate at the study sites to date and any treatment effects that were detected have been relatively subtle. There were, however, cases with evidence of less disease and reduced benefits to foliar fungicide applications when a sclerotinia tolerant hybrid was grown. At Indian Head in 2013, the disease ratings indicated slightly but not significantly lower infection in the tolerant canola hybrid 45S54 compared to 45H29 and a greater reduction in disease with fungicide in the susceptible hybrid than with 45S54. At Brandon in 2013 and, to a lesser extent, 2014, while hybrid effects on MDI and MDS were not significant, disease tended to be lower for 45S54. Again, fungicides appeared to be more beneficial with 45H29 in both cases. At Outlook in 2013, disease levels were considered too low to be of agronomic significance and were not statistically analyzed, but did appear to be lower in the tolerant variety and with foliar fungicide. In 2014 at Outlook, there was slight overall reduction in MDI with fungicide application but disease was similar for both hybrids. At Melfort in 2014, all plots were evaluated but no disease was observed while, in 2014, MDI averaged approximately 3% but was not affected by hybrid or foliar fungicide. At Melita, no disease symptoms were observed and therefore detailed ratings were not completed in 2013 but, in 2014, MDI varied with both hybrid and fungicide. On average, MDI was reduced from 5% to negligible levels with fungicide at Melita in 2014 but, unexpectedly and somewhat difficult to explain, was slightly higher for 45S54.

Focussing on seed yield, the two hybrids performed similarly at Indian Head, Melfort and Outlook, but 45H29 yielded higher at Brandon in both years and Melita in 2014. Despite the fact that no disease symptoms were noted, the strongest yield response to fungicide was observed at Melita in 2013, where fungicide resulted in a 24% yield increase with 45H29 but there was no response with the tolerant hybrid 45S54. A similar effect was observed at Brandon, albeit to a lesser extent. At Indian Head, there was an overall tendency for higher yields with foliar fungicide but the effect was similar for both hybrids. At Melfort, fungicide did not affect seed yield in either year or for either of the two hybrids while at Outlook there was no response in 2013 but, again unexpectedly, there appeared to be a yield benefit with fungicides for 45S54 in 2014 but not for 45H29. With the exception of Indian Head in 2014 where sclerotinia was observed but yields were more limited by spring flooding and fall frost, there was little or no sclerotinia infection noted at the sites where a yield response to fungicide was not detected. Seed size was typically higher for 45S54 than 45H29 but was not affected by fungicide in most cases. Neither hybrid nor fungicide treatment had a consistent impact on percent green seed and, in all cases except Indian Head in 2014, percent green seed was below the desired minimum of 2%.

Overall, under low to moderate disease pressure, preliminary results of this study suggest that disease levels usually tended to be lower with the tolerant hybrid (45S54) than with the susceptible hybrid, 45H29. The results also suggest that foliar fungicides provided less consistent benefits when a tolerant variety was used. Foliar fungicides frequently reduced disease levels and, at some locations, increased seed yields. Furthermore, no benefits to a dual fungicide application over a single application were

detected but, again, this may not apply under high disease pressure. This was the second of three years for this study and the field trials are to be continued at all five locations in 2015.

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## Appendices:

<b>Table 12. Rating system used to quantify sclerotinia infection levels at each location (Kutcher and Wolf 2006)</b>		
<b>Disease Rating (0-5)</b>	<b>Lesion Location</b>	<b>Canola Symptoms</b>
0	None	No symptoms
1	Pod	Infection of pods only
2	Upper	Lesion situated on main stems or branch(es) with potential to affect up to ¼ of seed formation and filling on plant
3		Lesion situated on main stems or a number of branches with potential to affect up to ½ of seed formation and filling on plant
4		Lesion situated on main stems or a number of branches with potential to affect up to ¾ of seed formation and filling on plant
5	Lower	Main stem lesion with potential effects on seed formation and filling of entire plant

**Table 13:** Tests of fixed effects and least squares for plant density at various locations in 2013 and 2014 SaskCanola sclerotinia trials. Least squares means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test;  $P < 0.05$ ).

Effect Variable	Indian Head		Melfort		Outlook		Brandon		Melita	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
----- Plant Density (plants m <sup>-2</sup> ) -----										
Hybrid (HYB)	0.356	0.001	0.950	<0.001	0.835	0.038	0.013	0.016	0.136	—
Susceptible (S)	55 a	37 b	49 a	53 a	63 a	68 a	148 b	71 a	141 a	—
Tolerant (T)	58 a	47 a	49 a	39 b	64 a	56 b	170 a	56 b	157 a	—
Std. Error	2.8	2.6	2.3	1.9	4.6	4.1	5.6	5.7	7.6	—
Fungicide (FUNG)	0.349	0.327	0.986	0.289	0.465	0.851	0.671	0.423	0.564	—
Untreated (UT)	59 a	41 a	50 a	49 a	58 a	66 a	160	62 a	155 a	—
20% bloom (T1)	57 a	45 a	48 a	45 a	62 a	61 a	158	60 a	139 a	—
50% bloom (T2)	57 a	38 a	49 a	44 a	61 a	61 a	152	60 a	158 a	—
Dual App. (2X)	51 a	42 a	48 a	47 a	71 a	60 a	166	72 a	139 a	—
Std. Error	3.5	3.2	3.1	2.5	6.3	5.5	7.9	7.0	10.8	—
HYB x FUNG	0.926	0.435	0.442	0.170	0.489	0.356	0.168	0.094	0.980	—
S-UT	58	38	54	38	52	78	137	76	150	—
S-T1	54	38	48	37	68	62	152	60	130	—
S-T2	57	35	46	40	65	61	137	60	150	—
S-2X	50	35	48	40	65	69	167	88	134	—
T-UN	60	44	46	60	64	54	183	49	160	—
T-T1	60	52	48	52	57	60	164	60	148	—
T-T2	58	41	52	48	57	59	167	60	167	—
T-2X	52	50	49	53	78	53	164	55	155	—
Std. Error	4.7	4.1	4.3	3.3	9.1	7.5	11.1	9.0	15.3	—
AICC	190.8	182.9	187.1	173.6	201.2	213.4	230.2	220.4	245.4	—



**Table 14:** Tests of fixed effects and least squares for seed weight at various locations in 2013 and 2014 SaskCanola sclerotinia trials. Least squares means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test;  $P < 0.05$ ).

Effect Variable	Indian Head		Melfort		Outlook		Brandon		Melita	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
-----Seed Weight (g 1000 seeds <sup>-1</sup> )-----										
Hybrid (HYB)	< 0.001	0.001	—	<0.001	< 0.001	<0.001	0.004	< 0.001	0.080	<0.001
Susceptible (S)	3.2 b	2.31 b	—	2.71 b	6.2 b	2.55 b	3.7 b	2.46 b	2.91 a	2.38 b
Tolerant (T)	3.8 a	2.57 a	—	3.28 a	6.5 a	2.91 a	3.9 a	2.66 a	3.15 a	2.70 a
Std. Error	0.05	0.168	—	0.04	0.05	0.05	0.07	0.04	0.13	0.03
Fungicide (FUNG)	0.299	0.859	—	0.743	0.559	0.456	0.987	0.348	0.429	0.079
Untreated (UT)	3.50 a	2.47 a	—	3.03 a	6.4 a	2.70 a	3.8 a	2.51 a	2.90 a	2.50 a
20% bloom (T1)	3.54 a	2.41 a	—	3.03 a	6.4 a	2.71 a	3.8 a	2.59 a	3.18 a	2.52 a
50% bloom (T2)	3.50 a	2.46 a	—	2.98 a	6.4 a	2.72 a	3.8 a	2.61 a	2.95 a	2.60 a
Dual App. (2X)	3.59 a	2.41 a	—	2.95 a	6.3 a	2.80 a	3.9 a	2.53 a	3.10 a	2.53 a
Std. Error	0.05	0.17	—	0.06	0.07	0.06	0.07	0.05	0.16	0.03
HYB x FUNG	0.699	0.067	—	0.306	0.504	0.134	0.992	0.749	0.357	10.5
S-UT	3.22	2.40 ab	—	2.75	6.16	2.62	3.71	2.40	2.90	2.43
S-T1	3.20	2.41 ab	—	2.80	6.26	2.51	3.73	2.48	3.15	2.39
S-T2	3.22	2.23 b	—	2.60	6.28	2.52	3.70	2.49	2.80	2.34
S-2X	3.28	2.18 b	—	2.70	6.13	2.56	3.76	2.47	2.80	2.36
T-UN	3.77	2.55 a	—	3.30	6.64	2.79	3.94	2.62	2.90	2.57
T-T1	3.87	2.41 ab	—	3.25	6.51	2.91	3.93	2.70	3.20	2.65
T-T2	3.79	2.68 a	—	3.35	6.46	2.92	3.94	2.73	3.10	2.87
T-2X	3.90	2.63 a	—	3.20	6.41	3.03	3.95	2.59	3.40	2.70
Std. Error	0.07	0.188	—	0.08	0.10	0.08	0.11	0.066	0.20	0.04
AICC	-18.7	14.0	—	-2.8	3.6	39.2	7.1	-14.2	36.8	-35.8

**Table 15:** Tests of fixed effects and least squares for percent green seed at various locations in 2013 and 2014 SaskCanola sclerotinia trials. Least squares means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test;  $P < 0.05$ ).

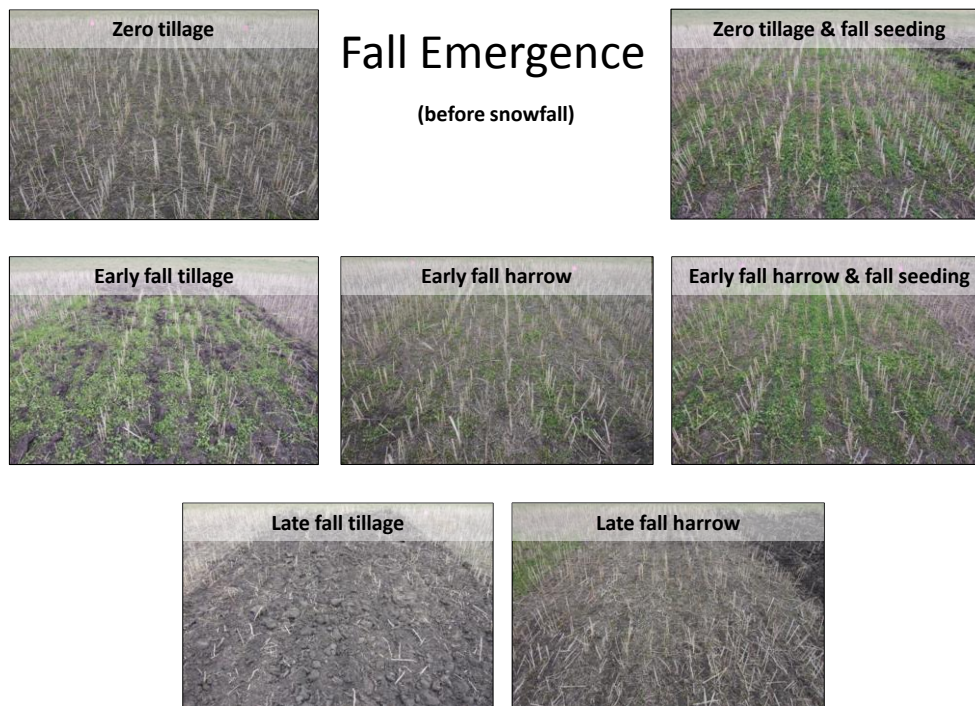
Effect Variable	Indian Head		Melfort		Outlook		Brandon		Melita	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
----- Green Seed (%) -----										
Hybrid (HYB)	1.000	0.538	—	—	0.483	0.866	1.000	0.365	0.347	0.189
Susceptible (S)	0.21 a	23.9 a	—	0.0	0.09 a	1.63 a	0.04 a	0.19 a	1.34 a	0.41 a
Tolerant (T)	0.21 a	22.9 a	—	0.0	0.05 a	1.60 a	0.04 a	0.14 a	1.11 a	0.25 a
Std. Error	0.08	4.07	—	—	0.04	0.10	0.02	0.04	0.17	0.09
Fungicide (FUNG)	0.881	0.740	—	—	0.874	< 0.001	0.026	0.012	0.395	0.477
Untreated (UT)	0.20 a	22.8 a	—	0.0	0.03 a	1.85 a	0.00 b	0.20 ab	1.31 a	0.38 a
20% bloom (T1)	0.18 a	24.8 a	—	0.0	0.06 a	2.1 a	0.03 b	0.13 bc	0.84 a	0.31 a
50% bloom (T2)	0.23 a	23.4 a	—	0.0	0.06 a	0.9 b	0.13 a	0.30 a	1.44 a	0.44 a
Dual App. (2X)	0.25 a	22.6 a	—	0.0	0.09 a	1.7 a	0.00 b	0.03 c	1.31 a	0.19 a
Std. Error	0.09	4.22	—	—	0.06	0.15	0.03	0.05	0.24	0.12
HYB x FUNG	0.850	0.124	—	—	0.184	0.005	0.724	0.305	0.946	0.709
S-UT	0.15	24.10	—	0.0	0.05	2.35 a	0.00	0.15	1.38	0.38
S-T1	0.20	22.10	—	0.0	0.17	2.25 a	0.05	0.15	0.88	0.38
S-T2	0.25	26.05	—	0.0	0.13	1.35 bc	0.10	0.20	1.63	0.50
S-2X	0.25	23.35	—	0.0	0.00	0.95 c	0.00	0.05	1.50	0.38
T-UN	0.25	21.5	—	0.0	0.00	1.95 ab	0.00	0.25	1.25	0.38
T-T1	0.15	27.6	—	0.0	0.00	1.90 ab	0.00	0.10	0.81	0.25
T-T2	0.20	20.8	—	0.0	0.00	0.80 c	0.15	0.40	1.25	0.38
T-2X	0.25	21.9	—	0.0	0.18	1.35 bc	0.00	0.00	1.13	0.00
Std. Error	0.12	4.50	—	—	0.08	0.21	0.04	0.08	0.34	0.17
AICC	9.7	164.8	—	—	-5.9	39.2	-36.0	-8.8	60.0	31.0

## Timing and Intensity of Soil Disturbance Following Canola Production (Melita 2014)

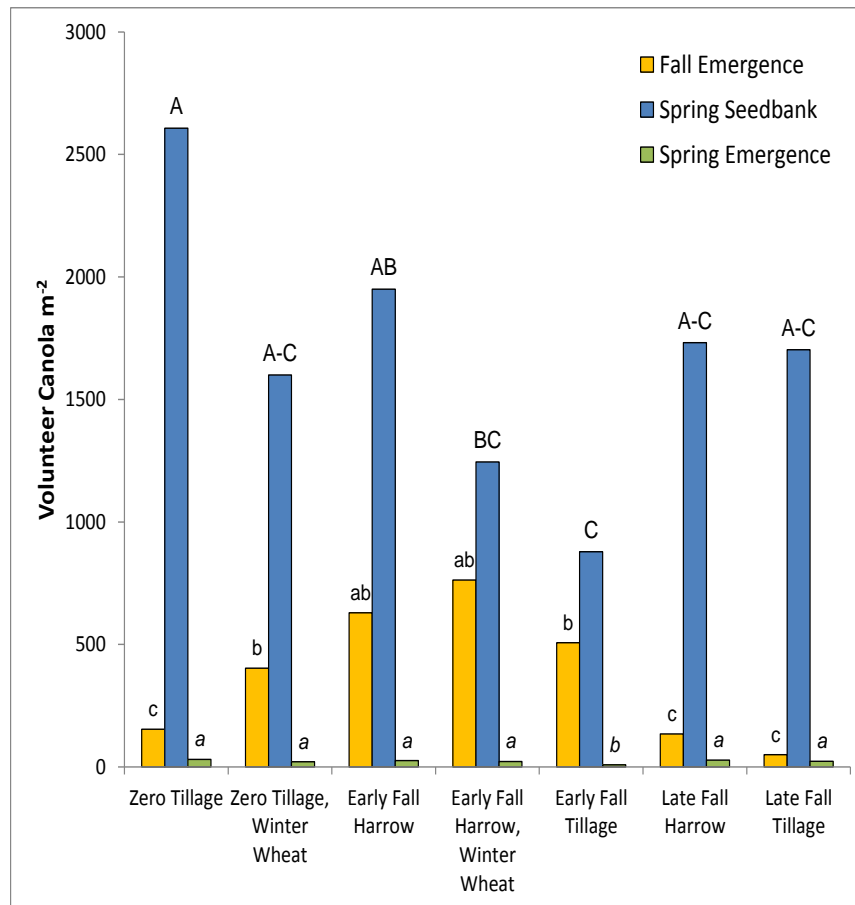
**Cooperators:** University of Manitoba:  
Supervisor:

Charles Geddes - Plant Science Masters Candidate  
Dr. Rob Gulden - Dept. of Plant Science

Canola is the main oilseed crop produced in western Canada. Volunteer canola, derived mainly from canola harvest losses, has become a significant agricultural weed in many fields throughout western Canada. Seedbank persistence and seed return of volunteer canola, along with genetically-engineered herbicide-resistance, create difficulties managing this weed. In fall 2013/spring 2014, the effect of type (zero tillage, tandem disc, tine harrow, and seeding winter wheat) and timing of soil disturbance following canola harvest (immediately or one month after) on the volunteer canola seedbank was evaluated near Melita MB. An artificial seedbank ( $7000 \text{ seeds m}^{-2}$ ) was supplemented on top of the seed losses from the previous canola crop immediately following canola harvest. High disturbance, in the form of tandem disk or tine harrow, prior to seeding winter wheat in the early fall, decreased levels of viable volunteer canola seed in the soil seedbank the subsequent spring from 2608 (zero tillage) to 879 and 1245 viable seeds  $\text{m}^{-2}$ , respectively. Depletion of viable seed in the spring seedbank was not directly correlated to emergence in the fall of canola production. Interestingly the Melita, MB study site resulted in the largest spring seedbank densities compared to sites in Carman, MB and Kelburn, MB. Soil disturbance following canola production has been identified as a valuable tool for managing the volunteer canola seedbank immediately after harvest and seedling emergence in subsequent years.



**Photos:** Various tillage regimes and volunteer canola seedling response to tillage in the fall of 2013, near Melita, MB.



**Figure 1:** The effect of timing and intensity of soil disturbance following canola production on volunteer canola fall emergence ( $P < 0.001$ ), spring emergence ( $P = 0.01$ ), and viable seed in the soil seedbank ( $P = 0.10$ ) the subsequent spring

## Integrated Management of Volunteer Canola in Soybean Production (Melita 2014)

**Cooperators:** University of Manitoba:  
Supervisor:

Charles Geddes - Plant Science Masters Candidate  
Dr. Rob Gulden - Dept. of Plant Science

Based on seeded acreage, soybean is currently the third most abundant crop grown in Manitoba. Populations of glyphosate-resistant volunteer canola can limit options for herbicide management within glyphosate-resistant soybean, creating a need for an integrated management approach. The integration of mechanical, cultural and chemical weed management methods were evaluated based on their efficacy for minimizing seed production of volunteer canola while minimizing yield losses in soybean. In 2014, soybean row spacing (9.5", 19.0", and 28.5"), seeding rate, and inter-row management (tillage or seeding cereals between soybean rows) were evaluated in Melita, MB. There was no difference in soybean yield or volunteer canola seed return between row spacings. The highest soybean yield (1460 kg ha<sup>-1</sup>) was in the narrow (9.5") row spacing seeded at a target density of 262500 plants per acre rather

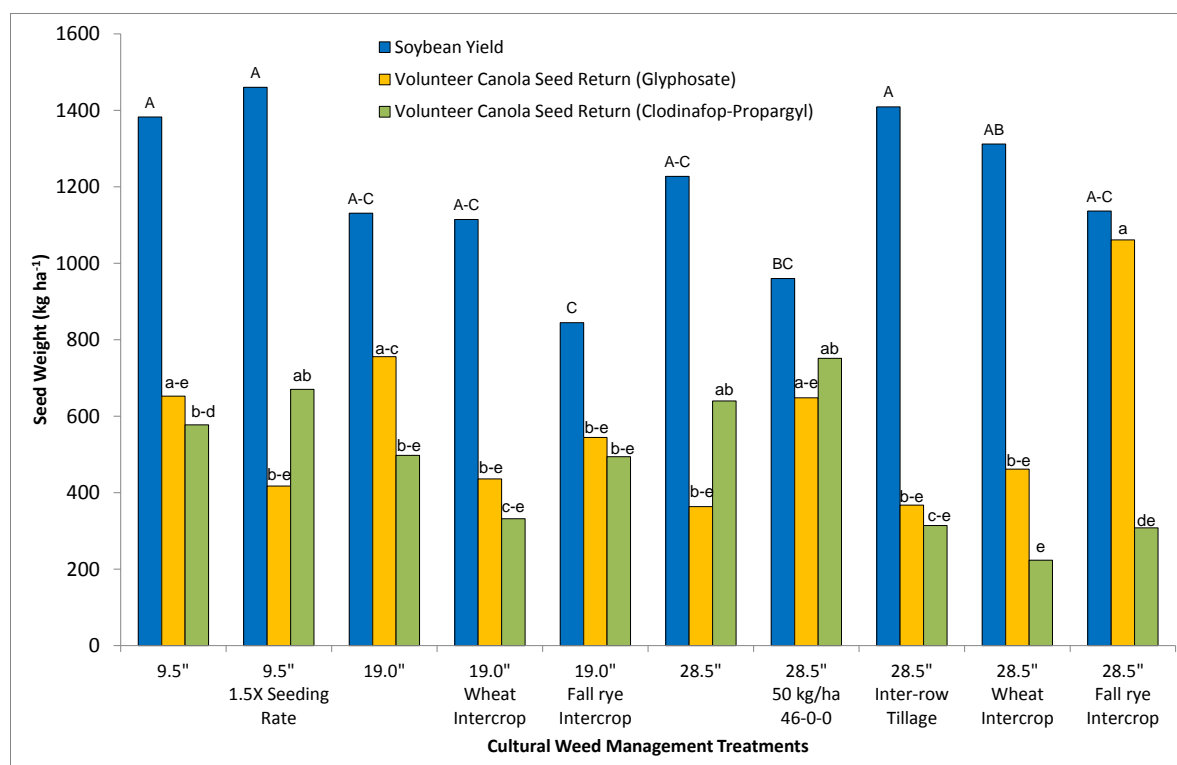
than 175000. Interestingly, seeding a wheat intercrop between wide (28.5") row soybean resulted in the lowest volunteer canola seed return ( $224 \text{ kg ha}^{-1}$ ) while maintaining soybean yield ( $1312 \text{ kg ha}^{-1}$ ). Under the right conditions, utilization of inter-row tillage, intercropping, or spring seeded inter-row mulches (sprayed with glyphosate post establishment) have been shown to be a useful tool for management of volunteer canola in soybean production.



**Photo (left):** Soybeans on 30" row spacing with wheat intercropped between the soybean rows on 9.5" spacing. Volunteer canola intermingled between the rows.

**Photo (right):** Dashed line dividing unsprayed plots (left) and in crop sprayed plots (right). Horizon and glyphosate herbicides used to control volunteer canola and grassy weeds in soybeans.





**Figure (above):** The effect of cultural weed management in soybean production on soybean yield (under both herbicide regimes;  $P = 0.955$ ), and volunteer canola seed return (separated by herbicide regime;  $P = 0.0352$ )

Project Funding Provided by:







28.5" row soybean with inter-row tillage



28.5" row soybean



28.5" row soybean with spring seeded fall rye intercrop



28.5" row soybean with 50 ka ha<sup>-1</sup> 46-0-0



28.5" row soybean with spring wheat intercrop

**Photos:** Plot treatments of Integrated Management of Volunteer Canola in Soybean Production using row spacing, intercrops of wheat or fall rye and tillage techniques.



19.0" row soybean with spring wheat intercrop



19.0" row soybean with spring seeded fall rye intercrop



9.5" row soybean at 1.5X seeding rate



9.5" row soybean

## Intercropping Pea and Canola based on Row Orientation and Nitrogen Rates Final Report 2011-2013

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### Introduction

Intercropping is the agricultural practice of cultivating two different crops in the same place at the same time (Andrews & Kassam 1976). In nature, plant species are rarely found as sole members in a population but rather are usually found as a diverse mix of different species. Benefits of intercropping can lead to greater than expected yields compared to the sole crop. Reasons for additional yield may be the result of greater efficiency in the use of nutrients, light and water (Szumigalski & Van Acker 2008). Intercropping is not a new concept and has been used by farmers for generations; however, recent improvements in farm machinery and individual variety characteristics and herbicide tolerance, have once again tweaked producers' interest in intercropping.

