



**WADO**

Westman Agricultural Diversification Organization  
**2016 ANNUAL REPORT**

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## 2016 Industry Partners (Alphabetical Order)

AgQuest	Manitoba Crop Variety Evaluation Team
Agriculture and Agri-Food Canada	Manitoba Pulse and Soybean Growers Association
Agrisoma	Mustard 21
ARDI – Agri-Food Research Development Initiative	National Sunflower Association of Canada
Barker’s Agri-Centre – Melita	Parkland Crop Diversification Foundation - Roblin
BASF	Parkland Industrial Hemp Growers
Canada MB Crop Diversification Centre- Carberry	Pepsico /Quaker
Canola Council of Canada	Paterson Grain
Cargill	Prairie Agricultural Machinery Institute - Portage
Composites Innovation Centre	Prairies East Sustainable Ag Initiative – Arborg
Ducks Unlimited Canada	RM of Two Borders
Farm Credit Canada	Rural Development Institute
Flax Council of Canada	Treelane Farm - Deloraine
FP Genetics	Secan Seeds
Gowan Agro Canada	Seed Manitoba
Hemp Genetics International	Southwest Regional Development Committee
La Coop fédérée	University of Alberta
MB Agriculture – Crops Branch and GO Teams	University of Manitoba
Manitoba Canola Growers Association	University of Saskatchewan (CDC)
Manitoba Corn Growers Association	Western Feed Grains Development Cooperative

## Farmer Co-operators – 2016 - 2017 Trial Locations

Barkers Farm – Melita	Prince Farm – Waskada
Fiasco Farms Ltd. - Melita	Kirkup Farms - 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 2016.

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		

Manitoba Agriculture staff members located in Southwest Manitoba are also part of the WADO board: Lionel Kaskiw – Souris, Amir Farooq – Hamiota, as well as Scott Chalmers and Brett Teetaert – Melita

WADO Board Advisor: Elmer Kaskiw – Shoal Lake



## 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 and Portage la Prairie. 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 Manitoba Agriculture 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 Manitoba Agriculture in Southwest Manitoba. Scott is responsible for project development, summer staff management, data analysis and extension/communications. Scott has been working with WADO since 2007.



Brett Teetaert joined WADO as Diversification Technician in March 2016. Brett brings with him a variety of skills and knowledge due to his diverse training and job experience. His education includes Industrial Metal Fabrication at ACC and an Agriculture Diploma at U of M. He holds his Pesticide applicators license and Class 1 Drivers License. He was previously employed as Sales Agronomist at Paterson Grain. Brett is responsible for field operations, plot management and data collection.

Liam

Bambridge from Melita, Chantal Elliott of Pipestone and Jessica Mayes of Pierson were all returning summer students. Having experienced students who are familiar with our operation allowed for an efficient season and we were able to effectively manage approximately 40 trials. Liam has been with WADO for five summers. Liam is currently taking Agribusiness at ACC and has accepted a seasonal position with a local seed farm. Liam will be missed at WADO, but we wish him all the best. Chantal has spent four summers with WADO. She completed her final year of an Environmental Science degree at the University of Manitoba. Jessica has been a summer student with WADO since 2013. She is enrolled in the Agriculture and Environmental Faculty at McGill University. She plans to return to WADO during the summer of 2017. Leanne Mayes continues as the WADO full time Research Associate.





WADO Staff 2016 (left to right): Brett, Liam, Scott, Chantal, Jessie, Leanne

## 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 Manitoba Agriculture

Box 519

Melita, MB R0M 1L0

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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>

## 2016 Weather Report and Data – Melita Area

Soil conditions for early spring planting were fairly dry. Due to several large rain events, these conditions soon changed. Soil became wet and in some places saturated. This led to several days delay in planting. Wet conditions persisted throughout the growing season which caused some flooding at our main site and several trials were lost. We also



experienced some light hail and wind damage. Our corn, sunflower and winter cereals were not adversely affected by the over abundant rainfall.

Harvest also had set backs due to weather as September received twice the normal rainfall. Dealing with excess moisture continues to be a challenge for farmers in the Southwest. Upcoming research into cover cropping and tile drainage will hopefully provide insight into water management practices for our area.