Little is known about intercropping peas and canola. However, given each crop's characteristics, there appears to be several ways these crops are compatible for intercropping which include:

1. Similar weed control chemistries for commercial use such as Clearfield® herbicide systems.
2. Peas producing an overabundance of nitrogen in the root zone (soil nitrogen credit).
3. Differing root depth profiles, i.e. canola deep rooting versus pea shallow rooting may help with water use sourcing.
4. Both grow well in Southwest Manitoba in field conditions.
5. Timing of seeding is similar in southern Manitoba.
6. Peas may benefit structurally by anchoring to canola stems potentially reducing lodging in pea, dirt tag, and potentially disease.
7. Maturity of seed is generally similar with canola being slightly later.
8. Separation of seed after harvest is easily done and manageable.

Peas (*Pisum sativum* L.) are legumes that can fix atmospheric nitrogen using a symbiotic association with *Rhizobium* bacteria, but can also absorb soil nitrogen from within the soil profile to facilitate proper growth. Producers typically plant peas on low nitrogen soils and inoculate with commercial based *Rhizobia* in order to reduce applied fertilizer costs by eliminating the need for expensive commercial urea, ammonia, and nitrate fertilizers. Well nodulated plants can derive 50% to 80% of their nitrogen requirement under favorable growing conditions with the remainder coming from soil borne sources. Soils containing low nitrogen do little to affect the normal nodulation process; however, prior to nodulation, plants may experience nitrogen deficiencies if soil levels are less than 10 lbs N/ac. A small amount of starter N fertilizer can reduce the effects of N-deficiency. Excessive soil and applied nitrogen concentrations past 47 lbs N/ac cause peas to become rather lazy and roots will choose to delay nodule



formation and instead absorb excess nitrates for growth (Voisin *et al.* 2002). Three to four weeks can pass before nodulation is fully restored (Saskatchewan Pulse Growers).

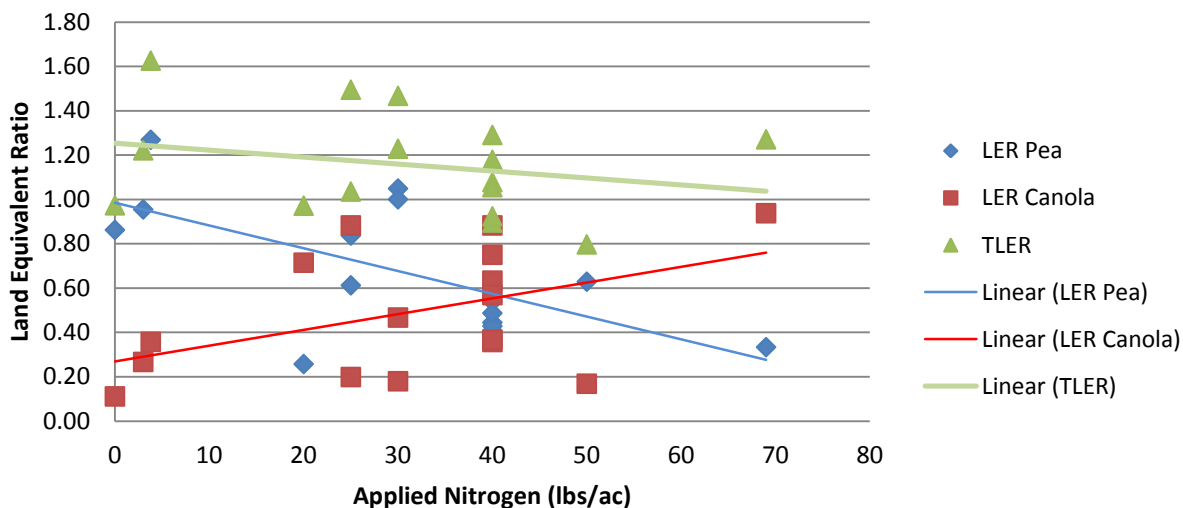
Canola (*Brassica napus* L.) absorbs nitrogen from ammonium or nitrates in the soil nitrogen pool. Consequently, canola is highly dependent upon this nitrogen pool and usually requires the use of externally applied fertilizers to fill this void in current commercial agriculture. Applying nitrogen at seeding is common; however, risks such as denitrification, leaching and immobilization can result, and generally only 47% of applied nitrogen fertilizer is recovered by the plant (Lafond *et. al.* 2007). Timing of nitrogen uptake is critical to plant stage. Delaying application can reduce nitrogen losses associated with applying during seeding. Holzapfel *et. al.* (2007) suggests that in canola, nitrogen can be delayed at least 30 days after seeding without yield reduction. This topdressing method comes with risk of the nitrogen volatilizing during warm dry climatic conditions if nitrogen fertilizer fails to migrate into the soil profile with timely rains.

There are few studies that have investigated the merits of intercropping peas and canola under differing nitrogen and/or plant configurations (Szumigalski & Van Acker 2006; Holzapfel 2011). There are others such as Frustec *et al.* (2010) who are looking at nitrogen fluxes in other crops such as fababean and rapeseed in an attempt to understand the over yielding connection and those dynamics of intercrops. Waterer *et al* (1994) also noted that additional nitrogen fertilization of pea mustard intercrops contributed little to yield and land equivalent ratio.

Often, intercropping is not only measured by total yield of products, but as a total economic value (total value/acre) by combining each crop value, or by Land Equivalent Ratio (LER). The LER is a measure of how much land would be required to achieve intercrop yields with crops grown separately as pure stands. When the LER is greater than 1.0, over-yielding is occurring and the intercrop is more productive than the component crops grown as sole crops. When the LER is less than 1.0, no over-yielding is occurring and the sole crops are more productive than the intercrop. For example; a LER rating of 1.20 from an intercrop of pea-canola means it would take 20% more land to equal that final yield if each crop was planted as separate components.

To date most producers were guessing on proper nitrogen fertilization in pea and canola with the general consensus being an application of 30 lbs/ac of nitrogen; a conservative compromise of both crops' normal rates, that being no nitrogen is applied to pea and usually around 80 lbs/ac for canola. Given the number of producers attempting pea canola intercropping and a lack of real agronomic recommendations available, there is a need to understand this concept better. Data collected from interviews with several farmers covering 3182 acres in Manitoba and Saskatchewan over the past 20 field years, suggests that the addition of nitrogen in the pea canola system is inconsequential to total grain production and/or total land equivalent ratios (Figure 1). From this, a hypothesis was developed indicating that the addition of nitrogen may be related to a negative impact on nodulation formation in the legume component, causing the canola to act more like a parasitic weed to the pea rather than a neutral companion. Given that it appears that nitrogen applied in intercrops of pea and canola is economically wasteful (in terms of land equivalent ratios), this subject deserves further investigation.

**Photo (right):** Producer field of pea canola near Mariapolis, MB in 2011. A field of mixed row with a TLER of 1.29.



**Figure 1:** Land Equivalent Ratio (LER) of pea-canola components, and total yield with variable rates of nitrogen surveyed by WADO from 2007 to 2014 from 20 producer fields in Manitoba and Saskatchewan. TLER = Total Land Equivalent Ratio

Intercropping peas and canola has been researched by WADO for several years. In 2009, WADO conducted a trial investigating the effects of pea and canola plant density on one another. Results indicated, as expected, that the higher the seeding rate for one crop over the other will translate to increased grain production due to increased competition. Large grain production responses were found *in all intercropping treatments* compared to their sole crop components i.e., canola or pea grown by itself. The real question was, why is it doing this? Was it better water use, something to do with light use, or was it better use of nutrients? At this point there were lots of questions and few answers.

Potentially, one of the reasons might be explained by Sawatsky N (1987) who found peas to leak nitrogen from their root zones (rhizodeposition) accounting for 22-46% of the below ground N-budget locked in roots and soil zones with 8.7 to 12% of the total plant nitrogen present in the soil. It is suspected that peas may be passing excess fixed nitrogen to canola that would have been unused in monocrop pea. Isotope nitrogen experiments would be needed to confirm this theory. Fustec *et al.* (2010) have described with the use of isotopic N<sup>15</sup> associated with rhizodeposition in the transfer of nitrogen in intercrops of pea and barley (*Hordeum vulgare* L.), fababean (*Vicia faba* L.) and forage

rapeseed (*Brassica napus* L.), and common vetch (*Vicia sativa* L.) and fodder cabbage (*Brassica oleracea* L.). Fustec *et al.* (2013) described the sharing of nitrogen between fababean and rapeseed illustrating that rapeseed accumulated 20% more nitrogen than in monocrops. This value, similar to Sawatsky's discovery in pea, may suggest that pea and canola might have a *commensal* relationship (a relationship defined as one who benefits positively (canola) and the other neutral (pea) when co-existing together).

Initial research from WADO suggests that peas and canola prefer to be intercropped together in the same row rather than being separated into individual crop rows (2011, 2012, and 2013). Reasons for this were not completely understood at that time. The results suggested during these years that row arrangement had something to do with it, whether it was root interactions, water interactions or something above ground (i.e. light, water management). Additionally, there was little response to nitrogen over the same intercrop treatments.

A three year trial was set up in Melita starting in 2011 to understand nitrogen dynamics when comparing row orientations or combinations of the crops themselves. Nutrient efficiency focused on applied nitrogen within only the canola rows, while row arrangement of the individual crops (single, double, or mixed in the rows) was modified to determine the effect of row arrangement and crop-nitrogen responses. It was hypothesized that if inoculated peas can be starved of applied nitrogen by dividing them into specific individual crop rows, the crop will be less likely to become in-efficient or "lazy" in symbiotic fixing of nitrogen. Therefore, improving the efficiency of the pea-canola system as a whole by having dedicated rows of each individual crop; compared to mixing everything together in the same row. In addition, dividing rows into individual crops will partition applied nitrogen to exclusively the canola rows where it should be better used economically. For example: a field of alternating rows of pea and canola, with canola rows only fertilized with nitrogen, could possibly result in a positive LER and yet use only half the nitrogen fertilizer compared to what is used in a monocrop or fully mixed field of canola or peas. The concept may even improve further by moving to double sets of alternating rows. This was an attempt to better explain the results from the 2010 Melita experiments. Excessive moisture in 2011 inflated error into the results of the WADO trial, potentially masking the results of the alternate row orientation and rain leaching away the effects of nitrogen applications. Nevertheless, there were some trends to pay attention to. A yield advantage was achieved for mixed row intercropping compared to all other options (this may have alluded to flood tolerance); however, there was little response to the use of nitrogen fertilizer applications. A separate trial conducted nearby, in cooperation with the Indian Head Agricultural Research Foundation, showed similar results.

Results from Indian Head, SK and Melita, MB (second study) in 2011, indicated that both row configuration and nitrogen applications played roles in their effect on intercropping performance. At the Indian Head site, canola yields were favoured by alternate rows, whereas pea yields were favoured by mixed rows. Pea yields were not affected by N rates, whereas canola yields were. In Melita, intercropping configurations were more productive compared to monocrop treatments, specifically favouring mixed row configurations compared to alternate row configurations. As well, Melita pea yields were sensitive to row configuration but not nitrogen application.

To further understand the effects of nitrogen rates, methods of applying, and timing of application effecting pea canola intercropping, WADO set up a separate experiment that compared sideband nitrogen and postponed applications of topdressed nitrogen over two years near Melita. Row arrangement in this experiment was a mixed row system exclusively. Results indicated that a positive response to nitrogen was found only in canola and not in pea or in combined total yield. It was concluded that increased nitrogen rates, regardless of method of application or timing, may increase canola yield but might also cause canola to out compete pea leading to a neutral response in pea with canola and a neutral total yield response in general. (Chalmers, WADO 2013 Annual Report).

It was originally hypothesized that double row configurations would be most efficient with respect to canola-nitrogen use while preserving the physical interaction of pea and canola side by side. It was hypothesized that mixed row configurations would be less efficient with nitrogen use, as peas would become lazy in the presence of applied nitrogen, and would rather compete for nitrogen with canola, than fix their own. The triple row configuration would be least efficient as an intercropping system with the only reason being there would be fewer physical pea-canola crop interactions (light, water use, nutrient use). Results from 2011, 2012 and 2013 suggest that mixed row configurations were most efficient in terms of yield and land equivalent ratio compared to all other configurations. Now, it is hypothesized that there is more that is happening below ground than expected, accounting for a mutually positive interaction between these two crops.

#### Trial Main Objectives:

1. Observe and quantify effect of row configuration on crop yield of pea, canola and total yield and land equivalent ratios.
2. Evaluate the response of nitrogen application in canola rows and its effect on canola and pea yields and total yield and land equivalent ratios.
3. Evaluate the relationships between percent light interception, and soil moisture to yield and land equivalent ratios in pea-canola intercrops.

## Methods

Plot treatments were seeded in a randomized complete block design and replicated four times.

A spring soil test was taken as a composite of samples taken over the trial area prior to seeding (Table 1) to determine residual fertility levels.

**Table 1:** Pea canola intercropping trial locations from 2011 to 2013 and their respective spring soil test nutrient levels prior to seeding derived from a sum of 0-6" and 6-24" depths. N=Nitrogen, P=Phosphorous, K = Potassium, S= Sulfur, OM = organic matter,

Year	Location	Legal Land Location	Soil Type	N ppm	P ppm Olsen	K ppm	S lbs/ac	pH	OM %
2011	Melita	SW-8-4-26 W1	Lagvale Sandy Loam	16	18	229	34	7.8	~2.0
2012	Melita	NE 36-3-27 W1	Leige Sandy Loam	35	8	230	98	8.1	4.2
2013	Elva	SE 36-3-28 W1	Stanton Sandy Loam	11	2	170	68	8.3	1.9
Average				21	9	210	67	8.1	2.7

Plot area was sprayed prior to seeding with Rival (0.57 L/ac), Credit (2 L/ac) and Liberty (0.75 L/ac) herbicides tank mixed then sprayed with a water volume application rate of 10 gal/ac. Plots were seeded with a SeedHawk dual knife single side band air seeder. Six rows at 9.5" spacing were planted twice to result in a single plot 2.88 m wide by approximately 8.5 meters long with 12 rows. Plots were land rolled after seeding for stones. Seed was placed  $\frac{3}{4}$ " below the furrow surface base. Fertilizer was side band 1" below and beside the seed during the seeding operation. Target seeded plant stand for canola was 100 p/m<sup>2</sup> in the monocrop treatments. For monocrop peas, a target plant density of 75 p/m<sup>2</sup> was used. Several varieties were used and are summarized in Table 2.

**Table 2:** Field pea variety, pea type, and canola varieties used from 2011 to 2013 and their respective seed distributors.

Year	Pea	Type	Company	Canola	Company
2011	CDC Striker	Green	Sask Pulse Growers	71-40 CL	Monsanto
2012	CDC Meadow	Yellow	Sask Pulse Growers	71-40 CL	Monsanto
2013	CDC Meadow	Yellow	Sask Pulse Growers	2012 CL	Nexera

All plots received 58 lbs/ac of granular 11-52-0 (MAP). Separate variable rates of nitrogen were supplied by 28-0-0 (UAN). Only canola monocrop and canola intercrop rows received applied nitrogen. This was accomplished by the use of ball valves located along fertilizer distribution lines, turned on when nitrogen was applied and turned off when denied to the pea rows.

Fertilizer applications according to their specific treatment were pre-calibrated as outlined in Table 3. Peas were inoculated with proper Rhizobium (granular Nodulator®, Becker Underwood) applied at 5 lbs/ac and were not fertilized with additional nitrogen unless in mixed rows with canola (treatments 6 & 7), and treatment 2 (N-check for peas).

**Table 3:** Trial treatment descriptions with their corresponding row orientation, seeding rate, nitrogen fertility level in both the canola row and overall field (plot) area including peas.

Trt	Crop Orientation	Crop Row and Nitrogen Placement Arrangement* (underscore = row gap)	N rate (lbs/ac)		Seeding Rate (p/m <sup>2</sup> )	
			Canola Row N equivalent	Overall Field	Canola	Pea
1	pea monocrop (check)	P_P_P_P_P_P_P	inoculated	0	-	75
2	pea monocrop (check)	Pn_Pn_Pn_Pn_Pn_Pn_Pn	inoculated	90	-	75
3	canola monocrop (check)	CN_CN_CN_CN_CN_CN	90	90	100	-
4	canola monocrop (check)	Cn_Cn_Cn_Cn_Cn_Cn	45	45	100	-
5	canola monocrop (check)	CNN_CNN_CNN_CNN_CNN_CNN	180	180	100	-
6	mixed rows	PCn_PCn_PCn_PCn_PCn_PCn	45	45	50	38
7	mixed rows	PCN_PCN_PCN_PCN_PCN_PCN	90	90	50	38
8	single rows	P_CN_P_CN_P_CN	90	45	50	38
9	single rows	P_CNN_P_CNN_P_CNN	180	90	50	38
10	double rows	P_P_CN_CN_P_P_CN_CN	90	45	50	38
11	double rows	P_P_CNN_CNN_P_P_CNN_CNN	180	90	50	38
12	triple rows	P_P_P_CN_CN_CN	90	45	50	38
13	triple rows	P_P_P_CNN_CNN_CNN	180	90	50	38

\*P= Peas, C= Canola, n=45 lbs/ac Nitrogen, N=90 lbs/ac Nitrogen, NN=180 lbs/ac Nitrogen

Plots were kept weed free using a single application of Odyssey herbicide applied at 17 g/ac (plus Merge adjuvant) at a water spray volume of 20 gal/ac, when both crops reached three nodes of plant growth. Plots were desiccated with Reglone herbicide at a rate of 0.91 L/ac at an application volume of 20 U.S. gal/ac at maturity (canola reached 70% seed color change). Plots were harvested with a Hege plot combine set to normal canola harvest settings. Both standing crops of pea and canola were harvested together at the same time for each plot. Specific dates of seeding, herbicide application, desiccation and harvest are summarized in Table 4 according to year including respective location and field stubble type.

**Table 4:** Pea canola intercropping trial specific year, location and respective stubble types, seeding date, in crop herbicide application, desiccation and harvest dates.

Year	Location	Stubble	Seed Date	Herbicide Date	Desiccation Date	Harvest Date
2011	Melita	Spring Wheat	19-May	11-Jun	19-Aug	06-Sep
2012	Melita	Summer Fallow	02-May	28-May	17-Aug	22-Aug
2013	Elva	Oat	11-May	28-May	16-Aug	23-Aug

Data collected over the three years varied; however, grain yield was consistent (Table 5). Other variables were observed including, pea seed splits, and crop seed size.

**Table 5:** A summary of all the variables and covariates taken into account over the three years of this trial.

Year	Variables						Covariates	
	Seed Weight	Split Peas	Grain Moisture	Grain Yield	Crop Maturity	Canola Shatter	Soil Moisture	Light
2011	✗	✗	✓	✓	✗	✓	✗	✓
2012	✓	✓	✓	✓	✓	✓	✓	✓
2013	✓	✓	✓	✓	✗	✓	✓	✓

Grain samples were separated into individual crops using a small bench seed cleaner (Eclipse Model 324, Seedburo Equipment Co.). Final grain yield was calibrated to a grain moisture content of 10% for peas and 10% for canola. Final grain yields were also converted to partial land equivalent ratios (PLER) for peas and or canola, which were combined into a total land equivalent ratio value using the following equation:

$$\text{Total LER} = I_a/S_a + I_b/S_b = \text{partial LER peas} + \text{partial LER canola}$$

Where total LER is the total Land Equivalent Ratio, I is the intercrop yield (in the rep), S is the sole crop yield (of the rep), and “a” and “b” refer to the crop components. Pea sole crop was the inoculated check and the canola sole crop used was the 90 lbs/ac N rate check.

Percent light interception of crop canopy was measured with a Li-Core LI-191 quantum light sensor (1 m long). Crop stage during observation was approximately late flower. The probe was placed under the crop canopy perpendicular to the seed row direction. Two measurements above the canopy and four measurements below canopy were observed per plot. Only the inside 8 of the 12 available rows of the

plot were measured to reduce edge effects. Light units were  $\mu\text{moles s}^{-1} \text{ m}^{-2}$  for each reading, measuring photosynthetic active radiation (PAR). Percent light intercepted (PLI%) was calculated as follows:

$$\text{PLI\%} = [\text{mean above canopy PAR} / \text{mean below canopy PAR}] \times 100$$

Soil moisture content was taken as an average of two readings per plot using a HydroSense II (Campbell Scientific). Sensor probes rods (CS658) are 20 cm long and measure soil volumetric water content (percent water) in a sandy soil (soil setting 1). Readings were taken during late flower development of both crops.

The multiyear grain yield and land equivalent ratio data set was analyzed with AgroBase Gen II statistical software using a Residual Maximum Likelihood (REML) variance components analysis also tested with interaction between row spacing and nitrogen rate components. Least significant difference (LSD) was calculated at the 0.05 level of significance.

Percent soil moisture and percent light interception covariates were analyzed using a two-way analysis of variance (ANOVA) only for intercrop treatments. Each year's data set was analyzed separately. Least significant difference (LSD) was calculated at the 0.05 level of significance if the ANOVA was significant. The relationship between soil moisture and light interception to crop yield components were determined using Pearson correlation and linear regression.

## Results

### ***Grain Yield and LER***

There were significant differences among all grain yield and land equivalent ratio (LER) components including their totals when combining all three years of data and comparing all treatments including checks (Table 6). There is a significant over yielding effect when intercropping pea and canola compared to their individual cropping components.

Monocrop peas did not respond to nitrogen in terms of a grain yield but did in terms of land equivalent ratio. When peas were intercropped, there was a greater yield response in the single row system compared to mix, double or triple rows, in respective decreasing yield. In terms of land equivalent ratio, when pea was intercropped, pea land equivalent ratio ranged from 0.58 to 0.73 depending on the row orientation and N rate used. Regardless of the value, these ranges are greater than one half which helps explain some of the over yielding potential for intercropping.

Monocrop canola responded to nitrogen applications. Moving from the 45 lb/ac rate to 90 lbs/ac was significant but not from 90 lbs/ac to 180 lbs/ac. When canola was intercropped with peas, canola yield tended to be greatest when in the mixed row system followed by double rows then by triple rows, then by single. The lack of canola yield in the single rows would suggest that peas had significant competitive pressure in this system compared to the other row orientations. Partial land equivalent ratio of canola intercropped with peas ranged from 0.38 to 0.65 indicating that canola contributes a weaker over yielding component compared to that of peas.

**Table 6:** REML analysis of pea, canola and total yield (inclusive of monocrop check means) and land equivalent ratios (LER) from intercropping pea and canola from 2011 to 2013 in Melita, MB.

Cropping System	Pea		Canola		Total		Pea		Canola		Total	
	kg/ha						LER					
Pea Monocrop 0N	5351	c	-		4891	c	1.02	f	-		1.01	ab
Pea Monocrop 90N	5732	c	-		5415	c	1.10	g	-		1.16	bcd
Canola Monocrop 45N	-		2026	f	2142	a	-		0.89	e	0.90	a
Canola Monocrop 90N	-		2367	g	2385	ab	-		1.02	f	1.01	ab
Canola Monocrop 180N	-		2486	g	2327	ab	-		1.02	f	1.01	ab
Mixed Rows 45N	2820	a	1377	de	4431	c	0.62	abcd	0.60	c	1.28	d
Mixed Rows 90N	2588	a	1553	e	4296	c	0.58	a	0.65	d	1.29	d
Single Rows 45N	3400	b	925	a	4290	c	0.70	e	0.38	a	1.03	abc
Single Rows 90N	3552	b	1109	ab	4587	c	0.73	e	0.46	ab	1.14	abcd
Double Rows 45N	2946	a	1249	bcd	4352	c	0.63	abcd	0.56	b	1.17	abcd
Double Rows 90N	2668	a	1435	de	4176	c	0.59	ab	0.60	cd	1.18	abcd
Triple Rows 45N	2910	a	1144	abc	4196	c	0.62	abcd	0.51	bc	1.11	abcd
Triple Rows 90N	2756	a	1126	abc	3987	bc	0.60	abc	0.47	a	1.08	abcd
P Value	<0.001		<0.001		0.009		<0.001		<0.001		0.036	
St. Error of Differences	225		118		824		0.03		0.05		0.10	
LSD (p<0.05)	450		237		1700		0.06		0.10		0.21	
Year	Residual Variance											
2011	977311		146900		37579		0.054		0.030		0.041	
2012	134567		39489		115168		0.003		0.012		0.009	
2013	582754		185759		548940		0.008		0.012		0.013	

These differences were further investigated by comparing only the intercrop data and their response to row orientation and nitrogen rates (Table 7). Findings indicate that significant differences existed in row orientation in pea and canola components but not in total yield. Furthermore, there were no differences in response to nitrogen rates or interactions between row orientation and nitrogen rates in intercrops.

Intercrop component yields were greater than half the monocrop yields except for canola in single and triple row orientation (Figure 3). This was a good indication of over yielding in intercrop treatments. Total yield varied little among all treatments (Figure 4) but did translate into significant differences when land equivalent ratio was used (Figure 5). The greatest total land equivalent ratios were found in mixed and double row orientations while the least was found in single and triple row orientations (Figure 6). Pea grain yields remained fairly consistent in all row orientations, slightly favoring single row orientation; however, canola tended to benefit the most with mixed and double row orientations rather than single and triple. This suggests that as pea and canola rows start to converge closer together, there appears to be a positive trend on improving total yield and therefore total land equivalent ratio values. As they deviate closer to monocrops, as in triple rows, yield and land equivalent ratios tend to diminish.



**Table 7:** REML variance components analysis of predicted means of pea intercropped with canola with relation only to row orientation, applied nitrogen rates (exclusive of monocrop means), and their interaction on crop component yield and land equivalent ratio (LER) from 2011 to 2013.

Row Orientation	N Rate	kg/ha				LER				
		Pea		Canola	Total	Pea		Canola	Total	
Mixed		2866	a	1481	c	4346	0.67	0.63	c	1.31
Single		3508	b	1003	a	4510	0.66	0.41	a	1.07
Double		2862	a	1405	c	4266	0.59	0.59	c	1.18
Triple		2929	a	1158	b	4086	0.60	0.50	b	1.10
S.E. Diff. Row		151		75		162	0.04	0.04		0.50
	45	3103		1234		4335	0.63	0.53		1.16
	90	2980		1290		4269	0.64	0.54		1.18
S.E. Diff. Rate		107		53		115	0.03	0.02		0.04
Mixed	45	2978		1447		4424	0.68	0.62		1.30
	90	2753		1516		4268	0.67	0.65		1.31
Single	45	3463		844		4346	0.64	0.38		1.02
	90	3554		1122		4675	0.68	0.45		1.13
Double	45	2980		1381		4361	0.59	0.60		1.18
	90	2744		1429		4172	0.60	0.59		1.19
Triple	45	2988		1223		4211	0.60	0.52		1.12
	90	2870		1093		3961	0.60	0.49		1.09
S.E. Diff. Row x Rate		213		106		229	0.05	0.05		0.07
LSD (p<0.05)	Rate	<b>212</b>		<b>106</b>		229	0.05	<b>0.05</b>		<b>0.07</b>
	Row	300		150		326	0.08	0.07		0.10
	Rate x Row	424		212		458	0.11	0.10		0.14
P values	Rate	0.254		0.297		0.564	0.733	0.554		0.498
	Row	<b>0.001</b>		<b>0.001</b>		0.078	0.079	<b>0.001</b>		<b>0.001</b>
	Rate x Row	0.679		0.122		0.267	0.900	0.535		0.538
Grand Mean		3041		1262		4302	0.63	0.53		1.17
Residual Year Variance		4.00E+04		1.05E+04		4.89E+04	2.73E-03	2.29E-03		4.63E-03

### ***Soil Moisture and Light Interception***

There were no significant differences among intercrop treatments in percent light interception in all three site years (Table 8). Additionally there were no significant differences ( $p=0.64$ ) in light interception when comparing monocrop treatments and intercrop treatments (data not shown).

There were significant differences in percent soil moisture in 2013 but not 2012. In 2012, soils were nearly saturated with rainfall likely masking moisture effects among treatments. In 2013, significant differences were found with mixed row orientation treatments having less available soil moisture compared to single row, double row, and triple row treatments in declining order, respectively.

**Table 8:** Percent light interception and percent soil moisture values from 2011 to 2013 of pea canola intercrops.

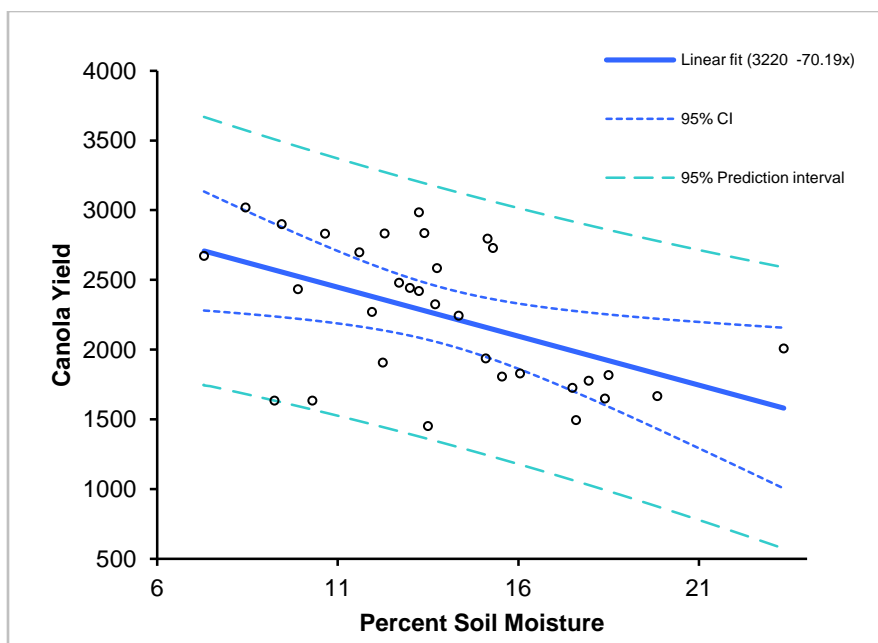
Treatment	Percent Light Interception			Percent Soil Moisture	
	2011	2012	2013	2012	2013
Mixed Rows 45N	56.7	93.5	79.1	36.3	11.3 a
Mixed Rows 90N	65.8	91.7	82.0	36.0	12.2 ab
Single Rows 45N	47.7	92.8	81.9	36.7	12.9 ac
Single Rows 90N	48.8	91.5	78.3	33.7	15.4 cd
Double Rows 45N	51.7	91.7	82.2	34.3	15.0 cd
Double Rows 90N	50.6	92.9	81.6	34.2	14.8 cd
Triple Rows 45N	49.6	92.9	75.6	34.0	14.1 bcd
Triple Rows 90N	59.9	92.9	78.3	35.1	15.5 d
P Value	0.356	0.494	0.646	0.887	<b>0.060</b>
LSD (p<0.01)	NS	NS	NS	NS	<b>2.5</b>

Yield and LER means in 2013 from pea and canola intercrop components were applied to soil moisture values that year by using Pearson correlation and linear regression. There was a direct relationship between canola yield and canola LER and total LER to soil moisture (Table 9). There was no relationship between pea yield, pea LER and soil moisture.

**Table 9:** Correlation and linear regression relationships of crop yield, land equivalent ratio to soil moisture indicating the strength of their relationship and the significance of that relationship, respectively, in 2013 among pea canola intercrop treatments. SM = Percent Soil Moisture, TYD = Total Yield, TLER = Total Land Equivalent Ratio, PLER = Pea Land Equivalent Ratio, CLER = Canola Land Equivalent Ratio

Relationship	Correlation		Regression		
	r	P value	R-squared	P value	Equation
Pea Yield x SM	0.02	0.899	0.00	0.899	PeaYD = 4812 + 5.2 (SM)
Canola Yield x SM	-0.50	<b>0.004</b>	0.25	<b>0.004</b>	CanYD = 3220 - 70 (SM)
Total Yield x SM	-0.28	0.127	0.08	0.127	TYD = 8032 - 65 (SM)
Pea LER x SM	0.14	0.437	0.02	0.437	PLER = 0.6 + 0.005 (SM)
Canola LER x SM	-0.52	<b>0.004</b>	0.28	<b>0.002</b>	CLER = 0.9 - 0.02 (SM)
Total LER x SM	-0.38	<b>0.033</b>	0.14	<b>0.033</b>	TLER = 1.4 - 0.016 (SM)

The relationship between canola and soil moisture (Figure 2) was inverse indicating greater yields and LERs were related to greater water use (or lower values of percent soil moisture). This could be supported further in that greater water use was related to row arrangement (Table 8). This is also supporting evidence that row configuration, nitrogen sharing from pea to canola and water use are all inter-related. That is, canola is using more water in plots where proximity to available pea nitrogen is closer as in mixed row orientation compared to single, double, and triple rows, respectively.



**Figure 2:** Linear regression of percent soil moisture (independent variable) and canola yield (dependent variable) of pea canola intercrop treatments in 2013.

### ***Pea Splits, Seed Size***

There were no significant difference in pea splits and pea seed weight among all treatments (Table 10) from combined available data 2012-2013. In 2012, results (not shown) were significant ( $p < 0.0001$ ) suggesting that intercrops reduced the number of pea splits due to the buffering effect of the canola during the threshing process by as much as 32% (measured by weight) compared to monocrop peas.

Similar pea seed weights help support that intercropping does not interfere with seed size. In canola seed, size appears to become larger in intercrops, which might indirectly explain some of the over yielding capability. However, most intercrop canola differences are not that different from monocrop canola with either 45 or 90 lbs N applied to them.



**Photo (left):** WADO research plots in 2010 near Melita. A treatment of double row plots averaging TLER of 1.49.

**Table 10:** Monocrop and intercrop pea and canola means for percent pea splits, pea seed weight, and canola seed weights from 2011-2013.

Treatment	Pea Splits % by wieght	Pea Seed Weight g/100	Canola Seed Weight g/500
Pea Monocrop 0N	8.6	22.2	-
Pea Monocrop 90N	8.8	21.9	-
Canola Monocrop 90N	-	-	1.71 ab
Canola Monocrop 45N	-	-	1.77 abc
Canola Monocrop 180N	-	-	1.68 a
Mixed Rows 45N	6.5	22.6	1.86 abc
Mixed Rows 90N	6.2	22.5	1.83 abc
Single Rows 45N	7.4	22.4	1.94 c
Single Rows 90N	6.4	22.0	1.86 abc
Double Rows 45N	7.0	22.3	1.82 abc
Double Rows 90N	5.8	22.3	1.71 ab
Triple Rows 45N	8.1	22.5	1.77 abc
Triple Rows 90N	6.2	22.5	1.81 abc
P Value	0.7	1.0	<b>0.025</b>
LSD (p<0.05)	NS	NS	<b>0.21</b>

### ***Canola Shatter, Maturity, Grain Moisture, Lodging***

There were general differences in crop maturity between crops but not between treatments. Peas often matured one to two weeks prior to canola, but when pea seed dry down combined with desiccation of the canola, harvest timing was relatively analogous.

Lodging was generally not an issue, although monocrop peas did tend to lodge more than intercropped peas by observation.

Grain moisture was a variable taken but was disregarded as results since samples had to be stored prior to measuring. Therefore, real time differences in moisture would not be realized for this experiment.

### ***Intercropping Economics***

Cost of production values were applied to gross income values derived from REML yield means. A summary of the costs of production for each cropping system is found in Table 11. Gross and net incomes realized are in Table 12. Net economic incomes are illustrated in Figure 7. Net incomes for most intercrop treatments were valued up to 45% than if half of each of the monocrop component values were combined. This indicates once again an over yielding effect or over income effect in economics context. These values do not supersede the sole values of monocrop peas but are superior to monocrop canola. Formal statistics were not used to determine differences in economic value; however, similar trends as in land equivalent ratio exist as well. Again, a downward trend is experienced as component crops move toward monocrop row orientation, again highlighting the importance of row

orientation. Also, most intercrop treatments with 90 lbs of N applied, appear to net less income than those with 45 lbs/ac applied nitrogen suggesting that nitrogen applications in intercrops is unwarranted or not justifiable.

## Discussion

This experiment helped to shed some light on the objectives that were originally sought when this project was initiated (objectives at end of introduction). The yield and LER results suggest that row orientation in intercrop pea canola is significant and that those relationships suggest a mutual relationship below ground between the crops. There is less significance to rate and without interaction to row orientation in relation to applied nitrogen (at the rates tested). Intrinsic benefits by intercropping were grain over yielding, improved land equivalent ratio, improved net income (compared to monocrop canola production), larger seed weights, fewer pea splits, and increased water use in intercropping treatments compared to monocrop treatments.

Additional nitrogen appeared to have little effect on intercropping systems in general. Similar results have been found by WADO from two years of research in 2012 and 2013. Side banding or timing a topdressing of nitrogen in pea-canola plots contributed little to no positive yield benefit from rate, placement or timing. This also supports the producer survey results (Figure 1), in which WADO has found that additional nitrogen in pea canola intercrop fields has little contribution to total land equivalent ratio. These observations are likely supported from formal research in peas where high rates of available nitrogen inhibit nitrogen fixation by rhizobia (Voisin *et al.* 2002) and also with Waterer *et al.* (1994) who also found that the addition of nitrogen had little contribution to yield and LER in pea mustard intercrops.

For the past three years WADO has been researching the merits of intercropping pea and canola, a few noticeable trends have appeared. Mixed row orientation appears to be the superior orientation for intercropping. Reasons for this may be many, however, recent research by Fustec *et al.* (2010) with hairy vetch and faba, combined with former findings from Swatsky (1987) with pea, suggest that legumes may contribute fixed nitrogen to the companion crop, and leak nitrogen as in the case of field pea, from their root zones. Added to this Xiao *et al.* (2004) found that beneficial nitrogen fixation increased with root intermingling. This strengthens the evidence of row orientation favoring mixed row configuration compared to triple row configuration in this report. Recent research by Fustec *et al.* in 2013 suggests that intercrops of rapeseed and fababean accumulated 20% more nitrogen than in monocultures. This may be somewhat responsible for the additional yield and LER responses that WADO has observed over the years.

Other interactions not yet defined may be related to, but not limited to, light, disease and insect incidence, maturity differences during the growing season, nutrient demands, and/or water use between these crops. WADO observed no differences in light interception in pea canola intercrops or their monocrop derivatives in relation to intercrop yield differences. The relationship with yield and LER becomes more positive in terms of soil moisture and its relationship to intercrop row arrangement. In 2013 there were significant differences in percent soil moisture with greater water use in the mixed,

single, double, and then triple row cropping systems, respectively. This is further evidence that closer proximity of the root zones may enhance nutrient (nitrogen) uptake, leading to growth and therefore greater water uptake (leading to lower soil moisture levels). This may assist in drying out waterlogged soils and may explain the large yield responses in mixed pea canola rows in 2011 (Holzapfel 2011) when soils were saturated compared to single or double row configuration intercrop systems.

Although pea splits, seed weights, lodging and maturity were measured in this project there were few differences to be concerned with in respect to row orientation or nitrogen rates.

Intercropping appears to make economic sense compared to monocropping. Although more income is generated in monocrop pea production in this study (given the market price used) compared to monocrop canola production, these results indicate that intercropping yield is greater (by more than 50%) than half monocrop values combined. This experiment suggests that a sizeable crop of canola could be produced along with a pea crop, using lower quantities of commercial applied nitrogen fertilizers and relying on nitrogen fixation. This in turn may reduce input costs and net greater income returns.

So why not just grow peas if they make more money? Yes, it is possible to make more money growing peas rather than intercropping or growing canola based on the results and costs taken into consideration in this experiment. However, in the context of food production per acre, intercropping appears to be more efficient based on land equivalent ratios realized. Peas can also be difficult to grow as a monocrop as rocks, lodging, flooding tolerance, diseases, insects, dirt tag, and splits can be major issues. Intercropping may reduce the risk of these factors in production. In addition, if a producer is in a position to expand the land base of the farm and their neighbors are not offering land for sale or rent, intercropping could indirectly increase production per acre rather than acquiring that property at a lifetime of cost.

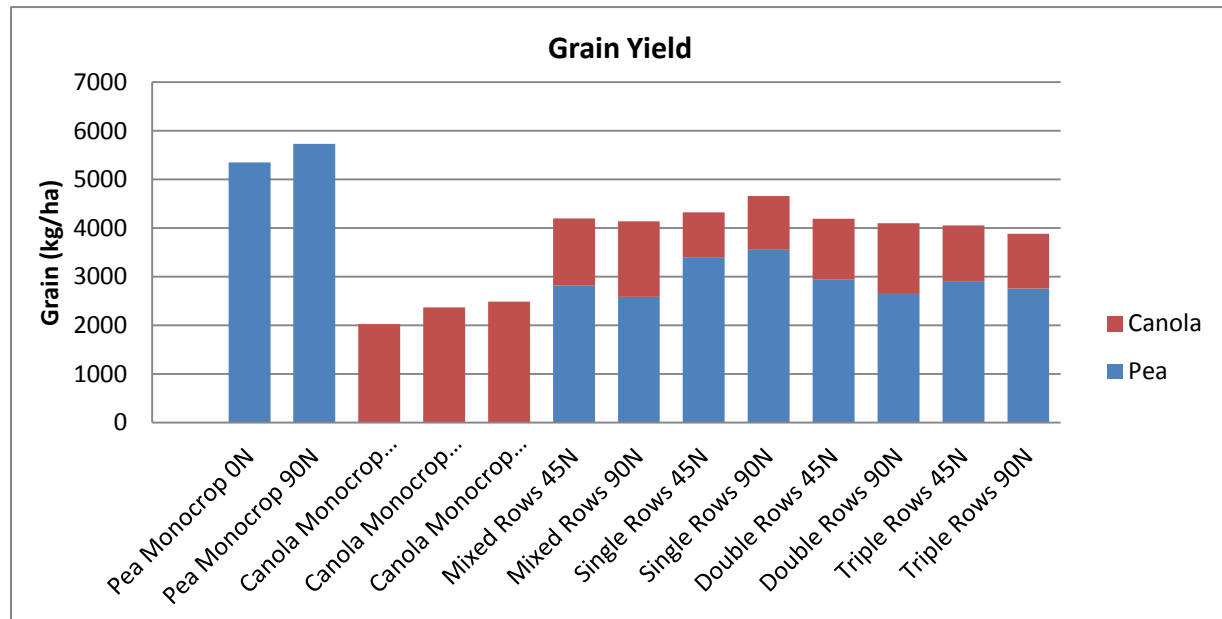
Intercropping has already been adopted by some early pioneers with moderate success in Manitoba and Saskatchewan. The interaction between pea and canola observed by WADO can be best described as a form of *commensalism*, described as an interaction that stimulates one organism but has no effect on the other (Terrestrial Plant Ecology, 3<sup>rd</sup>. Ed.). Results from the relationship between canola yield and percent soil moisture among row orientations suggests that pea may be providing some free nitrogen to canola leading to increased yield and LER, whereas the effect on pea is neutral (no yield loss experienced).

Intercrop performance appears to have greater potential in net revenues than cropping just canola. This could provide some sort of intrinsic insurance when one of the crop components does poorly in one year while the other component does well. Crop insurance for this system remains to be an issue in Manitoba due to the lack of available insurance in general. However, a couple firms in Saskatchewan have developed ways to insure intercropping pea canola in terms of hail insurance.

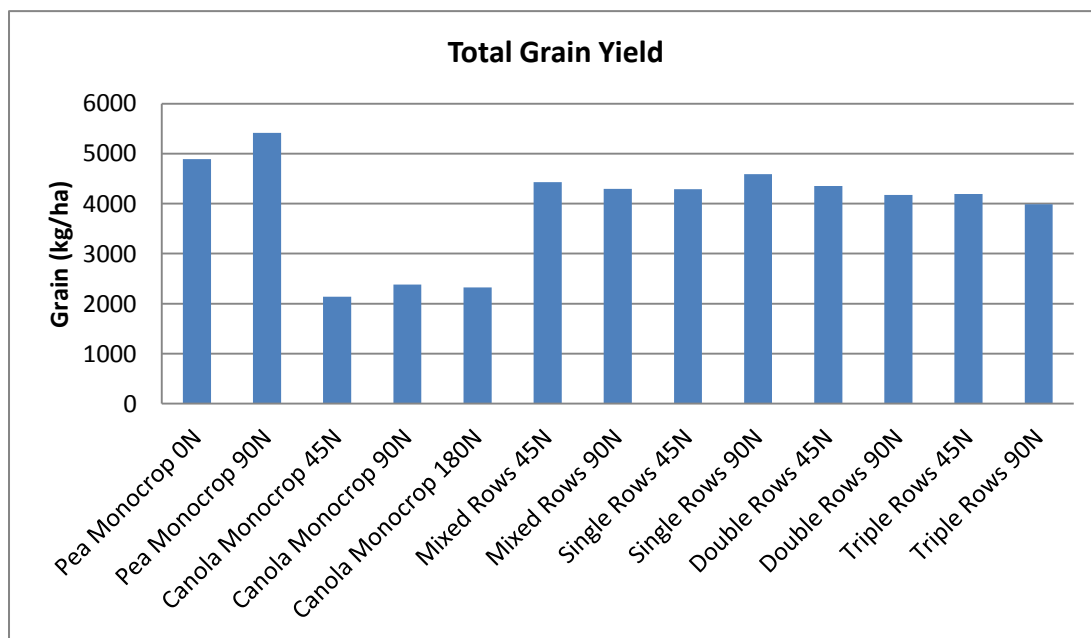
Intercropping is ideal for areas where canola and pea markets exist locally. Generally canola is marketable anywhere across the prairies but pea markets are fewer in Manitoba than Saskatchewan,

which may deflate market value prospects in Manitoba or inflate transportation costs out of Manitoba to Saskatchewan.

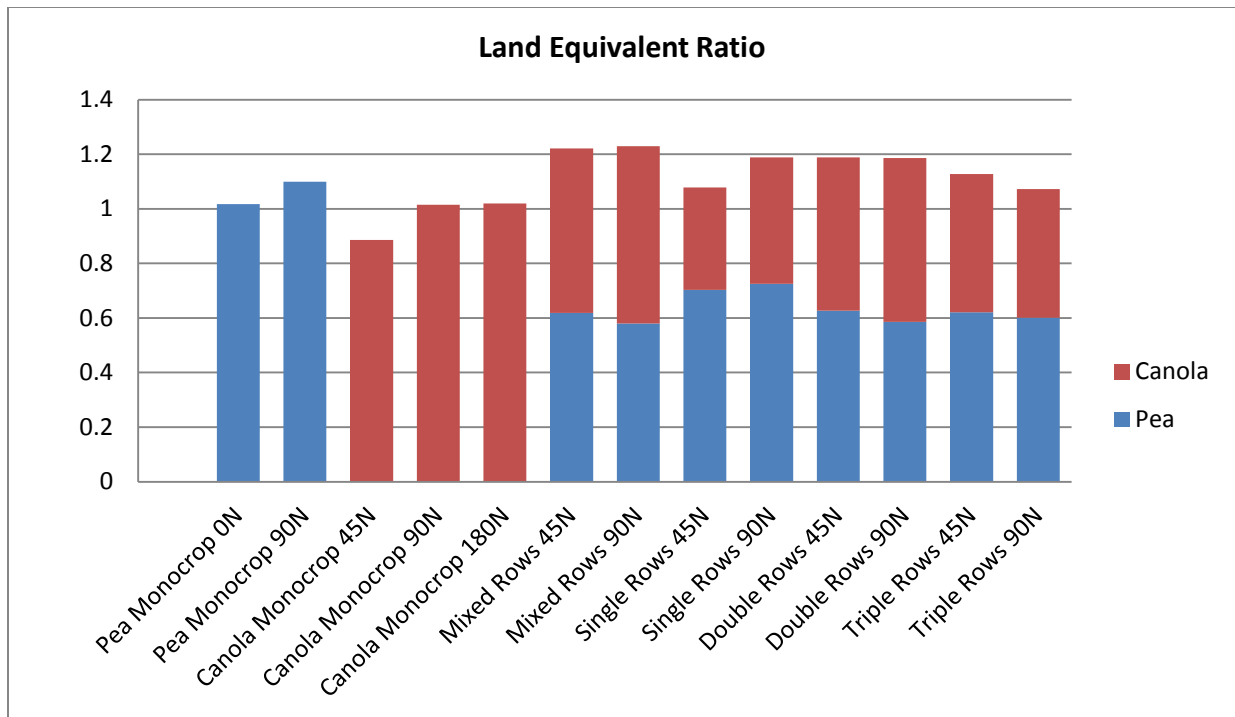
WADO has been tracking producer intercropping involvement. Producers are encouraged to contact WADO and report their intentions, agronomic and yield information for research purposes.