**Table 1:** Melita 2016 Season Report by Month (normals based on 30 year average)

Month	Precipitation		Temperature °C		Corn Heat Units		Growing Degree Days	
	Actual	Normal	Average	Normal	Actual	Normal	Actual	Normal
April	24	29	4.5	4.6	135	78	44	24
May	96	53	13.5	11.59	444	365	264	205
June	72	101	17.8	16.8	624	583	384	351
July	78	69	19.5	19.49	715	712	449	453
August	32	78	19.2	18.52	679	659	439	415
September	79	35	13.6	12.69	438	369	257	211
October	84	31	6	5.58	127	116	65	40

Source: [www.gov.mb.ca/climate/SeasonalReport](http://www.gov.mb.ca/climate/SeasonalReport)

**Table 2:** Season summary April 1 – October 31, 2016

	Actual	Normal	% of Normal
Number of Days	214		
Growing Degree Days	1902	1702	112
Corn Heat Units	3162	2884	110
Total Precipitation	465	399	117

Source: [www.gov.mb.ca/climate/SeasonalReport](http://www.gov.mb.ca/climate/SeasonalReport)

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 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>

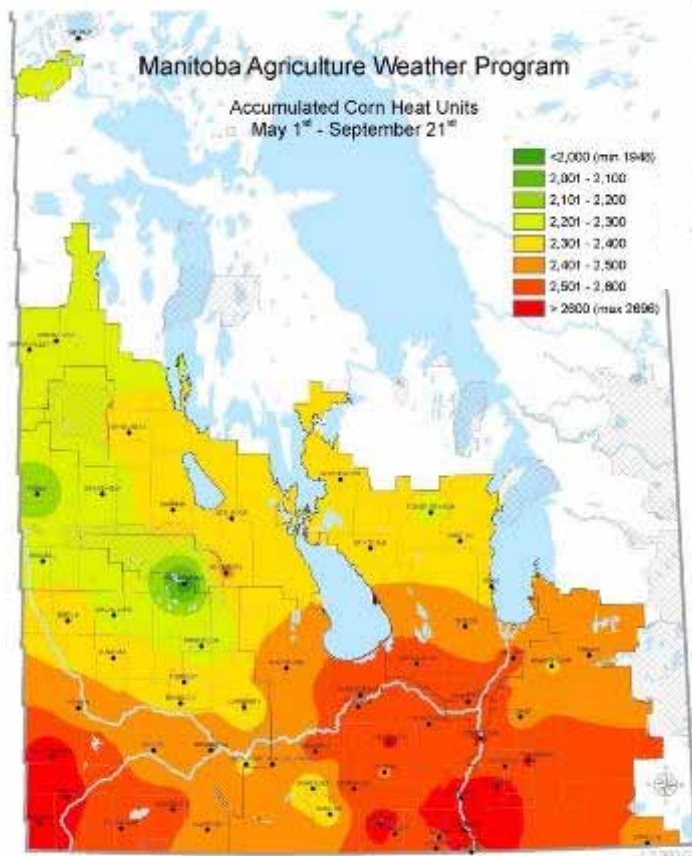
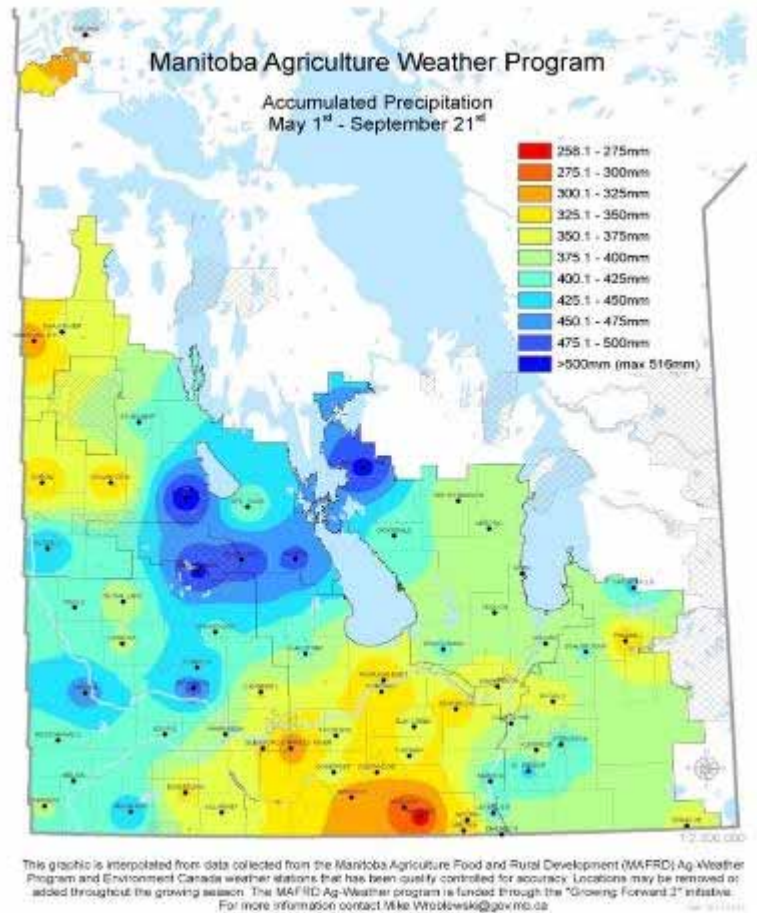
<http://www.gov.mb.ca/agriculture/weather/reston-cc.html>