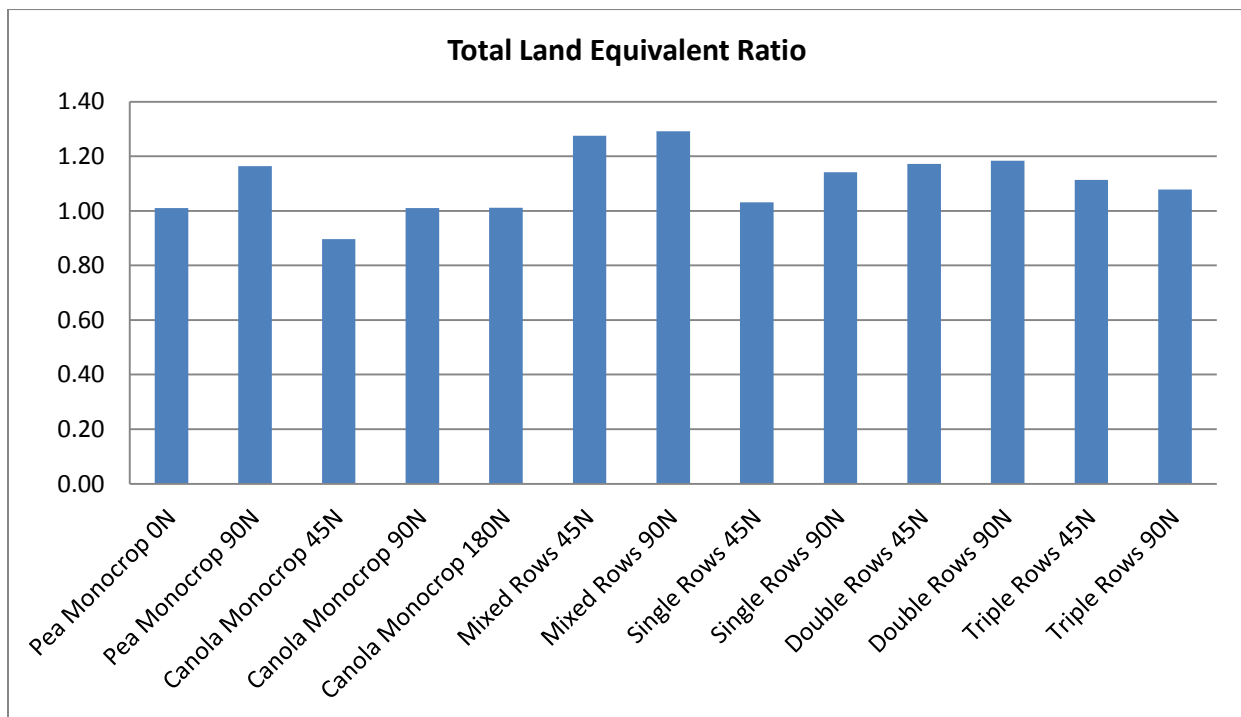
**Figure 3:** Pea canola component grain yield REML means within monocrop and intercrop systems from 2011 to 2013.



**Figure 4:** Total pea canola grain yield REML means within monocrop and intercrop systems from 2011 to 2013.



**Figure 5:** Pea canola component land equivalent ratios REML means within monocrop and intercrop systems from 2011 to 2013.



**Figure 6:** Total land equivalent ratio REML means within monocrop and intercrop systems from 2011 to 2013.

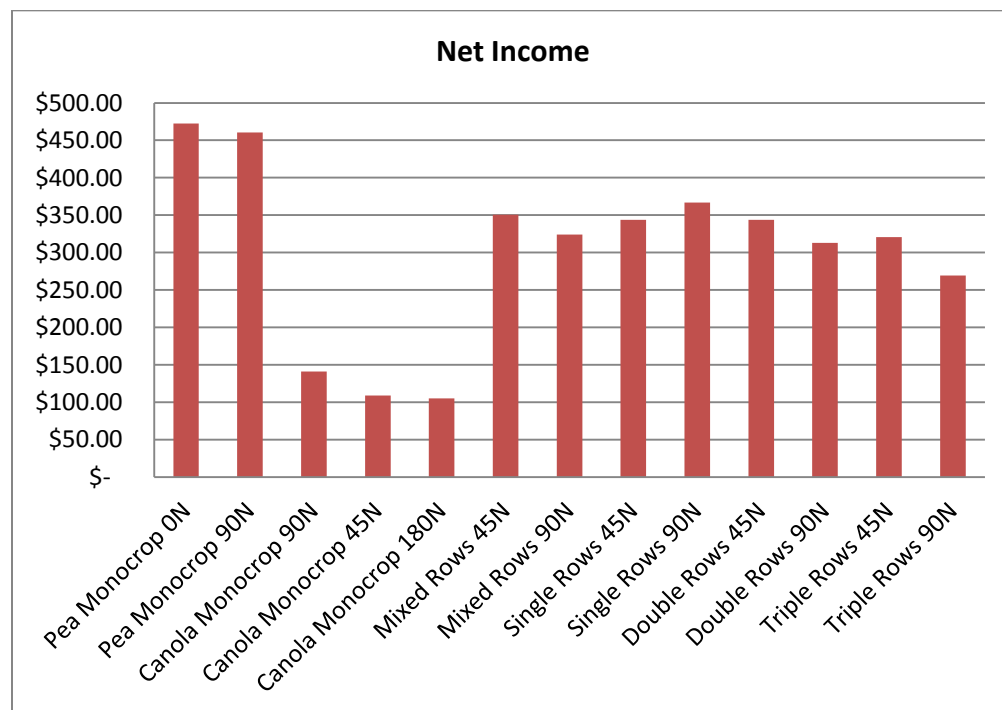


**Table 11:** Individual treatment cost of production of pea canola monocrop and intercrop systems.

Treatment No.	1	2	3	4	5	6	7	8	9	10	11	12	13
Crop Orientation	pea monocrop	pea monocrop	canola monocrop	canola monocrop	canola monocrop	mixed rows	mixed rows	single rows	single rows	double rows	double rows	triple rows	triple rows
Field N Rate lbs/ac	0	90	90	45	180	45	90	45	90	45	90	45	90
<b>Operating Cost</b>													
Seed and Treament	\$ 45.00	\$ 45.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 52.50	\$ 52.50	\$ 52.50	\$ 52.50	\$ 52.50	\$ 52.50	\$ 52.50	\$ 52.50
Fertilizer	\$ 13.75	\$ 72.30	\$ 72.30	\$ 44.40	\$ 128.10	\$ 44.40	\$ 72.30	\$ 44.40	\$ 72.30	\$ 44.40	\$ 72.30	\$ 44.40	\$ 72.30
Herbicide*	\$ 25.75	\$ 25.75	\$ 25.75	\$ 25.75	\$ 25.75	\$ 25.75	\$ 25.75	\$ 25.75	\$ 25.75	\$ 25.75	\$ 25.75	\$ 25.75	\$ 25.75
Fuel	\$ 14.56	\$ 14.56	\$ 14.24	\$ 14.24	\$ 14.24	\$ 14.24	\$ 14.24	\$ 14.24	\$ 14.24	\$ 14.24	\$ 14.24	\$ 14.24	\$ 14.24
Machinery Operating	\$ 10.50	\$ 10.50	\$ 10.50	\$ 10.50	\$ 10.50	\$ 10.50	\$ 10.50	\$ 10.50	\$ 10.50	\$ 10.50	\$ 10.50	\$ 10.50	\$ 10.50
Crop Insurance	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Other**	\$ 8.25	\$ 8.25	\$ 8.25	\$ 8.25	\$ 8.25	\$ 10.25	\$ 10.25	\$ 10.25	\$ 10.25	\$ 10.25	\$ 10.25	\$ 10.25	\$ 10.25
Land Taxes	\$ 4.35	\$ 4.35	\$ 4.35	\$ 4.35	\$ 4.35	\$ 4.35	\$ 4.35	\$ 4.35	\$ 4.35	\$ 4.35	\$ 4.35	\$ 4.35	\$ 4.35
Drying Cost	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Interest (5% for 6 months)	\$ 3.05	\$ 4.52	\$ 4.88	\$ 4.19	\$ 6.28	\$ 4.05	\$ 4.75	\$ 4.05	\$ 4.75	\$ 4.05	\$ 4.75	\$ 4.05	\$ 4.75
Total Operating	\$ 125.21	\$ 185.23	\$ 200.27	\$ 171.68	\$ 257.47	\$ 166.04	\$ 194.64	\$ 166.04	\$ 194.64	\$ 166.04	\$ 194.64	\$ 166.04	\$ 194.64
<b>Fixed Cost</b>													
Land Investment	\$ 22.50	\$ 22.50	\$ 22.50	\$ 22.50	\$ 22.50	\$ 22.50	\$ 22.50	\$ 22.50	\$ 22.50	\$ 22.50	\$ 22.50	\$ 22.50	\$ 22.50
Machinery Depreciation	\$ 27.50	\$ 27.50	\$ 27.50	\$ 27.50	\$ 27.50	\$ 27.50	\$ 27.50	\$ 27.50	\$ 27.50	\$ 27.50	\$ 27.50	\$ 27.50	\$ 27.50
Machinery Investment	\$ 6.88	\$ 6.88	\$ 6.88	\$ 6.88	\$ 6.88	\$ 6.88	\$ 6.88	\$ 6.88	\$ 6.88	\$ 6.88	\$ 6.88	\$ 6.88	\$ 6.88
Storage Cost***	\$ 3.52	\$ 3.52	\$ 3.52	\$ 3.52	\$ 3.52	\$ 7.04	\$ 7.04	\$ 7.04	\$ 7.04	\$ 7.04	\$ 7.04	\$ 7.04	\$ 7.04
Total Fixed	\$ 60.40	\$ 60.40	\$ 60.40	\$ 60.40	\$ 60.40	\$ 63.92	\$ 63.92	\$ 63.92	\$ 63.92	\$ 63.92	\$ 63.92	\$ 63.92	\$ 63.92
<b>Labour Cost^</b>	\$ 20.00	\$ 20.00	\$ 20.00	\$ 20.00	\$ 20.00	\$ 22.00	\$ 22.00	\$ 22.00	\$ 22.00	\$ 22.00	\$ 22.00	\$ 22.00	\$ 22.00
<b>TOTAL COST</b>	<b>\$ 205.61</b>	<b>\$ 265.63</b>	<b>\$ 280.67</b>	<b>\$ 252.08</b>	<b>\$ 337.87</b>	<b>\$ 251.96</b>	<b>\$ 280.56</b>	<b>\$ 251.96</b>	<b>\$ 280.56</b>	<b>\$ 251.96</b>	<b>\$ 280.56</b>	<b>\$ 251.96</b>	<b>\$ 280.56</b>
* based one burnoff application of Cleanstart (Credit @ 0.5L/ac, Aim @ 15 mL/ac), Odyssey @ 17.3g/ac, Merge Adjuvant, Arrow @ 80 mL/ac													
**based on an extra cost of \$1/ac to use a rotary seed cleaner, \$1/ac for an extra auger													
***based on needing double the storage for two separate crops													
^Labour cost inflated for intercropping due to the extra labour needed to ship, clean and harvest intercrops													

**Table 12:** Cost of production applied to grain component means from REML analysis realized from 2011 to 2013 with the corresponding gross and net income values of each pea canola monocrop and intercropping system.

Treatment	Crop System	COP	Income	
			Gross	Net
1	Pea Monocrop 0N	\$ 205.61	\$ 677.94	\$ 472.32
2	Pea Monocrop 90N	\$ 265.63	\$ 726.21	\$ 460.58
3	Canola Monocrop 90N	\$ 280.67	\$ 421.65	\$ 140.98
4	Canola Monocrop 45N	\$ 252.08	\$ 360.91	\$ 108.83
5	Canola Monocrop 180N	\$ 337.87	\$ 442.85	\$ 104.98
6	Mixed Rows 45N	\$ 251.96	\$ 602.57	\$ 350.61
7	Mixed Rows 90N	\$ 280.56	\$ 604.53	\$ 323.97
8	Single Rows 45N	\$ 251.96	\$ 595.54	\$ 343.58
9	Single Rows 90N	\$ 280.56	\$ 647.57	\$ 367.01
10	Double Rows 45N	\$ 251.96	\$ 595.73	\$ 343.77
11	Double Rows 90N	\$ 280.56	\$ 593.65	\$ 313.09
12	Triple Rows 45N	\$ 251.96	\$ 572.47	\$ 320.51
13	Triple Rows 90N	\$ 280.56	\$ 549.75	\$ 269.19



**Figure 7:** Net income values of pea canola monocrop and intercrop systems realized from grain yield means from 2011 to 2013.

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## Sunflower Intercropped with Hairy Vetch

Westman Agricultural Diversification Organization Inc. (2014)

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Hairy vetch (*Vicia villosa*) is considered a winter annual and also noted as a biennial or perennial. The plant is a fine stemmed, viney legume that is adapted to most soil types and is very competitive. Vines can grow over 100 cm long when able to trellis. Hairy vetch, grown on its own, lodges and tangles profusely with a height of 30 cm (similar to a good crop of Laird Lentils) and becomes difficult to swath. It apparently can contribute 60-120 lbs/ac nitrogen back to the soil from nitrogen fixation (source [www.hort.purdue.edu](http://www.hort.purdue.edu) ). Hairy vetch has become popular in organic plow downs, and the cover crop cultures for this reason. WADO's observations with hairy vetch indicate the plant has good late season frost tolerance, but has highly variable (16-80%) winter survivability depending on environmental conditions and seed source. Root development is rather shallow and similar to field pea, which may make it a good candidate with deep rooted crops in intercropping systems. Pod maturity is late seasoned (late August) when planted in the spring (May), and prone to shatter. Hairy vetch pasturage and seed can be toxic to livestock and should not be fed as forage in full bloom or containing seed, but is safe as a silage or hay. (Panciera R.J, Ritchey J.W & D.A 1992. Hairy Vetch Poisoning in Cattle: Update and Experimental Induction of Disease. J VET Diagn Invest. Vol. 4: 318-325). However, prior to seed production, hairy vetch feed quality is exceptional and is similar to alfalfa (WADO feed analysis, Oct 2008). Hairy vetch can be pastured, hayed, or ensiled (Heson P.R., Schotch H.A., 1968 Vetch culture and uses. US Department of Agriculture Farmers' Bulletin 1740. US Government Printing Office, Washington DC.).

Intercropping sunflower and hairy vetch may have some similar objectives as in corn and hairy vetch. Compatibility in herbicide use, timing of physiological development of both crops, potential fall-winter grazing in sunflower fields, and differing root zones make these two crops ideal candidates for intercropping. Authority 480 herbicide (sulfentrazone) distributed by NuFarm and FMC was registered for use in sunflower in 2011 in Manitoba. It is also compatible (unregistered) for weed control in hairy vetch according to observations by WADO (2009, 2011 and 2013). By nature sunflower planted in spring develops



its growth stages rather quickly in June. Hairy vetch on the other hand, develops rather slow initially, then peaks significant biomass development in August when planted in the spring. By this time, sunflower has finished physiological development, drops its leaves and allows hairy vetch to continue to flourish. The potential of intercropping sunflower and hairy vetch is rather large.

The objective of this trial is to:

1. Understand the interaction between sunflower yield and hairy vetch,
2. Understand the nitrogen economy and its economic value applied to monocrop and intercrop systems of sunflower and hairy vetch.

WADO conducted an experiment with row cropped sunflowers and intercropped hairy vetch in 2013 and 2014. In 2012, the same trial was conducted but seed yield was lost due to blackbirds.

## Methods

A soil test was taken prior to seeding the plots to determine background nutrient profiles. Trials were planted into a Hartney Argue Cameron Sandy Loam southwest of Broomhill, MB. Plots were seeded into spring wheat stubble.

Soil Test							
Legal Land Location NW 29-4-27W1							
Depth	pH	N ppm	P ppm Olsen	K ppm	S lbs/ac	Salts mmhos/cm	Organic Matter
0-6"	7.9	7	6	203	6	0.25	3.7
6-24"		7			7		

Trial area was pre-treated with a tank mix of Roundup, Aim and Authority herbicide at 1 L/ac, 10 ml/ac, and 100 ml/ac, respectively, prior to seeding on June 9th. Plot treatments consisted of 30" row confectionary sunflowers (10" spacing variety '6946' from NuSeed America) with and without hairy vetch. Sunflowers were direct seeded at a depth of 1" using an air seeding system with Seedhawk dual knife openers by directing three 9.5" rows into one 30" row. Hairy vetch seed was broadcast prior to seeding the sunflowers. Hairy vetch was inoculated with pea/lentil granular Rhizobia (BeckerUnderwood). Plot treatments were arranged in a Randomized Complete Block Design that were 1.44 m wide by 9 meters long and were replicated 4 times. Plots were seeded June 9<sup>th</sup>. Fertilizer was side band at a rate of 62 lbs/ac actual nitrogen and 35 lbs/ac actual phosphorous, 30 lbs/acre K and 20 lbs/ac S, using liquid 28-0-0 UAN and granular 11-52-0 MAP and granular potash (0-0-60) and granular ammonium sulfate (21-0-0-24).

A SPAD 502 meter (Spectrum Technologies) was used to measure leaf chlorophyll content in sunflower. Chlorophyll content can be correlated to potential yield and nitrogen deficiencies in leaves. Readings were taken from each plot by sampling 10 random leaves per plot during R5.5 (mid-flower) stage of sunflower development. The second most new leaf was used. The 10 samples were calculated as a plot average. SPAD readings were taken August 6.

One 0.25 m<sup>2</sup> biomass sample of hairy vetch was taken from each hairy vetch treatment plot on October 28<sup>th</sup>. Individual plot samples were sent to Central Testing Laboratories (Winnipeg, MB) for a wet chemistry forage test to determine protein content in order to determine nitrogen fixation accumulation. Individual plot soil tests were taken on October 28<sup>th</sup> prior to freeze up to assess any noticeable differences in soil nutrient content. Plots were soil sampled with 3 cores per plot at 0-6" and 6-24" depths. Soil samples were sent to Agvise Laboratories (Northwood, ND) for analysis of soil nitrogen parameters to assess any nitrogen mineralization and fixation accumulations.

Nitrogen values and economics was subject to a two-way analysis of variance (ANOVA) using Analyze-it 2.03 statistical software (Microsoft) when more than two treatments were compared. Otherwise all other parameters were analyzed with an independent t-test both treatments. Coefficient of variation, standard error, p-values, least significant difference at the 0.05 level of significance (fishers unprotected LSD) and R-squared were calculated.

## **Results**

There were significant differences in sunflower leaf SPAD meter readings, hairy vetch biomass production, hairy vetch protein content, and accumulations of nitrogen from biomass residues (Table 1). There were no differences in sunflower grain test weight or in grain yield.

There were also significant differences in soil nitrogen levels at the 0-6" depth, 6-24" and 0-24" depth totals at the 0.1 level of significance (Table 2). There were highly significant differences in total nitrogen in the system (biomass N + soil N) after harvest. These variations translated into highly significant differences in nitrogen economics but not when nitrogen economics were applied to grain harvest economics overall. This is likely due to the slight reduction in grain yield (although not significant, Table 1) which offset the economic gain of fixed nitrogen by hairy vetch within those sunflower plots. There were significant differences in percent soil organic carbon among treatments with plots cropped with hairy vetch being higher than those without (Table 3).

There were significant differences in weed biomass accumulation among treatments (Figure 1). Those plots that were cropped with hairy vetch had weed accumulations significantly lower than the sunflower monocrop plots.

**Table 1:** SPAD meter reading of sunflower plants, hairy vetch biomass, nitrogen accumulation in biomass, sunflower crop height, sunflower grain test weight, and sunflower grain yield in sunflower and hairy vetch intercrops compared to their monocrop derivatives.

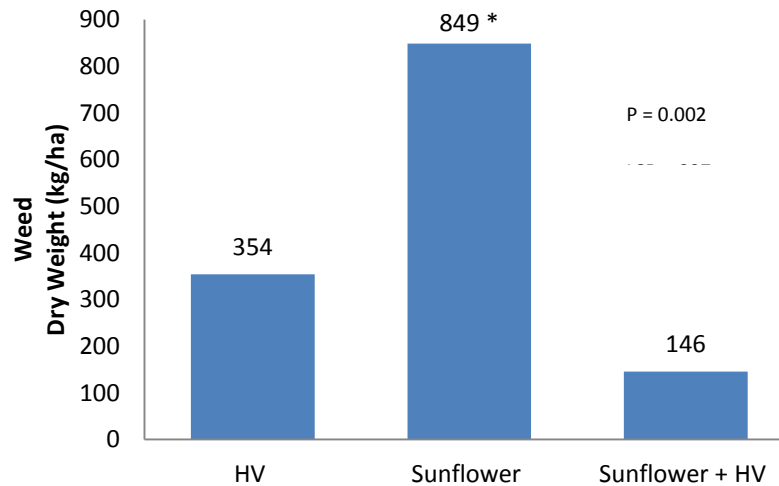
Treatment	SPAD	HV Biomass	Crude Protein HV	N Biomass Residues	Test Wt	Sunflower Seed Yield
	Mean	kg/ha	%	kg/ha	g/0.5L	kg/ha
Sunflower	31.2	-	-	-	120.8	2234
Sunflower + HV	29.7	5091	18.2	147	115.9	1743
HV	-	7602	21.7	266	-	-
Grand Mean	30.4	6347	20.0	206	118	1989
P value (two-tailed)	<b>0.013</b>	0.065	<b>0.044</b>	<b>0.027</b>	0.354	0.269
Standard Error	0.4	1113	1.4	41	5	403

**Table 2:** Total residual soil nitrogen, biomass nitrogen, total nitrogen values and their economic values (assuming a nitrogen value of \$0.55/lb) of the N itself and the value of that N applied to the grain system value (assuming 32.00 cwt value for sunflower grain) under plots of hairy vetch and sunflower intercropping compared to their monocrop derivatives

	Nitrogen lbs/ac				\$ /ac		
Treatment	0-6"	6-24"	0-24"	Biomass + Soil N	Total System N Value	Gross Income	
HV	19	17	36	272 c	\$ 149.83 c	\$ 149.83	a
Sunflower	11	11	21	21 a	\$ 11.55 a	\$ 648.28	b
Sunflower + HV	15	11	26	157 b	\$ 86.39 b	\$ 583.26	b
CV%	29	23	24	22	22	27	
LSD (p<0.05)	NS	NS	NS	58	\$ 31.71	\$ 214.29	
LSD (p<0.1)	6	4	9	-	-	-	
Grand Mean	15	13	28	150	\$ 82.59	\$ 460.46	
P value	0.079	0.055	0.0503	<b>0.0001</b>	<b>0.0001</b>	<b>0.002</b>	

**Table 3:** Percent soil organic matter after crop production in October and standard error after each cropping treatment.

Treatment	% Organic Matter	S.E.
HV	3.13 b	0.17
Sunflower	2.90 a	0.10
Sunflower + HV	3.15 b	0.13
CV	3.97	
LSD (p<0.05)	0.21	
P value	<b>0.0499</b>	



**Figure 1:** Weed biomass accumulation in monocrop and intercrops.

## Discussion

As in 2013, the prospect of intercropping hairy vetch with sunflower looks promising according to the 2014 results. It appears that there is no significant reduction in grain yield, test weight, or final economic values once again.

Hairy vetch is a possible host for cutworm and earworm development. This may aggravate the already susceptible sunflower plant who is also a favorite for cutworms early in development. Further field examination may be required in future testing to determine the extent of this issue.

Intrinsic benefit may be realized in future rotation crop such as greater soil N residue credits produced from the hairy vetch in the preceding year as well as soil and ecosystem health and grazing day potential that could be utilized in real time after harvest. With just over 2 ton per acre of available forage, a significant grazing period could be utilized. There were also no harvest issues having extra biomass below the sunflower heads as the hairy vetch did not interfere with harvest of the head or the knife or pickup of the combine.

The potential for grazing sunflower stubbles intercropped with hairy vetch seems promising but poisoning from hairy vetch in livestock is still a risk. The economic value of the N credit (assuming 55 cents/lbs N) from hairy vetch residues is similar to the value of the forage itself (assuming 2 cents/lbs market value). Based on the economic values it would be a decision in the hands of the producer to choose to graze or leave residues for N credit for the next crop.

A substantial increase in percent soil organic matter when intercropping with hairy vetch may also prove to have intrinsic benefits for future years crop economics.



Due to the competitive nature of hairy vetch, weed accumulations were significantly lower in those plots cropped with hairy vetch. An additional cost savings might be realized; however, during the course of this year's study, in crop herbicide applications were not applied. Weeds growing in monocrop plots may have reduced grain yield in those plots, shrouding the yield potential in the current results that may have been greater if they had been kept weed free. This may imply that further research may be warranted in this area.

Direct seeding into hairy vetch mulches may prove difficult with current seeding equipment commonly used by farmers. A vertical tillage unit or a discer may be required to manage such heavy and tangled residues. The development of seeding openers designed to manage thick thatches of biomass may prove beneficial in this scenario.

Use of applied nitrogen fertilizers in Hairy vetch is likely unorthodox. In legumes such as pea, addition of nitrogen fertilizers and or peas grown on nitrogen rich soils may fail to nodulate properly and prefer to uptake nitrogen from soil based nitrogen reserves. It is believed that hairy vetch reacts in a similar way if high levels of nitrogen are present at the time that nodulation should occur. This may create a nutrient deficiency overall for sunflower. SPAD meter results from this trial in 2014 suggest that sunflowers were struggling to have proper nitrogen nutrition in intercrop plots compared to monocrop plots. However, later in the season, evidence of insignificant grain yield differences in sunflower and insignificant soil test differences would suggest sunflower recovering yield possibly though nitrogen uptake from fixed nitrogen in vetch intercrops (ie. hairy vetch donating extra nitrogen to sunflower). In 2013, SPAD meter readings were not significant between intercrops and monocrops. Specific nitrogen placement in sunflower rows or slow release products may assist in proper nodulation in hairy vetch and sunflower nutrition.

Hairy vetch seed was not produced late season in 2014 as it was in 2013. Environmental conditions, such as heavy rain (164% of normal in 2014 versus 128% in 2013) may have delayed seed set in hairy vetch.

Volunteer seed banks of hairy vetch become a concern for the selection of the next crop. There are weed control options to control hairy vetch, but they are less likely to be found if a pulse crop would be in rotation after sunflowers such as peas, lentils, dry beans or faba beans. A cereal crop would likely pose the most options to control volunteer hairy vetch seedlings in the next growing season. If hairy vetch is planted later it reduces the time for the plant to produce seed before fall frosts.

Sunflower and weed biomass variables should have been measured in this trial to fully understand the nitrogen economy of each system. Furthermore,  $N^{15}$  isotope testing would assist in understanding the amount of transfer between crops.

**Photos:**



July 17<sup>th</sup>. All three cropping system treatments, hairy vetch, sunflower and the intercrop. Sunflower with a head start in growth. At this stage hairy vetch development appears slower and is focused on ground coverage with very little upward growth noted.



August 6<sup>th</sup>. Sunflower in a rapid growth stage at this point and hairy vetch just starting to accelerate its growth.



August 22<sup>nd</sup>. Sunflower has utilized most of its resources required for growth by now and plant growth peaks. Sunflowers start to set seed. Hairy vetch is climbing the sunflower stalks and enters a rapid growth stage.



October 9<sup>th</sup>. Sunflower completely mature and terminated by a frost. Hairy vetch continues to grow and fix nitrogen long after the sunflowers have stopped their nutrient demand.

Note the left plot is flat, characteristic of the hairy vetch monocrop, while the right plot has vetch climbing upright on the sunflower stalks.



October 28<sup>th</sup>. Hairy vetch still continues to grow. Dense thatch of hairy vetch almost three inches thick suppresses any sort of winter annual weed growth. Some of the mat has already started to decompose in contact with the ground.

## Performance of *Brassica carinata* Varieties to *Brassica napus* (Argentine Canola)

**Cooperators:** Agrisoma Biosciences Inc. – Ottawa, ON [www.agrisoma.com](http://www.agrisoma.com)

### Introduction

*Brassica carinata* A. Braun, commonly known as Ethiopian mustard, has an oil profile ideal for use in the biofuel industry, specifically for biojet fuel. This crop is extremely well suited to production in semi-arid areas. It offers good resistance to biotic stressors, such as insects and disease, as well as abiotic stressors, such as heat and drought. Carinata is a vigorous crop with a high branching growth pattern and large seed size. It has excellent harvestability with good lodging and shatter resistance. An elite line (AAC A100 & AAC A110) has been developed by Agrisoma Biosciences Inc. selected for 2012, and has the following production characteristics:

- Oil Content 44%

- Protein 28%
- Maturity Zone is Mid-long season (12-14 days later than oriental mustard)
- Blackleg Resistance Excellent
- Lodging Resistance Very Good to Excellent

*Brassica carinata* will be able to access the full suite of *Brassica* spp. pest control options. Minor use registrations targeting seed treatments, selective broadleaf and grass control herbicides have been initiated. (Source: Agrisoma Biosciences Inc.)

*Brassica carinata* has 34 chromosomes with genome composition BBCC, and is thought to result from an ancestral hybridisation event between *Brassica nigra* L. (genome composition BB) and *Brassica oleracea* L. (genome composition CC). *B. carinata* has high levels of undesirable glucosinolates and erucic acid making it a poor choice for general cultivation as an oilseed crop in comparison to the closely related *Brassica napus* L. (canola). On October 29 of 2012, the first flight of a jet aircraft powered with 100 percent biofuel, made from *Brassica carinata*, was completed by Agrisoma Biosciences Inc. (Source: Wikipedia)

Johnson *et al.* (2007) reported that nitrogen requirements for *Brassica carinata* are similar to *Sinapis alba* L. (yellow mustard) and *Brassica napus* (Argentine canola).

In 2012, WADO partnered with Agrisoma Biosciences Inc. to determine the nitrogen-yield response of *B. carinata*, compared to canola and camelina. Results of these studies are found in the 2012 WADO Annual Report. In 2013 and 2014, Agrisoma partnered with WADO to test some new and existing *B. carinata* lines compared to a common *B. napus* (Argentine canola). The 2013 report, which showed a similar comparison, can be found in the 2013 WADO Annual Report.

## Methods

A soil test was taken prior to seeding the plots to determine background nutrient profiles (table 1). Trials were planted into a Newstead Loamy Sand south of Melita, MB. Plots were seeded into winter wheat stubble from the 2013 harvest.

**Table 1:** Spring soil test values prior to seeding in the 0-24" depth for the *B. carinata* variety trial in Melita, MB in 2014.

Legal Land Location	Depth	pH	N ppm	P ppm Olsen	K ppm	S lbs/ac	Organic Matter %
NE 26-3-27 W1	0-6"	7.5	1.5	7	427	14	3.5
	6-24"		9			50	

Fourteen *B. carinata* cultivars and two *B. napus* varieties (L130 LL, 9553 RR) were seeded into plots arranged in a randomized complete block design and replicated four times. Plots were seeded May 15, 2014 at a depth of 1/2". Final plot dimension was 1.44 m wide by 9 m long. Fertilizer was side band at a rate of 72 lbs/ac nitrogen a granular blend of 12-17-15-10 applied at 200 lbs/ac. Before seeding, the area

was burned off with a tank mix of glyphosate, Rival, and Aim at a rate of 1 L/ac, 0.5 L/ac, and 30 ml/ac, respectively on May 14. Matador insecticide was applied June 6<sup>th</sup> at a rate of 35 ml/ac to control flea beetle infestations. On June 17, Muster and Centurion herbicide was sprayed at a rate of 12 g/ac (plus adjuvant Agral 90) and 0.1 L/ac, respectively to control broadleaf and grassy weeds. Plots were swathed August 15<sup>th</sup> for *B. napus* types and August 29<sup>th</sup> for *B. carinata* types. Plots were harvested for seed yield on September 11<sup>th</sup> with a Classic Wintersteiger plot combine. Data collected included emergence, stand, days to flower, days to maturity, height, seed yield, percent green seed, seed weight, and seed moisture content. Sub samples were sent to Agrisoma for oil content analysis. Data was analyzed with a two-way analysis of variance (ANOVA) Agrobase Gen II statistical software using the nearest neighbours analysis (NNA).

## Results

There were significant differences among varieties of *B. carinata* and between *B. napus* to *B. carinata* (Table 2). *B. napus* varieties were among the worst yielding varieties compared to most other *B. carinata* types. The top yielding varieties differed by as much as 100% compared to the best *B. napus* variety.

There were significant differences in days to flower, crop height, and percent green seed especially with '5499' averaging 24.5%, whereas most other varieties averaged near 1.6%. Also significant differences were found in seed weight, where generally *B. carinata* types were heavier than *B. napus* types by about 28% on average. There were no significant differences in lodging.

**Table 2:** Brassica carinata variety performance and yield values in Melita, MB in 2014.

Variety	Days to Flower days	Crop Height cm	Lodging 1-5 (5=flat)	Seed Weight g/500 seeds	Yield kg/ha	Green Seed %
5488	61	104	3	3.9	2570 a	0.8
110994EM	56	103	3	3.6	2554 a	2.3
AAC A110	58	102	2	3.5	2505 a	1.3
5223	57	85	3	3.6	2450 ab	1.5
5228	56	95	3	3.6	2349 abc	2.3
5489	57	85	3	3.6	2280 abc	3.3
5492	59	98	4	3.6	2255 abc	2.0
5454	60	89	3	4.0	2220 abcd	1.3
5499	57	87	3	3.8	2191 abcd	24.5
5494	56	84	3	3.6	2113 abcd	1.5
5493	57	83	3	3.8	1971 bcd	1.5
5503	55	81	4	3.5	1917 cd	1.0
5500	55	79	4	3.2	1907 cd	1.8
L130 LL	54	97	3	2.9	1717 de	0.8
5509	54	84	3	2.9	1350 e	1.3
9553 RR	54	91	2	2.7	1287 e	1.3
Coefficient of Variation	2.2	10.5	25.1	6.6	14.6	68.2
LSD (p<0.05)	2	14	1.1	0.3	438	2.9
P value	<0.0001	0.002	0.059	<0.0001	<0.0001	<0.0001
Significant?	Yes	Yes	No	Yes	Yes	Yes
Grand Mean	56	90	3	3	2102	3
R-Square	0.79	0.55	0.40	0.78	0.69	0.92

## Observations

Some of the highest yielding varieties of *carinata* were also the tallest in crop height. Being *carinata* and inherently shatter resistant, these varieties would likely be suited for straight cutting as their height (leading to canopy lodging) would likely reduce shatter losses during harvest. These varieties would include 5488, 110994EM, and AAC A110.

Over the past several years growing *carinata*, WADO has experienced heavy flea beetle infestations requiring multiple insecticide applications throughout the season over the same trial. Producer should plan to use a registered seed treatment or in crop insecticide spray.

During the time of the trial, the Melita location received 128% of normal rainfall. *B. carinata* is more adapted to drier conditions than canola. *B. carinata* and canola yields may have been suppressed by excessive soil moisture. This was similar to growing conditions in 2013; however, the *B. napus* check (Nexera 2012 CL) fared better in 2013 than in 2014.

## Conclusions

Given the extensive ancestry of *carinata* in the rather large and diverse mustard family, *carinata* has a promising future. WADO plans to continue its research efforts with *B. carinata* and Agrisoma Biosciences Inc.

In general, most varieties of *B. carinata* statistically held up against the yield potential of the *B. napus* canola variety. This is comparable to results observed in the WADO 2012 and 2013 trials.

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**Photo:** Argentine canola (left) and *Brassica carinata* on right August 7, 2014 near Melita, MB. Canola is maturing earlier than *B. carinata*.

## Herbicide Screening and the Effects of Betamix $\beta$ Herbicide Rates for Buckwheat Production

**Cooperator:** Manitoba Buckwheat Growers Association – Les McEwan

### Introduction

Currently buckwheat has few herbicides registered for controlling weeds in Manitoba. Only Poast Ultra (450 g/L sethoxydim, BASF Canada) is currently registered for use preseed or in crop at all stages. Restrictions for its use must be followed to avoid unacceptable residues of sethoxydim in the harvested crop. Sethoxydim is a Group 1 herbicide. Recent herbicide resistance among several weed species including Wild Oats (1990), and Green Foxtail (1991) to Group 1's has become evident in Manitoba fields. Other weed species such as Redroot Pigweed, Wild Buckwheat, Cleavers, and volunteer canola have herbicide tolerances of their own and often populate buckwheat stands. As a result, buckwheat can be a difficult crop to manage.

Betamix- $\beta$  EC (Bayer CropScience Canada) is a selective post emergent herbicide used in sugar beets, spinach, June-bearing strawberries and is registered across Canada. Betamix is composed of two active ingredients including desmedipham (153 g/L) and phenmedipham (153 g/L) and is a Group 5 herbicide.

In June-bearing strawberries and garden beets, Betamix is applied at rates between 1.15-1.75 L/ha (0.47 L/ac - 0.70 L/ac). Referenced from Bayer CropScience Label.

Weeds Controlled include:

Group I: Weeds vulnerable to Betamix if sprayed before reaching the 4 leaf stage.

<u>Common Name</u>	<u>Scientific Name</u>
Lamb's-quarters	<i>Chenopodium album</i>
Wild Buckwheat	<i>Polygonum convolvulus</i>
Green Foxtail (Wild Millet)	<i>Setaria viridis</i>
Yellow Foxtail (Pigeon Grass)	<i>Setaria glauca</i>
Mustard	<i>Brassica spp. Sisymbrium spp.</i>
Pigweed	<i>Amaranthus spp.</i>

Group II: Weeds which may be controlled if sprayed before reaching the 2 leaf stage, when use of Betamix is preceded by a pre-plant or pre-emergence herbicide treatment.

<u>Common</u>	<u>Name Scientific Name</u>
Nightshade	<i>Solanum spp.</i>
Kochia*	<i>Kochia scoparia</i>
Goosefoot	<i>Chenopodium spp.</i>
Ragweed	<i>Ambrosia spp.</i>
Stinkweed	<i>Thlaspi arvense</i>
French weed	Field Pennycress

\*Spray Kochia while in the rosette stage, less than 2.5 cm in diameter.

In the summer of 2012, WADO initiated a small herbicide screening trial on buckwheat to explore the response of buckwheat to several herbicides (non-registered) including post-seeding pre-emergent use of Linuron 400 SC [United Agri-Products] (400 g a.i./L) at a low and high rates. Minimal crop injury (at 0.75 L/ac rate) and to a lesser extent, lack of stand reduction, indicated that the use of linuron might exhibit promising potential as a weed control option in buckwheat. In 2013, WADO tested several increments of increasing rates of linuron applied pre-emergent to buckwheat. Based on results from this trial, linuron appeared to be a promising herbicide offering plant stand safety, with no apparent effect on grain yield and the potential to be used at low rates. Grain samples were not sent away for residue testing. The results of that trial are summarized in the 2012 & 2013 WADO Annual Reports.

As of September 2012, after a re-evaluation of the herbicide linuron, Health Canada's Pest Management Regulatory Agency (PMRA), under the authority of the Pest Control Products Act, is proposing to phase out the sale and use of all linuron products in Canada. This is because an evaluation of available scientific information found that, under the current conditions of use, the human health and environmental risks estimated for linuron do not meet current standards. To understand more about what the outcome is for linuron in regards to the proposal please visit: [http://www.hc-sc.gc.ca/cps-spc/pest/part/consultations/\\_prvd2012-02/prvd2012-02-eng.php](http://www.hc-sc.gc.ca/cps-spc/pest/part/consultations/_prvd2012-02/prvd2012-02-eng.php). Unfortunately, this was not good news in terms of seeking a minor use registration of the product in the future.



In addition, WADO tested some other *post emergent* products also being researched by other institutions including desmedipham/phenmedipham and Armezon (topramezone). Wall and Smith in 1999 (AAFC) used desmedipham in buckwheat at rates of 500-700 g a.i./ac with success. WADO was unable to get desmedipham for testing (absent in North American Inventory), however, this active was available blended with another chemical as Betamix  $\beta$  (desmedipham + phenmedipham; Bayer Crop Science). WADO hoped that the phenmedipham component of the product would have little effect on buckwheat in addition to the desmedipham component already found to be tolerant by buckwheat by Wall and Smith.

Armezon (BASF Chemical Company, USA) was tested at AAFC (Scott, SK) by Eric Johnson in 2012. Armezon is a Group 27 herbicide. Johnson had some success at lower rates without plant injury. Further testing on Armezon was also initiated again in 2013.

In 2014 a trial was set up to test the efficiency of Betamix on stands of buckwheat. Objectives of this trial included:

1. To observe the crop injury response of buckwheat to various Betamix rates on plant growth and grain yield.
2. To document weed populations and weed control between rates of Betamix.
3. To determine optimal rate of Betamix for maximum yield potential in buckwheat.

## Methods

Plots were located south of Melita, MB on the legal land location NE 27-3-27 W1. Plot treatments were located in winter wheat stubble. A post emergence application of glyphosate (Roundup Transorb) at a rate of 0.33 L/ was applied on June 16. Buckwheat was seeded on June 10 into 6 row plots (9.5" spacing) 1.44 m wide by 9 meters long using SeedHawk dual knife openers. Seeding rate was 183 p/m<sup>2</sup> (63 lbs/ac) using the 'Horizon' variety provided by Nestibo Agra (Deloraine, MB). Fertilizer was side band during seeding at a rate of 88 lbs/ac nitrogen using 28-0-0 UAN, and a granular blend of 12-17-15-10 applied at 200 lbs/ac.

Spring Soil Test:

Depth	pH	N ppm	P ppm Olsen	K ppm	S lbs/ac	Organic Matter %
0-6"	7.4	2.5	4	424	7	3.1
6-24"		4.5			46	

The plot field did not have any residual pre-emergent herbicide applications in 2013 and 2014. Spray treatments were applied July 9<sup>th</sup> at approximately 10 cm crop height. A hand held sprayer pressurized by CO<sub>2</sub> was used to spray each herbicide treatment. Four fan nozzles (8002VS) at 50 cm spacing were pressurized to 40 psi during application. Betamix was applied with water at 10 gal/ac and product rates ranged from 0.25 L/ac to 2.00 L/ac. Treatments were arranged in a randomized complete block design

and replicated three times. A weedy check and a hand weeded check were included to determine a base line for weed pressure and herbicide injury, respectively.

Plots were sprayed with Assure II to control grassy weeds on July 9<sup>th</sup> and 23<sup>rd</sup> at a rate of 0.2 L/ac. The hand weeded check was weeded several times throughout the season to minimize the effects of weed flushes after weeding.

Plots were swathed September 29<sup>th</sup>. Plots were harvested October 10 with a Hege 140 plot combine. Samples were collected, cleaned using a table seed cleaner (Eclipse 432, Seedburo) and weighed. Samples were corrected to 16% moisture.

Data collected included: percent crop injury at flower (of the unsprayed check), photos of each plot at flower, percent flowers delayed (of the unsprayed check), weed spectrum, weed biomass (taken during flower), grain yield, grain test weight, and grain moisture. Weed biomass was taken as a wet weight of fresh weeds hand picked out of plots with an area of 1.44 m<sup>2</sup>. Data was analyzed using Analyze-it 2.03 statistical software (Microsoft Co.) using a two way analysis of variance. Coefficient of variation and least significant difference (Fishers unprotected) was calculated.

Crop injury, flower delay, and weed biomass were used as independent variables and were tested against grain yield (dependent variable) to determine the strength of their relationship to each other using a Pearson correlation analysis to test for their correlation coefficient (r) and the significance of their relationship. If significant, a linear regression analysis was also performed to test for the strength of their association (R-squared) and their equation describing their relationship ( $y = mx + b$ ) also using Microsoft Analyze-it v2.03 statistical software.

## Results

There were significant differences ( $p < 0.05$ ) in percent crop injury at flower (Figure 1), percent flowers delayed ( $p < 0.05$ ) and weed biomass ( $p < 0.1$ ). There were no significant differences in grain yield, and grain test weight (Table 1) despite there being a negative trend associated with increasing rates of Betamix (Figure 1). There was a negative trend in weed biomass with increasing rates of Betamix (Figure 2). In addition, rates used in treatments 3, 5, 6, and 8 resulted in lower weed biomass than the unsprayed check indicating that there was control occurring in weed populations using Betamix herbicide. The 2 L/ac rate did result in a substantial weed reduction similar to the hand weeded check.

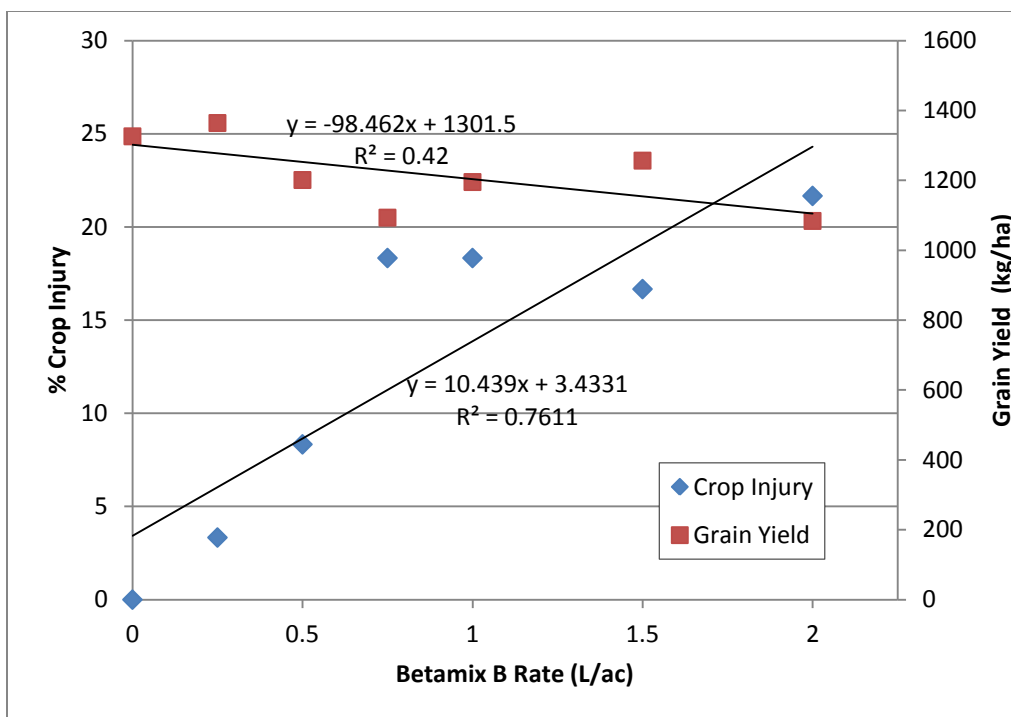
**Table 1:** Percent crop injury of check, percent flowers delayed of check, grain yield, test weight and weed biomass in buckwheat plots under rates of Betamix herbicide in Melita, MB in 2014.

Treatment	Description	Crop Injury at Flower % of checks	Flower Delay Rating % of checks	Grain Yield kg/ha	Test Weight g/0.5L	Weed Biomass (wet) kg/ha
1	Check, unsprayed, hand weeded	-	-	1326	253	926 ab
2	Check, unsprayed, not hand weeded	-	-	1234	256	4352 e
3	0.25 L/ac Betamix $\beta$	3.3	8.3	1364	251	1852 abcd
4	0.5 L/ac Betamix $\beta$	8.3	20.0	1201	249	2731 bcde
5	0.75 L/ac Betamix $\beta$	18.3	21.7	1093	261	3310 cd
6	1 L/ac Betamix $\beta$	18.3	30.0	1195	256	1551 abc
7	1.5 L/ac Betamix $\beta$	16.7	21.7	1257	249	2755 bcde
8	2 L/ac Betamix $\beta$	21.7	46.7	1084	251	509 a
Grand Mean		14.4	25	1219	253	2248
CV%		44	40	16	4	61
LSD ( $p < 0.05$ )		<b>11</b>	<b>18.17</b>	NS	NS	NS
LSD ( $p < 0.10$ )		NA	NA	NS	NS	<b>1967</b>
P value		<b>0.036</b>	<b>0.016</b>	0.64	0.74	<b>0.059</b>
R-squared		0.73	0.77	0.66	0.33	0.60

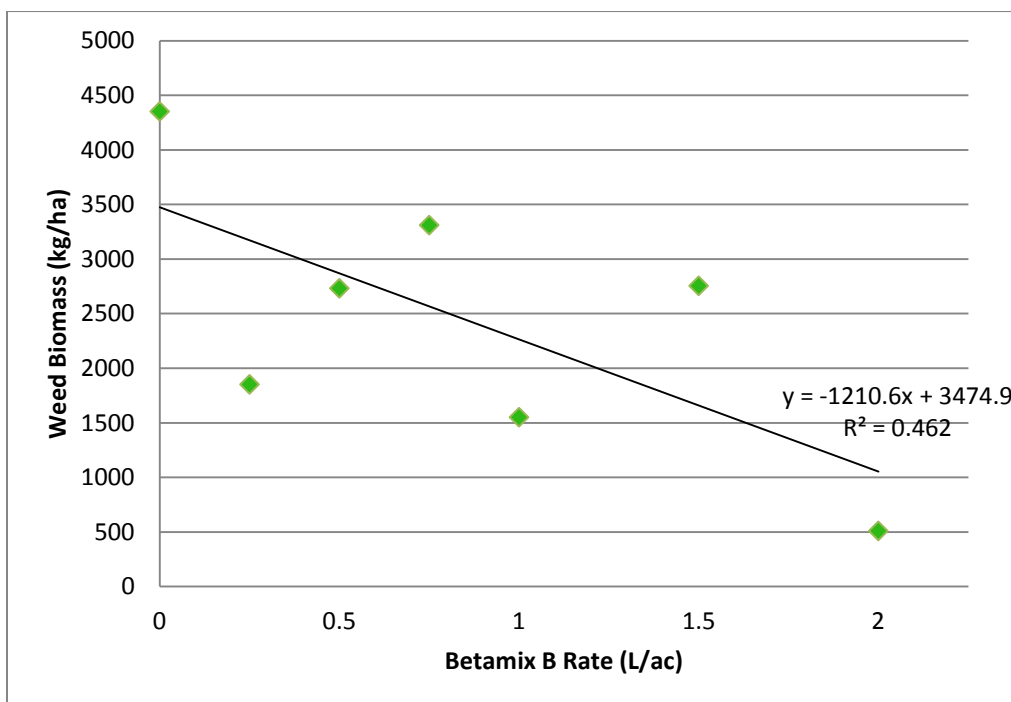
There were significant inverse relationships between crop injury and grain yield as well as flower injury and grain yield (Table 2). There was no relationship between weed biomass and grain yield. This may indicate that the benefits of reduced weed density due to increased Betamix rates were less than that of the effects from herbicide crop injury. In other words, applying higher rates of Betamix did reduce weed competition which should have increase grain yield in buckwheat, but rather reduced buckwheat yield to a greater degree from crop injury. This was supported when a strong relationship ( $r = -0.61$ ) existed between crop injury and yield as well as flower injury ( $r = -0.49$ ) and yield, whereas the relationship between weed biomass and yield was insignificant and weak ( $r = 0.10$ ).

**Table 2:** Relationships between crop injury, flower delay and crop yield in buckwheat from applications of Betamix herbicide in Melita, MB in 2014.

Relationship	Correlation r	P value (2-tailed)	Significant?	Regression R <sup>2</sup>	P value	Significant?	Equation
Weed Biomass x Yield	0.10	0.633	No	0.01	0.633	No	Yield = 1183 + 0.0163(WeedBio)
Crop Injury x Yield	-0.61	0.007	Yes	0.37	0.007	Yes	Yield = 1444 - 16.95(CropInjury)
Flower delay x Yield	-0.49	0.038	Yes	0.24	0.038	Yes	Yield = 1395 - 7.936(FlwrInjury)



**Figure 1:** Responses of mean grain yield and mean crop injury to rates of Betamix in buckwheat near Melita, MB in 2014.



**Figure 2:** Weed response to rates of Betamix in plots of buckwheat near Melita, in 2014.

Within the plots that were surveyed, there were a number of weeds that were controlled by Betamix while others were not (Appendix 1).

Volunteer canola was present in all plots as a weed and there were visual differences in volunteer canola biomass among rates of Betamix. Therefore, there was suppression of volunteer canola rather than control in plots sprayed with Betamix. This trial did not divide weed biomass values among individual weed species. Environmental conditions may have influenced weed control from Betamix applications including excessive moisture before or after application (Appendix 2).

## *Discussion*

Betamix appears to improve weed control in buckwheat production but leads to greater crop injury with higher rates. A 0.5 L/ac rate caused a 10% crop injury at the flower stage; however, this nor higher rates translate into a significant enough crop injury to reduce grain yield. There was a downward trend in yield with increasing rates of Betamix.

Betamix herbicide appears to be a promising herbicide for post application control of weeds in buckwheat. Samples are currently being processed to determine herbicide residues left in grain samples containing Betamix herbicide components. Please contact WADO for further updates on these values.

WADO will likely continue this trial in 2015 to compile a greater data set. After results have been compiled, a formal request to Bayer CropSciences Canada may be initiated, to ask permission to further pursue a formal minor use registration request with Health Canada's Pest Management Regulatory Agency (PMRA ) for use of Betamix on buckwheat in Manitoba.

## *References*

Yeong Ho Lee, Sung Kook Kim, Deug Yeong Song, Hyeon Gui Moon, Seung Keun Jong. 2001. Effects of chemical control on annual weeds in buckwheat. National Crop Experiment Station, RDA, Suwon 441-100, Korea. The proceedings of the 8th ISB: 168-171. Available online at: <http://lnmcp.mf.umi-lj.si/Fago/SYMPO/2001sympoEach/2001s-168.pdf>

E. Johnson. 2012. Tolerance of topramezone herbicide to buckwheat. Pesticide Management Centre. Agriculture and Agri-Food Canada., Scott, SK.

Wall and Smith. 1999. <http://pubs.aic.ca/doi/pdf/10.4141/P98-104>

Betanal (phenmedipham) Label <http://bayeres.com.au/bl/clickstats/default.asp?rid=7287&sid=es>

Betamix  $\beta$  label: [http://www.cropscience.bayer.ca/~media/Bayer%20CropScience/Country-Canada-Internet/Products/Betamix%20B/Betamixb\\_label.ashx](http://www.cropscience.bayer.ca/~media/Bayer%20CropScience/Country-Canada-Internet/Products/Betamix%20B/Betamixb_label.ashx)



**Photos:** Students weighing weeds from plot (above). Buckwheat plots showing some subtle signs of herbicide action compared to weedy checks.



**Appendix 1.** Weed spectrum among the plots tested. Weed biomass represents a 1.44 m2 sample of total weed biomass of all weed types combined and not individual weed species.

Plot	Rep	Treatment	Betamix Rate (L/ac)	Canola	Wild Buckwheat	Porchalaca	Wild Mustard	Red Root Pigweed	Sow Thistle	Dandelion	shepards Purse	French Weed	Goats Beard	Smartweed	Cocklebur	N. Willow Herb	Lambs Quarters	Canada Fleabane	Biennial Woodworm	Knot Weed	Weed Biomass (kg/ha wet weight)
101	1	4	0.50	*	*			*		*	*	*							*		2361
102	1	6	1.00	*	*		*	*			*	*							*	*	625
103	1	1	Hand Weeded	*	*		*	*			*	*									1389
104	1	3	0.25	*				*			*								*		1458
105	1	2	Weedy Check	*	*		*			*	*	*									5069
106	1	5	0.75	*	*		*	*		*	*	*									2083
107	1	8	2.00	*	*	*			*										*		764
108	1	7	1.50	*	*	*		*	*	*	*								*		5347
201	2	2	Weedy Check	*	*	*		*			*				*		*		*	*	4931
202	2	3	0.25	*	*		*	*		*	*				*		*		*		278
203	2	7	1.50	*	*			*											*		764
204	2	6	1.00	*	*	*	*	*	*	*									*		1806
205	2	5	0.75	*	*						*								*		2153
206	2	1	Hand Weeded	*	*			*			*			*	*				*		139
207	2	4	0.50	*	*	*		*	*		*								*		2778
208	2	8	2.00	*		*			*		*			*					*	*	139
301	3	4	0.50	*	*	*		*							*		*				3056
302	3	8	2.00	*	*		*	*		*									*		625
303	3	3	0.25	*	*				*						*		*		*		3819
304	3	7	1.50	*	*	*		*							*		*		*		2153
305	3	6	1.00	*	*			*									*		*		2222
306	3	1	Hand Weeded Check	*	*				*		*				*		*		*		1250
307	3	2	Weedy Check	*	*	*	*	*			*						*		*		3056
308	3	5	0.75	*	*	*	*	*							*				*		5694

\* Weed present in plot

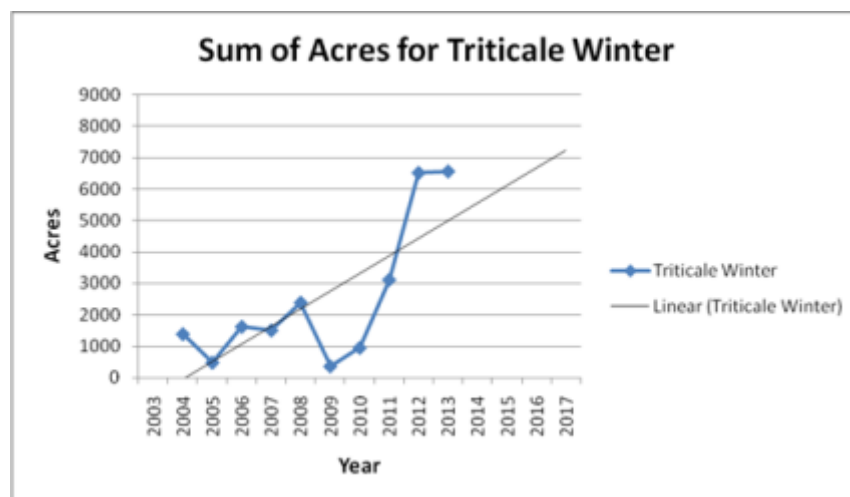
# Winter Triticale Grain and Forage Variety Trial

## Cooperators:

- Manitoba Agriculture Food and Rural Development
- Manitoba Agricultural Services Corporation
- Manitoba Diversification Centres

## Background

Winter triticale was nearly non-existent in Manitoba a decade ago (Figure 1). Now seeded acres have risen considerably with 6500 acres being planted in Manitoba in 2012 (Arneson R., 2013. Western Producer). Winter triticale is not an insured crop in Manitoba; and little is known about the insurance production values of the crop in Manitoba. A group of research trials was initiated by a partnership between Manitoba Agricultural Services Corporation and the Manitoba Diversification Centres, headed by Manitoba Agriculture Food and Rural Development. The purpose of the trials was to assess the adaptation of winter triticale to Manitoba growing conditions.



**Figure 1:** Acres of winter triticale seeded in Manitoba from 2003 – 2013. (Source MASC, MAFRD)

A multi-site one year project was initiated with sites hosting a winter triticale variety trial at Manitoba Diversification Centres including the towns Melita, Roblin, Carberry, and Arborg. This report will only be reporting the Melita data. To view the other sites please visit [www.diversificationcentres.ca](http://www.diversificationcentres.ca).

## Objectives

1. To assess forage production and quality of winter triticale in comparison to fall rye, winter wheat, and spring seeded barley.



2. To assess grain production and quality of winter triticale in comparison to fall rye, winter wheat, and spring seeded barley.
3. To assess characteristics other than grain and forage production, such as winter-kill tolerance, stand, heading date, and crop height, among varieties of winter triticale in comparison to fall rye, and winter wheat.

## Methods

The trial consisted of 5 varieties of winter triticale, 1 variety of fall rye, 1 variety of winter wheat, and one variety of spring forage barley in plots arranged in a randomized complete block design. Treatments were replicated 4 times. Plots were located west of Melita, MB on SW 1-4-27 W1 on Waskada loamy fine sand. Pre-seed soil fertility values are in Table 1 for the field area.

**Table 1:** Pre-seed soil test of plot area taken September 2013.

Previous Crop	Depth	N	P	K	S	OM
		lbs/ac	ppm Olsen	ppm	lbs/ac	
Canola	0-6"	9	12	410	14	3%
	6-24"	5			36	

Plots were seeded with a six row plot seeder with Seedhawk dual knife openers on 9.5" spacing. Plots were seeded September 20 for winter cereals and May 16 for barley. Seed depth was 0.5". Fertilizer was side band at seeding and consisted of 60 lbs/ac nitrogen and 30 lbs/ac phosphorous. Plots were topdressed May 6<sup>th</sup> with 50 lbs/ac nitrogen using granular urea.

Plots were kept weed free using recommended rates of Achieve and Buctril M applied June 13.

Half the plot was harvested for forage on July 22<sup>nd</sup> using a flail mower (Swift Machining, Swift Current, SK). Forage harvests were weighed, sampled then dried to determine % moisture. Dry samples were compiled and sent to a lab for feed testing (Central Testing Laboratories; Winnipeg, MB) using a near infrared feed test (3FFNIR). Grain harvest was accomplished August 30<sup>th</sup> using a Hege 140 plot combine.

**Photo:** Forage harvest of triticale plots in Melita, MB in 2014.



Data collected from plots included fall and spring plant density, plant stand, leaf disease, heading date, crop height, forage yield, days to grain maturity, grain test weight, percent Fusarium damaged kernels, and crop yield.

Composite grain samples were sent to Central Testing Laboratories, (Winnipeg, MB) for quality tests. A visual pick of grain samples for Fusarium damaged kernels was performed by WADO staff to estimate severity of kernel infection on 100 kernels per plot.

Data was analyzed using Agrobase Gen II statistical software. A two-way analysis of variance (ANOVA) was used to analyze data. Coefficient of variation and least significant difference (Fishers unprotected) was calculated at the 0.05 level of significance.

## Results

There were significant differences in leaf diseases, heading dates, crop heights, forage yield, grain maturity, grain test weight, Fusarium damaged kernels, and grain yield among treatments (Table 2).

In terms of grain yield, wheat yielded the most, followed by the barley. Most all varieties of triticale suffered from extreme Fusarium Head Blight, reducing test weights significantly compared to winter wheat. Triticale variety 'Bobcat' had the largest fusarium damaged kernel rating of all varieties reducing the test weight and yield significantly compared to other crops and varieties. 'Pika' had the least amount of Fusarium damaged kernels among the triticale varieties with substantial grain yield. However, this is incomparable to 'Desperado' barley.

Most triticale varieties yielded significantly more forage than fall rye and barley but not wheat. Louma, Pika, and Fridge were the highest yielding forage varieties of the trial.

There were no significant differences in fall plant stand but there were in spring plant stand. This did not translate into differences in winter mortality among the winter cereal crops. A significant final stand reduction in triticale variety 'Bobcat' may have contributed to lower forage and grain quantities compared to other varieties.

**Table2:** Crop and variety differences in winter triticale, winter wheat, forage barley and fall rye in Melita, MB in 2014.

Crop Type	Variety	Fall Plant Density	Spring Plant Density	Winter Mortality	Stand	Leaf Disease (scale 1-11)	Heading Date	Crop Height	Forage Yield	Grain Maturity	Test Weight	Grain Yield	Fusarium Damaged Kernels
		p/m <sup>2</sup>	p/m <sup>2</sup>	%	%	11=severe	days	cm	kg/ha	days	g/0.5L	kg/ha	%
Winter Triticale	Luoma	247	132	47	95	8.0	43	112	8309	94	320	2590	12.8
Winter Triticale	Pika	191	130	32	90	7.0	44	107	7551	94	305	1689	5.5
Winter Triticale	Fridge	179	117	34	85	7.0	43	111	6928	101	302	1545	16.0
Winter Triticale	Metzger	237	137	42	90	7.0	44	99	6626	99	292	1520	10.3
Winter Wheat	Flourish	205	121	49	88	8.0	44	70	6005	86	359	3322	13.0
Winter Triticale	Bobcat	207	115	43	80	7.0	42	77	4515	91	278	1048	41.5
Spring Forage Barley	Desperado	n/a	n/a	n/a	83	2.0	76	69	3616	96	291	2995	2.5
Winter Rye	Hazlet	219	162	34	83	10.0	41	86	2829	85	324	1486	11.8
	Coefficient of Variation	15.9	14.6	24.5	4.3	11.8	1.8	5.0	15.6	5.4	1.5	18.4	16.4
	LSD (p<0.05)	50	28	15	5.5	1.2	1	7	1333	7.4	7	546	3.4
	Prob. Entry	0.109	0.038	0.142	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	0.002	<0.0001	<0.0001	<0.0001
	Significant?	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Grand Mean	212	131	40	87	6.9	47	91	5797	93	309	2024	14.2
	R-Square	0.47	0.51	0.47	0.72	0.92	1.00	0.96	0.88	0.71	0.98	0.88	0.97

## Discussion

Winter Triticale proved to be a significant forage producer, producing over 8300 kg/ha. Grain yield in triticale was less impressive compared to other crops like barley or winter wheat. This may have been due to reduced grain weights from severe infections of Fusarium Head Blight. Triticale variety 'Luoma' showed the best promise in terms of a high producing forage variety with high relative feed value (Appendix 1) exclusively among the triticale varieties tested. 'Pika' showed good promise as a dual purpose variety for both grain and forage yield with lower Fusarium damaged kernels.

Winter wheat strength was shown in grain production despite the high Fusarium damage to kernels. While fall rye had lower Fusarium damage, the yield was under that of wheat. Winter wheat had the highest relative feed value and TDN of all the varieties with decent forage yield compared to barley and rye (Appendix 2). Barley resulted in high grain production and low Fusarium damaged kernels, but came short of the forage yields of winter triticale.

High grain protein values were realized in all crops except barley and fall rye. Ergot fungus (*Claviceps purpurea*) was present in all crops. The greatest amounts of ergot were found in fall rye followed by most triticale varieties, then in barley and winter wheat, respectively.

TDN and Metabolizable Energy were lowest in barley grain compared to all other crops which faired similar as a group.

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Arneson R., Triticale gaining foothold in Manitoba., Western Producer., August 13, 2013. Available online at: <http://www.producer.com/daily/triticale-gaining-foothold-in-manitoba/> .

## Appendix 1 - Forage Tests

Variable	Variety							
	Pika	Bobcat	Fridge	Metzger	Luoma	Hazlet	Flourish	Desperado
Moisture%	8.74	7.36	6.53	6.69	7.67	7.13	6.52	6.51
Dry Matter %	91.26	92.64	93.47	93.31	92.33	92.87	93.48	93.49
Crude Protein %	8.82	12.12	11.75	11.91	10.06	9.60	9.62	12.30
Insoluble Protein %	6.05	8.96	6.93	7.75	6.68	6.88	6.60	8.32
Soluable Protein %	2.77	3.16	4.82	4.16	3.38	2.72	3.03	3.98
Ca %	0.24	0.36	0.38	0.37	0.34	0.32	0.18	0.45
P %	0.2	0.25	0.24	0.27	0.19	0.22	0.22	0.30
Mg %	0.12	0.15	0.15	0.14	0.14	0.12	0.13	0.19
K %	1.55	2.08	2.50	2.04	1.43	1.49	1.55	2.43
Na %	0.01	0.01	0.01	0.02	<0.01	0.02	0.01	0.03
NaCl%	0.02	0.02	0.02	0.04	0.01	0.05	0.02	0.08
Acid Detergent Fibre %	40.82	42.53	42.81	41.82	40.18	40.16	37.91	39.87
Neutral Detergent Fibre %	65.43	66.85	69.25	67.82	64.64	65.19	62.46	66.83
Non Fibre Carbohydrates %	14.95	10.23	8.20	9.47	14.5	14.41	17.12	10.08
Total Digestable Nutrients %	55.03	53.20	52.90	53.96	55.71	55.73	58.13	56.04
Metabolizable Energy	2.02	1.95	1.93	1.98	2.04	2.04	2.12	2.05
Digestable Energy	2.43	2.35	2.33	2.38	2.46	2.46	2.56	2.47
Net Energy Lactation	1.23	1.19	1.18	1.20	1.25	1.25	1.31	1.26
Net Energy Maintenance	1.17	1.10	1.09	1.13	1.19	1.19	1.26	1.20
Net Energy Gain	0.61	0.55	0.53	0.57	0.63	0.63	0.69	0.63
Relative Feed Value	81	78	75	77	83	82	88	81

## Appendix 2 - Grain Tests

Test	Variety							
	Pika	Bobcat	Fridge	Metzger	Louma	Hazlet	Flourish	Desperato
Crude Protein (%)	15.98	17.41	15.92	15.57	15.25	12.82	16.10	10.50
Crude Fibre (%)	2.94	3.46	3.26	3.67	3.15	3.58	2.69	5.02
Fat (%)	1.67	2.32	1.89	1.67	2.01	2.00	2.12	2.12
Ash (%)	2.25	2.77	2.62	2.67	2.40	2.24	2.07	2.79
Calcium (%)	0.06	0.06	0.05	0.05	0.05	0.05	0.04	0.06
Phosphorus (%)	0.52	0.51	0.47	0.45	0.41	0.38	0.42	0.41
Magnesium (%)	0.16	0.16	0.15	0.13	0.12	0.11	0.14	0.14
Potassium (%)	0.64	0.64	0.57	0.57	0.50	0.53	0.45	0.48
Sodium (%)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Sodium Chloride (calc from sodium) (%)	0.03	0.03	0.03	0.02	0.03	0.02	0.02	0.03
Copper (mg/kg)	5.82	5.74	5.48	5.62	6.01	4.63	4.73	5.01
Iron (mg/kg)	40.8	55.3	44.6	39.8	45.2	47.0	38.0	53.2
Manganese (mg/kg)	41.2	43.5	40.6	38.8	38.6	29.2	40.7	20.7
Zinc (mg/kg)	32.2	39.1	32.4	31.5	36.0	23.8	24.9	27.5
Ergot (%)	0.12	0.38	0.66	0.26	0.25	1.50	0.06	0.04
Ergot (kernels/kg)	50	208	176	102	103	324	6	16
Non Fibre Carbohydrates (%)	76.3	73.2	75.4	75.5	76.3	78.5	76.1	78.7
Total Digestible Nutrients (%)	85.9	84.9	85.2	84.8	85.6	85.3	86.3	83.3
Digestible Energy for Swine (kcal/kg)	4120	4080	4061	4012	4084	4019	4177	3811
Gross Energy for Swine (kcal/kg)	4377	4412	4373	4353	4379	4349	4412	4297
Metabolizable Energy for Swine (kcal/kg)	3994	3943	3938	3893	3965	3923	4048	3739
Metabolizable Energy for Poultry (kcal/kg)	3407	3417	3398	3370	3412	3392	3443	3323
Digestible Energy for Cattle/Sheep (Mcal/kg)	4.00	3.97	3.98	3.95	3.99	3.96	4.02	3.86

## WADO Flax Fibre Project 2014

### Cooperators

- European Flax Fibre Company
- Eric Liu – MAFRD – Fibre and Composites Specialist (Winnipeg)
- Manitoba Diversification Centres (Portage, Arborg, Melita)
- Prairie Agricultural Machinery Institute (Portage la Prairie)

### Objectives

1. To grow two fibre flax varieties across several regions in Manitoba and assess for flax fibre yield and quality (in a small field scale of 4 acres).
2. Pull the large plots of each variety and leave to ret (the softening and separating of fibres by partial rotting) over the fall of 2014.
3. Bale and ship back to Europe for quality and fibre yield assessment.

### Location

Elva, MB Legal Land Description: NE 26-3-27 W1

## Crop Rotation

In 2013 the area was winter wheat. Weeds burned off prior to seeding included:

Green Foxtail [*Setaria viridis* (L.) P.Beauv]

Yellow Foxtail [*Setaria pumila* (Poir.) Roem. & Schult.]

Wild Oats [*Avena sativa* L.]

Wild Mustard [*Sinapis arvensis* L., Brassica kaber (DC.) L.C. Wheeler var. pinnatifida (Stokes) L.C. Wheeler]

Red Root pigweed [*Amaranthus retroflexus* L.]

Volunteer canola [*Brassica napus* L.]

## Site Soil Test (pre-plant)

Soil Test			N	P	K	S	Organic Matter
Legal Land Location	Depth	pH	ppm	Olsen ppm	ppm	lbs/ac	%
NE 26-3-27 w1	0-6"	7.7	3.5	4	370	5	3.2
	6-24"		5.5			18	
	0-24"		9			23	

## Soil Characteristics

MCIC Soil Zone: F      Newstead Loamy Sand

## Methods

### Pre-seed Herbicide application (burnoff):

Authority (sulfentrazone) @ 100 mL/ac + Credit (glyphosate) @ 1 L/ac + Aim (carfentrazone) @ 15 mL/ac  
---all tank mixed applied at 10 gal/ac applied May 22 just after seeding.

**Seed Date:** May 22, 2013

**Seed Rate:** 75 lbs/ac

**Seed Depth:** 1/2"

### Varieties, Layout, Size:

Two flax fibre varieties named Alize and Vesta were seeded in blocks about 2 acre in size per variety side by side. The block was 193 meters long. Approximately 30 strips (1.44 meter wide) of Alize and Vesta were seeded. Long strips aided in fiber harvest in terms of the number of turns required at the headlands of each variety.



**Fertilizer Applied:**

Side band 49 lbs/ac N from 28-0-0 UAN, 200 lbs/ac of a granular blend of 12-17-15-10.

**Seeder:** Seedhawk dual knife system with 6 rows with 9.5" spacing.

**Soil Seeding Conditions:** Perfect with fair soil moisture. Tractor was traveling about 3.5 mph.

**Herbicide Application in Crop:**Application 1:

Products: Centurion (Clethodim, surfactant) + Koril (Bromoxynil) + MCPA Ester 500 (tankmixed)  
 Rates: 100 mL/ac and 0.4 L/ac, 0.2 L/ac  
 Date: June 17, 2014

Application 2:

Products: Assure II + Basagran Forte (tankmixed) – to control mustard and wild oats.  
 Rates: 200 ml/ac, 0.9 L/ac  
 Date: July 30, 2014

There was about 7 days difference between the maturity of Alize and Vesta with Alize being the earlier one (Sept 8).

**Measurements**

Just prior to pulling plants, 6 random field samples from each variety were taken to determine plant density, stem density, grain yield, stem weight yield and plant height (Table 1).

**Table 1:** Results of height, plant density, and stem density of fibre flax varieties taken same day as pulling harvest in Melita, MB in 2014.

Field Sample Measurement	Mean		St. Deviation	
	Alize	Vesta	Alize	Vesta
Plants/m <sup>2</sup>	366	604	217	133
Height cm	80	81	8	9
Stems/m <sup>2</sup>	525	775	229	122
Total Plant Weight (g/m <sup>2</sup> )	755	760	329	228
Est. Total Plant Biomass (kg/ha) (non retted)	7554	7604	1333	921
Est. Total Straw Yield Less Seed Yield (kg/ha) (none retted)	7056	7160	1167	798
Seed Yield (kg/ha)	498	443	166	123

**Table 2:** Results of yield after baling of fibre flax in Melita, MB in 2014.

Bale Harvest	Alize	Vesta
Total Harvest Area m <sup>2</sup>	6177	6177
Bales collected (retted)	14	16
Bales/ha (retted)	23	26
Total Weight Collected (kg)	1950	2497
Straw Yield (kg/ha) (retted)	3156	4042
Estimated Fibre Yield (kg/ha) (assuming 30% fibre content)	947	1213
Average Bale Dimensions (cm)	Length	Diameter
	114	100
Average Bale Weight (kg)	148	

### Comments

Seeding was successful and plots were visually impressive. All operations including seeding and herbicide applications were successful. Seeding was accomplished using GPS guidance which kept rows straight and easy to pull at fibre harvest.

Minor lodging was noted in both varieties, but where lodging was most prevalent was in areas infected with stem disease (Pasma) likely due to excess moisture.



The puller unit worked fantastic in general, pulling 5 rows at a time. Soil conditions were dry that day and with a sandy soil texture, plants pulled with ease. There were very little issues with weeds likely due to the use of Authority herbicide.

Plant stage was at physiological maturity where 95% of the bolls were brown, stems were generally green and leaves were only on the upper third of the plant whereas all other leaves had dropped naturally. Unit would travel about 4-5 mph. It took about 4 hours to pull the 4 acres.



Stem breakage occurred during pulling as there was a hail storm in July that damaged a small percentage of flax stems. Some of the stems were left behind (photo in hand).





### Order of Fibre Harvest Operations:

Pulling Date – Sept 8, 2014

Cam from PAMI operated the unit.

Turning Date: Oct 7, 2014

Cam from PAMI operated the unit.

Baling Date – Nov 18, 2014

Used a Verhaeghe 504 VE baler. Baling took about 2 days and was done by Cam Kliever of PAMI.



Bale Picking Date – Nov 19, 2014

Bales had to be baled in such a way that the stems aligned in the same direction so that the bale was formed with roots on one side and seed bolls on the other. Baling was cumbersome due to two factors, high winds and frozen soils. Steel fingers on the baler pickup would scratch the ground, sometimes hitting rocks and sparking. High winds of 30 km/hr perpendicular to the direction of pickup, caused the swath to catch the wind and off-centre the intake of the windrow. This caused bunching in the pickup and stacks of flax straw within the field. With great determination the field was eventually baled. Future modifications to the pickup design on the baler should be considered.

It took about four hours to pick all the bales and transport them to the shop at Melita with WADO's gooseneck trailer. Bales were stored on pallets and covered with a tarp with wood pallets on top for fall storage. Bales were wrapped with sisal.



**Photo (left):** Illustration of the intake system of the baler. A conveyer of steel and rubber fingers feeds the flax into the baler with stems aligned the same direction for the entire duration of the bale making process. The driver must be careful to keep the direction of the flax correct after every turn.

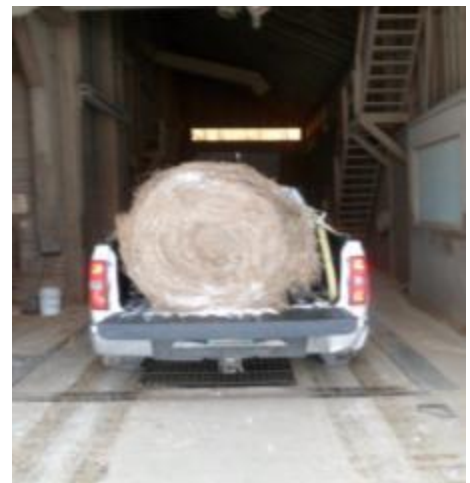


**Photo (right):** Bunches of straw in the baler intake were problematic during high winds. Bunches had to be untangled by hand dozens of times in the field.



**Photo (left):** Quality of fibre after retting and baling.

**Photo (right):** A bale was placed in a pickup truck, weighed and measured to determine bale density so that that density could be applied to all other bales for shipping purposes. WADO used a local producer owned elevator and measured to the nearest kilogram.



### ***What's Next?***

The plan is to ship the bales to Europe for analysis. Logistics need to be sorted out such as phytosanitary certificates prior to shipping the bales.

## Manitoba Industrial Hemp Variety Trials - Trial Descriptor

- Jeff Kostuik – CMCDC Carberry
- Susan McEachern – PCDF - Roblin
- Angela Melnychenko – PCDF – Roblin

### Site Information

<b>Locations:</b>	Arborg, Manitoba Carberry, Manitoba Melita, Manitoba Roblin, Manitoba
<b>Cooperators:</b>	Prairies East Sustainable Agriculture Initiative (PESAI), Arborg, MB Canada-Manitoba Crop Diversification Centre (CMCDC), Carberry, MB Westman Agriculture Diversification Organization (WADO), Melita, MB Parkland Crop Diversification Foundation (PCDF), Roblin, MB
<b>Plant Breeding Programs:</b>	Alberta Innovates Technology Futures Hemp Genetics International (HGI) Parkland Industrial Hemp Growers Coop (PIHG) Terramax Corporation

### Background

**Table 1:** Industrial Hemp Commercial Licenses Issued in 2014

Province	Total Licenses Issued	# of Cultivation Licenses Issued out of the Total
AB	262	166
BC	13	2
MB	292	219
ON	46	22
PE	3	1
QC	88	60
SK	431	298
<b>TOTAL</b>	<b>1135</b>	<b>768</b>

Source: Health Canada

**Table 2:** Licensed Acreage for the Cultivation of Industrial Hemp in 2014

Variety	Licensed Acreage (hectares)						
	AB	BC	MB	ON	PE	QC	SK
Alyssa			69.00			5.98	
Anka				250.25	5.00	8.58	
Canda			790.30	89.05			271.40
CanMa						152.59	122.13
Carmen						4.05	
CFX-1			190.90	6.00		142.41	914.58
CFX-2	1,394.37		431.95			0.11	9,709.99
CRS-1	65.00		6,086.45	6.00		0.11	169.70
Delores			1,017.10			0.11	
ESTA-1					0.03		
Felina 34				0.14			
Ferimon						215.29	
Finola	7,402.50	17.40	449.16			0.11	5,797.30
Joey			8.00				
Jutta				0.04			
USO 14			59.88				
USO 31			108.07				
X-59 (Hemp Nut)	1,470.75		1,837.66				4,618.26
Yvonne						2.99	
Other (varieties under plant breeding)	10.00		3.60	1.11		0.12	6.00
<b>TOTAL</b>	<b>10,342.62</b>	<b>17.40</b>	<b>11,052.07</b>	<b>352.59</b>	<b>5.03</b>	<b>532.45</b>	<b>21,609.36</b>

Source: Health Canada

There were a total of 43,912 licensed hectares of industrial hemp grown across Canada in 2014. Manitoba had the second highest licensed acreage at 11,052 hectares, behind Saskatchewan with 21,609 hectares. (Health Canada 2014)

The Parkland Crop Diversification Foundation has been working on hemp agronomy since it's legalization to be grown in Canada in 1998. Each year a hemp grain and fibre variety trial has been established to provide an opportunity to showcase and research hemp varieties grown in western Canada. From these trials, quality information is obtained for the hemp grain and fibre industries.

This trial was grown at six locations in 2014. The four Manitoba locations included Arborg, Carberry, Melita and Roblin. In partnership with other researchers, this trial was also grown at Qu'Appelle, Saskatchewan and Vegreville, Alberta.

Data from the four Manitoba locations has been included in this report. Information from Qu'Appelle and Vegreville will be available at a later date. This trial is a great tool for producers and industry to make more informed management decisions in regards to hemp production.

## Objective

To evaluate industrial hemp varieties for fibre and grain yield, as well as other characteristics.

## Procedure and Project Activities

The four Manitoba locations that hosted this trial include Arborg, Carberry, Melita and Roblin, MB. There were 10 varieties (Table 3) that were grown at each location. The experimental design was small plot, randomized complete block design over 4 replicates. When seed setup took place, seed size and germination were factored into the target seeding rate of 250 plants per meter squared to ensure all plots were targeted for the same plant population.

**Table 3:** 2014 Manitoba Industrial Hemp Variety Trial Varieties Grown at Arborg, Carberry, Melita and Roblin, MB

Canda	Delores
CFX-1	Finola
CFX-2	Joey
CRS-1	Silesia
Debbie	X59

**Table 4:** 2014 Manitoba Industrial Hemp Variety Trial Inputs at Arborg, Carberry, Melita and Roblin, MB

	Arborg	Carberry	Melita	Roblin
<b>Plot Size Seeded</b>	10.96m <sup>2</sup>	8.4m <sup>2</sup>	16.47m <sup>2</sup>	7.0m <sup>2</sup>
<b>Plot Size Harvested</b>	8.22m <sup>2</sup>	5.0m <sup>2</sup>	12.96m <sup>2</sup>	Fibre: 1m <sup>2</sup> Grain: 4m <sup>2</sup>
<b>Seeding Date</b>	May 25	May 16	May 23	May 28
<b>Seeding Rate</b>	250 pl/m <sup>2</sup>	250 pl/m <sup>2</sup>	250 pl/m <sup>2</sup>	250 pl/m <sup>2</sup>
<b>Fibre Harvest Date</b>	September 5	August 12	August 8	August 22
<b>Grain Harvest Date</b>	September 25	September 12	September 11	September 16
<b>Grain Days from Seeding to Harvest</b>	124	119	112	112

**Table 5:** 2013 Fall/ 2014 Spring Soil Nutrient Analysis Estimated Available Nutrients from 0-24" Depth at Arborg, Carberry, Melita and Roblin, MB

	Arborg	Carberry	Melita	Roblin
* N	123 lbs/acre	15 lbs/acre	10.5 ppm	82 lbs/acre
* P	15 ppm	14 ppm	7 ppm	22 ppm
* K	395 ppm	193 ppm	427 ppm	231 ppm
* S	144 lbs/acre	14 lbs/acre	64 ppm	52 lbs/acre

\* N = Nitrate

\* P = Phosphate (Olsen)

\* K = Potassium

\* S = Sulphate

**Table 6:** 2014 Spring Nutrient Applications at Arborg, Carberry, Melita and Roblin, MB

	<b>Arborg</b>	<b>Carberry</b>	<b>Melita</b>	<b>Roblin</b>
* N	80 lbs/acre	175 lbs/acre	118 lbs/acre	80 lbs/acre
* P <sub>2</sub> O <sub>5</sub>	27 lbs/acre	12 lbs/acre	35 lbs/acre	0
* K <sub>2</sub> O	0 lbs/acre	0	30 lbs/acre	0
* S <sub>2</sub> O <sub>4</sub>	10 lbs/acre	0	15 lbs/acre	0

\* N = Nitrogen

\* P<sub>2</sub>O<sub>5</sub> = Phosphorus

\* K<sub>2</sub>O = Potash

\* S<sub>2</sub>O<sub>4</sub> = Sulphur

## References

Health Canada. *Licensed Acreage for the Cultivation of Industrial Hemp in 2014*. Health Canada, 2014.

## Manitoba Industrial Hemp Fibre Variety Trial

- Jeff Kostuik – CMCDC Carberry
- Susan McEachern – PCDF Roblin
- Angela Melnychenko – PCDF Roblin
- Mercedes Alcock – FibreCity Winnipeg

## Site Information

**Locations:** Arborg, Manitoba  
Carberry, Manitoba  
Melita, Manitoba  
Roblin, Manitoba

**Cooperators:** Prairies East Sustainable Agriculture Initiative (PESAI), Arborg, MB  
Canada-Manitoba Crop Diversification Centre (CMCDC), Carberry, MB  
Westman Agriculture Diversification Organization (WADO), Melita, MB  
Parkland Crop Diversification Foundation (PCDF), Roblin, MB  
FibreCITY, Winnipeg, MB - Simon Potter and Mercedes Alcock

## Plant Breeding Programs:

Alberta Innovates Technology Futures (AITF)  
Hemp Genetics International (HGI)  
Parkland Industrial Hemp Growers Coop (PIHG)  
Terramax Corporation

## *Background*

Hemp fibre has been used since ancient times and it has been referred to as the oldest known cultivated fibre plant. Hemp was likely instrumental in early cordage and textile manufacturing. In ancient times, the wild hemp plants would lose their leaves in the fall and the winds would cause the hemp stalks to lodge onto the ground. The hemp stalks would rot over the winter and the tough flexible fibres would remain on the ground in the spring. This would have been the first human encounter with the fibre source and applications of hemp. (Clarke and Merlin 2013)

The principal traditional uses of hemp fibre have been twine, rope, nets, webbing, sacking, rugs, tarpaulins, heavy industrial canvas, clothing fabric and pulp for paper. The use of natural fibres such as hemp has declined in the twentieth century because of more affordable petrochemical fibre products being available.

Recently, there has been resurgence for more “green” fibre sources for the manufacturing industry. This has sparked an interest in industrial hemp fibre. Hemp is a biodegradable, recyclable and renewable resource. Industries such as the automobile industry are incorporating hemp fibre into their molded interior panels. The construction industry uses hemp fibre insulation and hurd chips for insulation fill and press board manufacturing. Hemp can also be used in agriculture and highway infrastructure as a nonwoven agriculture fleece, matting and mulch for weed and erosion suppression. The dust created from fibre and hurd extraction can be pressed into briquettes and made into charcoal. The paper industry can use unretted hemp fibre for specialty paper production. In addition, hemp pulp processing uses a more environmentally friendly chemistry than acid-based pulping for softwood pulp.

Another new area of interest for hemp fibre is cellulose nanofibres. Some expected areas of use for the nanofibres are medical (drug carriers, surgical materials, prostheses and dressings), cosmetics (creams and nutritional ingredients, feminine protection products and masks), the environment (sensors, filters, nanofilters and absorbers), energy (electric cells and hydrogen storage), chemistry (catalysts with high efficiency and ultra-light materials and composites), electronics (computers, shields for electromagnetic radiation and electronic equipment), textiles (clothing and functional products) and defense (special-purpose clothing and face masks) (Harfield 2013). Hemp fibres are one of the strongest fibres that nature has created. Scientists from Washington State University have announced a breakthrough in battery separator technology which is forecasted to replace the industry with a standard polyolephin separator within the next three years. Green N, Inc. forecast that hemp production in Colorado and Oregon will be sufficient to supply the new Tesla Gigafactory by 2023. (Battery Life Magazine 2014)

Interest in hemp fibre processing has increased in Canada as well. Composites Innovation Centre (CIC) in Winnipeg is taking a lead role by developing the necessary test capabilities, material data-bases and standards for processing hemp. Emerson Hemp Distributors at Emerson, MB process hemp fibre for animal bedding and green building materials. Step Forward Paper<sup>TM</sup> supplies paper to Staples. The paper is currently manufactured from wheat and flax. Hemp fibre is being considered as an option and Step plans to build a state-of-the-art facility in Manitoba.

In Vegreville, Alberta, Alberta Innovates and Technology Futures (AITF) has taken a lead role in plant breeding and processing hemp fibre for companies to test in their applications. In Southern Alberta, two companies are building hemp processing plants. Cylab International is moving its operations from China to Nanton, AB. Cylab will build a decortication plant that will process hemp fibre into construction materials, animal bedding and other products. Biofuel will be the by-product. The plant will also extract oils from the hemp leaves and stalks for use as a binding agent. Long term plans are to extract cannabidoils as well. Stemia is the other company and they will be located at Chin, AB. Fibre from hemp decortication will be used for construction, automobiles and paper industries. (Glen 2014)

Establishing a fibre industry for any crop is challenging. Dealing with crop residue has generally been a contentious issue with producers, particularly balancing logistics with value. Processors, end users and consumers often regard crop residues as 'waste streams' instead of 'product streams' and as a result expect prices of crop residues to be extremely low. The time between oil seed harvest and first snow can be short and contain a diverse and sizeable amount of activity for producers. Value for crop residue must be sufficient to encourage producers to provide the level of effort, priority and care required to supply the straw purchaser with quality and timely product. Processors, end users and consumers may have to adjust their price expectations to reflect a more accurate valuation of the effort in straw collection so the fibre industry can be successfully launched.

PCDF has played an important role in researching varieties that are well adapted to Manitoba growing conditions. Testing sites are established with the other diversification sites and samples are collected for analysis. PCDF's role has been instrumental in establishing a hemp industry and attracting companies to setup their processing plants in Manitoba.

### ***Objective***

To evaluate different varieties of industrial hemp for fibre yield and quality.

### ***Procedure and Project Activities***

Please refer to the Manitoba Industrial Hemp Variety Trials - Trial Descriptor (Page 158) for information on trial treatments, locations, inputs, nutrient analysis and spring nutrient applications at each trial location.

## Results and Discussion

**Table 1:** 2014 Manitoba Industrial Hemp Fibre Variety Trial Plant Population (pl/m<sup>2</sup>) and Height (cm) at Roblin, MB

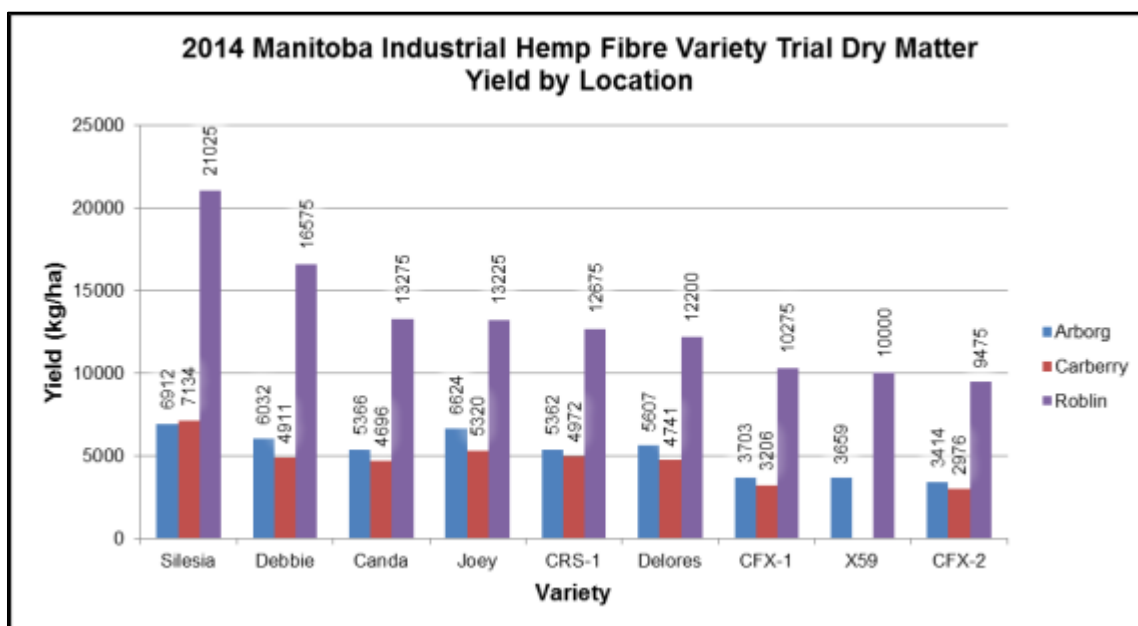
Variety	Plants/m <sup>2</sup>	Height (cm)
Canda	308	157
CFX-1	223	123
CFX-2	243	122
CRS-1	258	143
Debbie	260	153
Delores	218	151
Finola	258	100
Joey	203	153
Silesia	260	179
X59	255	118
<b>Grand Mean</b>	<b>244</b>	<b>144</b>
<b>CV%</b>	<b>17.6</b>	<b>6.2</b>
<b>LSD 5%</b>	<b>62.1</b>	<b>12.8</b>
<b>Significant Difference</b>	<b>Yes</b>	<b>Yes</b>

**Table 2:** 2014 Manitoba Industrial Hemp Fibre Variety Trial Dry Matter Yield (kg/ha) at Arborg, Carberry, Melita and Roblin, MB

Variety	Arborg			Carberry			Melita	Roblin			Over all Rank
	Yield kg/ha	Sign Diff	Rank	Yield kg/ha	Sign Diff	Rank	Yield kg/ha	Yield kg/ha	Sign. Diff.	Rank	
Canda	5,366	c	5	4,696	b	6	3,730	13,275	bc	3	4
CFX-1	3,703	d	7	3,206	c	7	3,108	10,275	cd	7	7
CFX-2	3,414	d	9	2,976	c	8	4,766	9,475	d	9	9
CRS-1	5,362	c	6	4,972	b	3	5,180	12,675	cd	5	4
Debbie	6,032	abc	3	4,911	b	4	4,766	16,575	b	2	3
Delores	5,607	c	4	4,741	b	5	5,457	12,220	cd	6	5
Finola	--	--		--	--	--	1,658	--	--	--	--
Joey	6,624	ab	2	5,320	b	2	4,973	13,225	bc	4	2
Silesia	6,912	a	1	7,134	a	1	4,006	21,025	a	1	1
X59	3,659	d	8	--	--	--	3,523	10,000	cd	8	8
<b>Grand Mean</b>	5,186	--	--	4,745	--	--	4,117	12,980	--	--	--
<b>CV%</b>	12.0	--	--	11.8	--	--	29.2	17.8	--	--	--
<b>LSD 5%</b>	911.2	--	--	824.6	--	--	2065.3	3360.3	--	--	--
<b>Sign Diff</b>	Yes	--	--	Yes	--	--	Yes	Yes	--	--	--



**Chart 1:** 2014 Manitoba Industrial Hemp Fibre Variety Trial Dry Matter Yield (kg/ha) by Location



Yield for this trial is determined by cutting 1m<sup>2</sup> from each plot. The hemp stalks are then air dried. Once dry, all the leaves and stems are removed. The dry stalks stripped of leaves and stems are then weighed to determine biomass yield. It should be noted that there are no mechanical losses associated with this harvest method. Straw samples are then sent to CIC/FibreCITY for further fibre quality assessment measurement. This information will be available once the fibre has been tested for quality.

Fibre yield is directly related to the variety and the end use it is bred for. Majority of the varieties in this test are bred primarily for dual purpose. Silesia is the only variety targeted strictly for the fibre industry. Finola is the only variety that is strictly for grain production because of its short height and low fibre yield.

In regards to fibre yield data, the Melita location had a %CV of 29.2% and the LSD value is high. The lower the %CV value, the more accurate the data is and the higher the confidence in the varietal performances. Generally 15% is the cut-off point for an acceptable %CV. For these reasons, the Melita data will not be included in the discussion.

Silesia was consistently the highest fibre yielding variety for all three locations and it was significantly higher yielding than the other varieties at Carberry and Roblin. Overall, most of the varieties were consistent in their ranking for fibre yield across the three locations. Canda and CRS-1 were the only two varieties that saw some variability. With that said, fibre content appears to be a somewhat stable trait regardless of the location it is grown in. This can also be seen in the 2013 data (Parkland Crop Diversification Foundation 2014). Silesia was the highest fibre yielding variety for all locations with a

%CV less than 15%. Silesia was significantly higher yielding for some of the locations as well. The Roblin site has consistently been the highest hemp fibre production site for 2013 and 2014. This would suggest that the Parkland region is more conducive to hemp fibre production. It would also support why PIHG is conducting their breeding efforts in the region and PIHP has built a processing plant at Gilbert Plains.

Plant stands and plant height are factors that can impact fibre yield ability. The desired plant stand range for dual purpose production is 250–300 plants/m<sup>2</sup>. Table 1 illustrates the plant stand counts that were taken a few weeks after emergence. Majority of the varieties were within the target range. Generally, fibre hemp varieties are taller in height to maximize fibre production. Table 1 and 2 illustrate a direct correlation in ranking for highest fibre yielding and tallest hemp varieties.

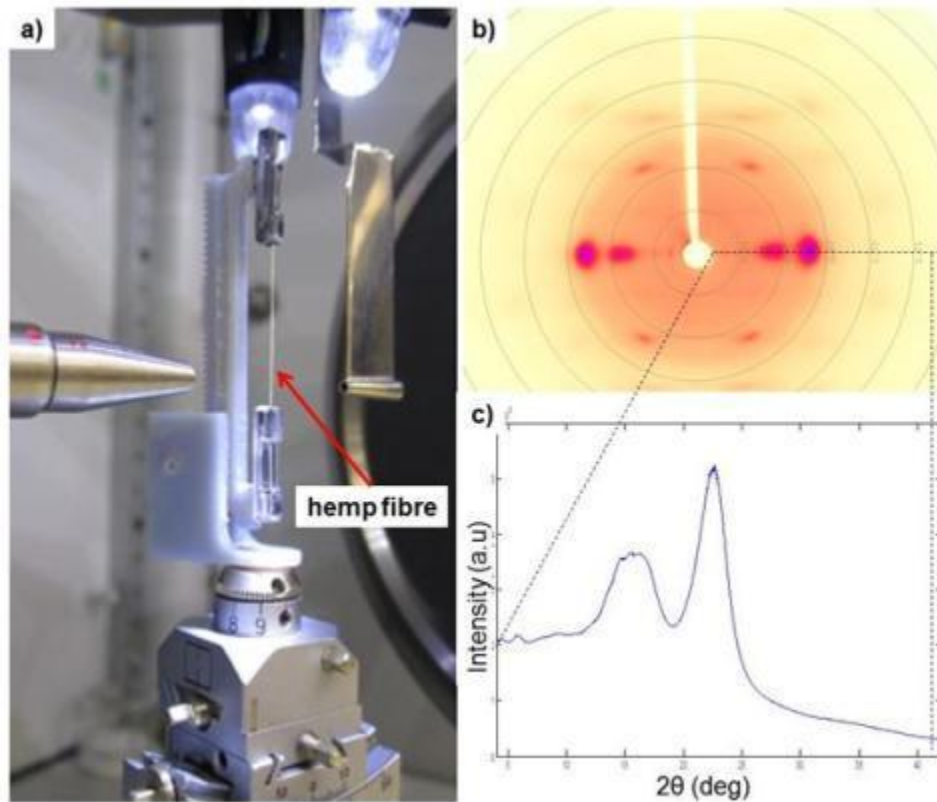
### ***Fibre Quality Assessment at CIC's FibreCITY***

Unlike cotton, which has a global cotton quality testing and grading program, other natural fibres, including hemp, have no standardized quality factors or requirements. Buyers and sellers of hemp worldwide, evaluate hemp quality based on experience gained from trial and error. Long term sellers of hemp have organoleptic tests they perform to get a 'feeling' for the value of a particular fibre/straw source. Unfortunately, these methods are subjective and difficult to be reproduced from one seller to the next. As a result, the experience based assessments cannot contribute to expanding the fibre industry in North America where long term experience is absent and competition with graded materials such as cotton or standardized materials such as fibreglass or synthetic fibres is present.

FibreCITY is a new, fibre-focused laboratory within the CIC that has a suite of analytical equipment for the measurement of fibre properties with a particular focus on evaluating fibre for use in composites. The straw samples sent by PCDF for characterization were the first set of hemp materials to be received and examined by FibreCITY. As the FibreCITY lab develops its capability to handle these fibre types, results of testing the PCDF hemp fibres will be provided to PCDF. Fibre assessment testing such as fibre tensile strength, density, crystallinity and surface chemical composition are some of the many evaluations that will be done on different sub-sets of the hemp supplied. For example, Figure 1 depicts a hemp fibre within the x-ray diffractometer and the resulting preliminary x-ray diffraction pattern to derive fibre crystallinity information.

**Figure 1:**

- a) Photo of hemp fibre bundle in the x-ray beam path of x-ray diffractometer
- b) Image of 2D x-ray diffraction pattern of hemp fibre bundle
- c) Corresponding powder diffraction graph extracted from dashed line in diffraction image and used for crystallinity analyses



It is believed that fibre crystallinity is related to the fibre tensile strength. Tests are underway to explore this relationship with hemp fibres received from PCDF. Further assessment of the differences found in fibres at different positions along the stalk, within a sample group, or within a variety grown at different locations will be investigated. The testing will not be exhaustive due to the amount of effort required to completely characterize the materials provided; however, the testing performed will provide greater insight into the development of future test regimes to create an efficient and cost effective grading system for hemp. With this grading system, producers/processors would have a metric to determine quality/yield in support of the value and pricing of the crop residue.

### **Conclusions**

Hemp fibre applications have been around for a very long time and some historians think it could be as early as the Neolithic time period. Hemp fibre was used in many applications from rope and netting to

paper and cloth. Hemp fibre's appeal diminished when more economical petrochemical fibre products became available. In recent times there has been resurgence for using more "green" sources of material in manufacturing. New applications are being developed and hemp fibre may have a profitable future in the world of "cellulose nanofibers" and battery polyolephin separators for the hybrid and electric car industry.

The appeal for hemp fibre is growing and production is increasing in western Canada. Processing plants are being built in Manitoba and Alberta.

PCDF has played an important role in the development and launching of the industrial hemp industry in Manitoba and the Parkland region. Fibre production dovetails well with the grain evaluation side of the industrial hemp variety trial. PCDF will continue its efforts in this regard and support the industrial hemp industry in Manitoba

### *Acknowledgments*

PCDF would like to acknowledge the funding contribution made by Growing Forward 2 to make this research project possible. Thank you to AITF, HGI, PIHG and Terramax Corporation for providing the varieties for this trial, CMCDC, PESAI and WADO for growing this trial and to FibreCITY for analyzing the quality data.

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**Photo (left):** Variation in height of hemp varieties grown in the trial.

**Photo (right):** Hemp stalks drying.



# Manitoba Industrial Hemp Grain Variety Trial

## Site Information

Locations:                   Arborg, Manitoba  
                                  Carberry, Manitoba  
                                  Melita, Manitoba  
                                  Roblin, Manitoba

Cooperators:               Prairies East Sustainable Agriculture Initiative (PESAI), Arborg, MB  
                                  Canada-Manitoba Crop Diversification Centre (CMCDC), Carberry, MB  
                                  Westman Agriculture Diversification Organization (WADO), Melita, MB  
                                  Parkland Crop Diversification Foundation (PCDF), Roblin, MB

Plant Breeding Programs:  
                                  Alberta Innovates Technology Futures (AITF)  
                                  Hemp Genetics International (HGI)  
                                  Parkland Industrial Hemp Growers Coop (PIHG)  
                                  Terramax Corporation

## Background

The Canadian hemp grain industry has been gaining momentum in the last few years. Interest has been expanding from the producer to consumer. Producers are constantly searching for cropping options that will generate a positive impact on the financial health of their business. Processors are expanding their operations to accommodate the production needed to meet increased consumer demand. The nutritional attributes of hemp have sparked the rise in consumer awareness and consumption.

The total licensed acres of industrial hemp grown in Canada in 2014 totaled 108,463 acres (Health Canada 2014). This is up from 67,000 acres in 2013 (Glen 2014) . The increased acreage encompasses seasoned growers and new producers. Approximately 50% of the acreage is in Saskatchewan. Manitoba is ranked second, followed by Alberta. Looking into the future, the Canadian Hemp Trade Alliance is projecting acreage to be around a quarter of a million acres by 2018 (Arnason 2014).

In the past, Canadian industrial hemp producers and processors have been supplying the U.S. consumer market and



it is a lucrative business. What impact could the U.S. production have on the Canadian industrial hemp industry? It could very well mean opportunity. It has taken the Canadian industrial hemp industry from 1998 to present day to get all the players aligned and functioning successfully. The same scenario could be applied to the U.S. They will need a ramp up period to establish and educate producers and develop infrastructure for processing. New processors and suppliers will require a timeframe to establish brand and product quality awareness. In the meantime, the Canadian industrial hemp industry can continue to expand their exposure to the U.S. market (retailers and consumers), maintain high quality standards and develop brand loyalty from consumers. (Gilmour 2014)

Canada exports \$40 million in hemp products annually which translates to 85% of our total production (Glen 2014). Consumer demand is robust for products like hemp hearts, protein powder, hemp milk and other related products. The DNA structure of hemp is closely aligned to the human DNA. It offers protein, omegas and dietary fibre in almost perfect proportions for human nutritional needs. Hemp seed oil has an almost perfect balance of omega 3-6-9 which is beneficial in overall human health. The oil is cold pressed to retain its natural nutritional value. Hemp components are gluten free, non-dairy and free of trypsin inhibitors. Trypsin is an enzyme that is essential in human digestion and it breaks down proteins into amino acids so the body can absorb them. Proteins play an important role in our healthy body functions. About one-quarter to one-third of hemp production is organic.

A growing interest is occurring in the medical world and the applications of CBD (cannabidiol), a cannabinoid found in hemp. Studies have shown that CBD has a wide range of potentially beneficial psychological and physiological effects. Some of the effects include anti-inflammatory, analgesic, antioxidant, antiemetic, antispasmodic, antipsychotic, antiepileptic, vasorelaxant, immunosuppressive and neuroprotective actions. CBD is also effective in controlling anxiety, psychosis and movement disorders. It protects against diabetic-induced retinal damage. There are beneficial effects on bone formation and fracture healing. It is antimicrobial and antifungal. There is a potential use in the treatment of chemotherapy-induced and anticipatory nausea. There may even be promising uses in the treatment of cancer. (Clarke and Merlin 2013)

Parkland Industrial Hemp Growers (PIHG) has received Growing Forward 2 funding for new research focused on the medicinal properties of hemp. The goal is to identify germplasm with high levels of CBD and begin a breeding program to develop varieties. There will have to be a major change to the current laws governing the Canadian hemp industry so that CBD production will be achievable. CBD is produced in the bracts and leaves of the plant. Currently laws (Health Canada) forbid the harvest of these plant parts because of its association to marijuana use (THC). Industrial hemp has less than 0.3% THC so its threat to society as a recreational drug should be minimal to non-existent. The CBD market is projected at \$300 million in the U.S. (Nyquist 2014)

PCDF has been involved in hemp research for many years. The research conducted has provided growers in the Parkland region with information regarding variety selection adapted to the region. PCDF has developed important relationships with other research groups and organizations, breeding programs, end users and producers affiliated with the hemp industry.



## Objective

To evaluate different varieties of industrial hemp for grain yield and quality.

## Procedure and Project Activities

Please refer to the Manitoba Industrial Hemp Variety Trials - Trial Descriptor (Page 158) for information on trial treatments, locations, inputs, nutrient analysis and spring nutrient applications at each trial location.

## Results and Discussion

**Table 1:** 2014 Manitoba Industrial Hemp Grain Variety Trial Plant Population (plants/m<sup>2</sup>) and Height (cm) at Roblin, MB

Variety	Plants/m <sup>2</sup>	Height (cm)
Canda	308	157
CFX-1	223	123
CFX-2	243	122
CRS-1	258	143
Debbie	260	153
Delores	218	151
Finola	258	100
Joey	203	153
Silesia	260	179
X59	255	118
<b>Grand Mean</b>	<b>244</b>	<b>144</b>
<b>CV%</b>	<b>17.6</b>	<b>6.2</b>
<b>LSD 5%</b>	<b>62.1</b>	<b>12.8</b>
<b>Significant Difference</b>	<b>Yes</b>	<b>Yes</b>

Table 1 summarizes the plant populations and heights of the entries tested. This project is conducting research on grain and fibre production. The target plant population for growers conducting dual purpose production is 250-300 plants/m<sup>2</sup>. Overall, a good percentage of the entries were within the target range. If a grower was producing hemp solely for grain, then the recommended plant stand would be 100-125 plants/m<sup>2</sup>. Hemp varieties vary in height and this is evident in the height data. Typically, the varieties targeted for grain production are shorter than dual purpose or fibre varieties.



**Table 2:** 2014 Manitoba Industrial Hemp Grain Variety Trial 1000 Kernel Weight (g) at Roblin, MB

Variety	1000 Kernel Weight (g)
Canda	21
CFX-1	19
CFX-2	18
CRS-1	19
Debbie	19
Delores	20
Finola	15
Joey	21
Silesia	16
X59	20

Table 2 summarizes the seed size of each of the entries. Data was collected on a composite sample from all reps for each variety so no statistical analysis was conducted. Seed size varied from 15 grams to 21 grams. Generally, the larger seed size would be more appealing for processors and end use products such as hemp hearts.

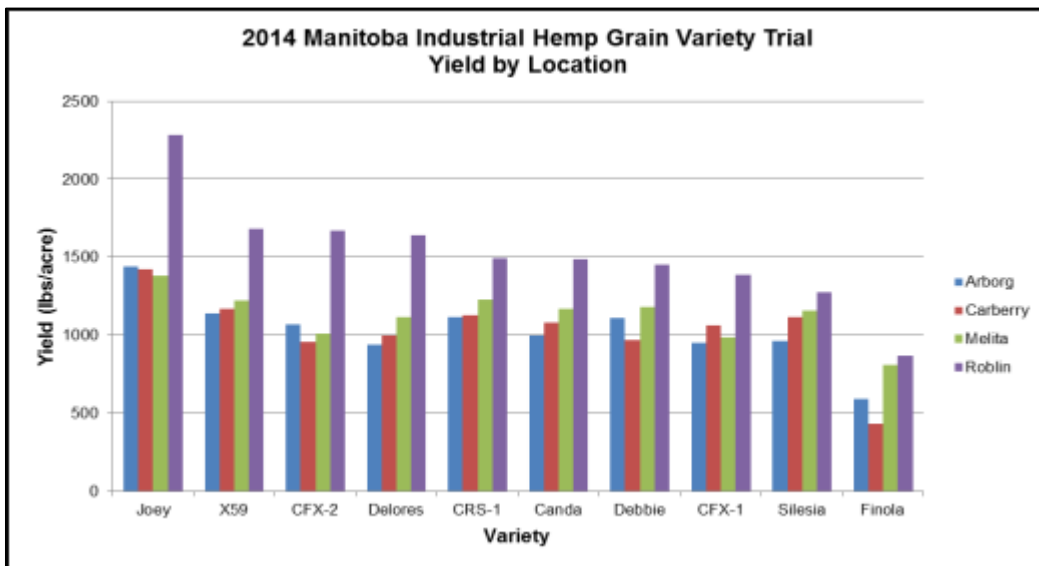
**Table 3:** 2014 Manitoba Industrial Hemp Grain Variety Trial Yield (lbs/ac) Results from Arborg, Carberry, Melita and Roblin, MB

Variety	2014 Mean Yield (lbs/ac)	Number of Site Years Tested	% of Check (CRS-1)	2014 Arborg Yield	2014 Carberry Yield	2014 Melita Yield	2014 Roblin Yield
Canda	1182	17	95	997 bcd	1078 bc	1168 bc	1486 bc
CFX-1	1094	17	88	949 d	1061 bc	984 cd	1384 c
CFX-2	1176	16	95	1070 bcd	954 c	1008 cd	1670 b
CRS-1	1241	20	100	1117 b	1128 bc	1229 ab	1491 bc
Debbie	1176	10	95	1109 bc	967 c	1181 abc	1449 bc
Delores	1173	18	95	940 d	996 bc	1116 bc	1639 b
Finola	674	15	54	588 e	429 d	810 d	870 d
Joey	1632	12	132	1441 a	1421 a	1381 a	2285 a
Silesia	1127	10	91	962 cd	1113 bc	1158 bc	1274 c
X59	1302	11	105	1138 b	1170 b	1219 ab	1681 b
<b>Grand Mean</b>				1031	1032	1125	1491
<b>CV%</b>				10.0	12.1	10.8	11.0
<b>LSD 5%</b>				149.4	182.2	209.7	238.1
<b>Significant Difference</b>				Yes	Yes	Yes	Yes

Grain yield is summarized for all the diversification sites in Table 3. MAFRD's website recommends new growers to budget for 400 to 500 lbs/acre yield and experienced growers to budget for 600 to 800 lbs/acre (Manitoba Agriculture and Rural Development n.d.). All the Diversification sites were within or above the MAFRD recommendations for yield. One word of caution is that research plots tend to yield higher than a large production area, but varietal performance patterns should be similar. The %CV was

below 15% for all locations. Joey was consistently the highest yielding variety for all the locations and it was significantly higher yielding than all the other entries at Arborg, Carberry and Roblin. At Melita, Joey was comparable in yield to CRS-1, X59 and Debbie and significantly higher yielding than the other entries. Finola was consistently the lowest yielding variety for all the locations. One appealing attribute of Finola for growers is its short height. This makes harvest ability and straw management easier.

**Chart 1:** 2014 Manitoba Industrial Hemp Grain Variety Trial Yield (lbs/acre) from Arborg, Carberry, Melita and Roblin, MB



**Table 4:** 2014 Manitoba Industrial Hemp Grain Variety Trial Long Term Yield Results

Variety Name	% Relative Yield of Check (CRS-1)	# of Location Years	Kg/Ha		Lbs/acre	
			Average Yield Based on # of Site Years	Average Check Yield Based on Comparative Years of Testing* (CRS-1)	Average Yield Based on # of Site Years	Average Check Yield Based on Comparative Years of Testing* (CRS-1)
Alyssa	82	13	1316	1601	1172	1426
Anka	81	10	1364	1693	1215	1508
Canda	111	17	1605	1440	1430	1283
CanMa	88	3	1150	1304	1024	1162
Carmen	42	1	447	1058	398	942
CFX-1	93	17	1436	1552	1279	1382
CFX-2	95	16	1324	1402	1179	1248
CRS-1	100	20	1526	1526	1359	1359
Debbie	94	10	1350	1441	1203	1283
Delores	97	18	1534	1577	1366	1404
Finola	58	15	862	1498	767	1335
Heidrun	72	4	1448	2025	1290	1803
Joey	120	12	1836	1536	1636	1368
Jutta	94	8	1564	1663	1393	1481
Petera	24	1	257	1058	229	942
Silesia	75	10	1030	1372	918	1222
USO 14	62	7	1154	1866	1028	1662
X59	103	11	1413	1371	1259	1221
Yvonne	76	4	1529	2025	1362	1803

\* This value is used to calculate the % relative yield of check for that particular variety plus the same years of testing.

Table 4 summarizes the long term yield results for all the industrial hemp varieties that have been tested over the years at PCDF. Please note the number of location years. The more years of testing gives better representation of how a variety will perform over a varying amount of environmental conditions. Joey continues to lead the group for yield ability at 120% of the check CRS-1. The top 7 yielding varieties in this table are varieties that are currently being tested in the Manitoba industrial hemp grain variety trial. Varietal improvements have been made through the breeding efforts of various organizations.

Joey was developed by the Parkland Industrial Growers (PIHG) and seed is expected to be available in 2016 (Parkland Industrial Hemp Growers 2014). Canda (grain), Debbie (grain), Delores (grain), Alyssa (dual purpose) and Petera (fibre) are all available from PIHG in Dauphin. X59 or Hemp Nut is developed and marketed by Terramax Corporation in Qu'Appelle, SK. X59 is known for its large hemp heart size for the food market. CFX-1, CFX-2 and CRS-1 are all grain varieties and they are developed and marketed by Hemp Genetics International (HGI) in Saskatoon. Silesia is a Polish variety that is destined more for the fibre industry and is available through Dr. Jan Slaski at Alberta Innovates and Technology Futures (AITF) in Vegreville, AB. It is also more adapted to Alberta's growing conditions. Finola was developed by two

breeders from Sweden and Finland and it is marketed by Hemp Oil Canada at St. Agathe, MB. Finola is used in the grain market only because of its short stature.

In 2014, the MASC acreage summary showed that CRS-1 represented 43.9% of the acreage and it is followed by X59 at 24.5%, CFX-1 at 9.7% and CFX-2 at 6.0%. Other acreages are represented by Finola, Canda and Delores at 5.7%, 4.8% and 3.8%, respectively. The total MB acreage was 17,453. (Manitoba Agricultural Services Corporation 2014)

## Conclusions

Industrial hemp continues to expand its acreage in western Canada. Interest in the crop is generated from the farm gate to consumers and the medical field. The general public is becoming more health conscious and they are relying more on the foods we eat than synthetic pharmaceuticals to accomplish this. Industrial hemp products provide them this opportunity because its DNA is closely aligned to human DNA in providing the essential components for healthy living. In addition, the industrial hemp bracts and leaves have a cannabinoid CBD that has amazing applications in the medical world and market potential is huge.

PCDF is recognized as the hemp research centre for the Manitoba Diversification Centres. Jeff Kostuik has many years of experience with hemp production and he is viewed as the hemp agronomy contact for MAFRD. The Roblin site will continue to be the flagship for hemp variety and agronomy testing.

## Acknowledgments

PCDF would like to acknowledge the funding contribution made by Growing Forward 2 to make this research project possible. Thank you to AITF, HGI, PIHG and Terramax Corporation for providing the varieties for this trial and to CMCDC, PESAI and WADO for growing the trial.

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## FMC Chemical Demonstration

### Site Information

**Location:** Melita and Crandall, Manitoba  
**Cooperators:** Brad Ewankiw- FMC Account Manager, Manitoba

### Background

Founded in 1883, FMC is a US based specialty chemical company which is now growing its business in Canada. FMC Corporation serves agricultural, industrial and consumer markets globally with innovative solutions, applications and quality products. The company employs approximately 5,000 people throughout the world. They are focused on providing solutions to issues faced by Canadian producers such as weed resistance in minor use crops with limited solutions. The FMC demo trial was set up to showcase some of the products they have available or will be launching soon in Western Canada.

The demo included the following products:

- Authority Charge, a new herbicide tank-mix available for peas, flax, sunflowers and chickpeas to control kochia, lamb's-quarters, redroot pigweed and wild buckwheat. Authority Charge includes the active ingredients sulfentrazone (group 14 residual herbicide) and carfentrazone (group 14 burnoff additive for glyphosate). Authority also has activity on other weeds such as cleavers.
- Authority Supreme, a combination of sulfentrazone and a new active ingredient, pyroxasulfone, which is not yet registered for flax and peas. Authority Supreme provides broad spectrum residual activity on many grass and broadleaf weeds, including wild oats, barnyard grass, green foxtail, yellow foxtail, lamb's-quarters, redroot pigweed, shepherd's-purse, stinkweed, wild buckwheat and many other species.
- Focus, a new group 15 and group 14 herbicide combination product for corn, soybeans, and in coming years, wheat. Focus is a combination of pyroxasulfone and carfentrazone and will be a much anticipated additional mode of action for grassy weed control in spring and winter wheat. With residual activity on wild oats, barnyard grass, green and yellow foxtail as well as many small seeded broadleaf weeds, Focus will be an interesting product for growers.

- Command (clomazone) is a group 13 herbicide which is already registered in Canada in soybeans and vegetable crops. In canola, it will bring a much needed additional herbicide option for cleaver control. Cleavers can be a difficult weed to control because it begins to germinate early in the year and continues in season. Clomazone is a residual soil applied herbicide which will provide long lasting control in combination with the canola herbicide system (RoundupReady, LibertyLink, or Clearfield).

## Objective

To demonstrate the efficacy of FMC's different chemical products to control different target weeds with different applications of herbicide treatments and visually compare them to industry standard products traditionally used.

## Design, Materials & Operation

Treatments: 7 & 8 (Table 1, 2)  
 Replication: 1  
 Plot size: 4.32 m x 9 m  
 Test design: Demonstration Blocks  
 Fertilizer applied: 86 lbs/ac N, 30 lbs/ac P for Wheat, Canola, Sunflowers. Soybeans inoculated instead of an N application.  
 Melita Soil Classification: Newstead Loamy Sand pH 7.5  
 Crandall Soil Classification: Newdale Clay Loam pH 7.0

The various different types of crops were seeded into oat stubble. Chemical applications were applied as prescribed. Since this trial was for demonstration purposes only, it was not harvested for data.

**Table 1 : 2014 FMC Chemical Demonstration Treatments at Crandall, MB**

TRT	Crop	Herbicide Regime	Part 1	Part 2	Part 3
1	Soybean	Authority Charge + Glyphosate	Authority @ 118 ml/ac	Aim @ 15 ml/ac	Glyphosate (540) @ 750 ml/ac
2	Soybean	Authority Supreme + Glyphosate	Authority @ 118 ml/ac	Pyroxasulfone @ 72 g/ac	Glyphosate (540) @ 750 ml/ac
3	Wheat	Focus + Glyphosate	Pyroxasulfone @ 72 g/ac	Aim @ 15 ml/ac	Glyphosate (540) @ 750 ml/ac
4	Wheat	Authority Supreme + Glyphosate	Authority @ 118 ml/ac	Pyroxasulfone @ 72 g/ac	Glyphosate (540) @ 750 ml/ac
5	Wheat	Horizon NG + Buctil M	Horizon @ 376 ml/ac	Buctril M @ 0.4 L/ac	Glyphosate (540) @ 750 ml/ac
6	Canola	Glyphosate	Glyphosate @ 0.5 L/ac	Liberty in Crop @ 1.35 L/ac, Centurion @ 25 ml/ac	Glyphosate (540) @ 750 ml/ac
7	Canola	Command + Aim + Glyphosate	Clomazone @ 135 ml/ac	Aim @ 15 ml/ac	Glyphosate (540) @ 750 ml/ac

**Table 2: 2014 FMC Chemical Demonstration Treatments at Melita, MB**

TRT	Crop	Herbicide Regime	Part 1	Part 2	Part 3
1	Soybean	Authority Charge + Glyphosate	Authority @ 118 ml/ac	Aim @ 15 ml/ac	Glyphosate (540) @ 750 ml/ac
2	Soybean	Authority Supreme + Glyphosate	Authority @ 118 ml/ac	Pyroxasulfone @ 72 g/ac	Glyphosate (540) @ 750 ml/ac
3	Soybean	Glyphosate	Glyphosate (540) @ 750 ml/ac		Glyphosate (540) @ 750 ml/ac
4	Wheat	Focus + Glyphosate	Pyroxasulfone @ 72 g/ac	Aim @ 15 ml/ac	Glyphosate (540) @ 750 ml/ac
5	Wheat	Authority Supreme + Glyphosate	Authority @ 118 ml/ac	Pyroxasulfone @ 72 g/ac	Glyphosate (540) @ 750 ml/ac
6	Sunflowers	Authority Charge + Glyphosate	Authority @ 118 ml/ac	Aim @ 15 ml/ac	Glyphosate (540) @ 750 ml/ac
7	Sunflowers	Rival @ 0.65 L/ac + Glyphosate	Muster Toss-n-go @ 12 g/ac	Centurion @ 120 mL/ac	Glyphosate (540) @ 750 ml/ac
8	Sunflowers	Authority Supreme + Glyphosate	Authority @ 118 ml/ac	Pyroxasulfone @ 72 g/ac	Glyphosate (540) @ 750 ml/ac