## 2016 Precipitation Map and Corn Heat Unit Map

Source: <http://www.gov.mb.ca/agriculture/weather/manitoba-ag-weather.html>





## WADO Tours and Special Events



WADO attended Ag Days in Brandon, MB on January 16 – 18. Manitoba's Diversification Centres managed a booth showcasing new farming opportunities and possibilities. Over 50,000 people were in attendance.

On July 19, we hosted our annual field day and lunch. Approximately 75 people joined us for lunch and then toured our main plot site SW of Melita. This location showcased many of our variety trials including: oats, barley, soybeans, peas, narrow row beans, buckwheat, hemp, canola, and juncea. Also at this site were several trials that were part of the University of Manitoba's research on soybeans and WADO's own research project on intercropping pea and canola. It was an extremely hot day and we would like to thank everyone who endured the heat and spent the day with us. We would also like to thank John Deere for sponsoring a John Deere 825 Side by Side which was used to transport supplies and people throughout the day.



Scott Chalmers also presented at several winter meetings in early 2017 on Companion Cropping. These meetings included the Northern Plains Agricultural Innovation Alliance tradeshow and conference in Minot hosting over 300 people, meeting at the Brandon Ag Centre with 29 in attendance, and 'Getting it



Right' soybean production meeting hosted by Manitoba Soybean & Pulse Growers Association in Portage la Prairie with 120 in attendance. Scott also spoke to students during the University of Manitoba's special crops lab on pea-canola intercropping in February.

## 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 Agrobases 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.

## **Trials Awaiting Reports**

The following trials were carried out by WADO in 2016, but require multiple site years of data or additional analysis before results will be published:

- Expanding the Seeding Window of Winter Wheat in Western Canada – University of Manitoba
- Mitigating Herbicide Residual Activity on Fall Stand Establishment in Winter Wheat - University of Alberta
- Winter Annual Control Through Alternative Pre and Post Seed Weed Management – University of Alberta
- Soybean Inoculant Trial – University of Manitoba
- Soybean Frequency in Crop Rotation – University of Manitoba
- Residue Management for Early Planted Soybean – University of Manitoba
- Corn Phenology – University of Manitoba
- Inbred Corn Variety Nursery – Agriculture and Agri-Food Canada (Ottawa)

## **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” 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 mailed out with the Manitoba Cooperator or on the web.

The tables on the following two pages outlines our agronomy practices for MCVET trials we participated in. Yield data is published in the Seed Manitoba Guide.



	Legal	Stubble	Burnoff	Soil Moisture	pH	Organic Matter	N (0-24)	P (Osen PPM)	K (PPM)	S	Seed Date	Seed depth	Seeder	Fertility
Winter Wheat	NE 10-4-26W1	Canola									15-Sep	0.5"	Seedhawk	55-24-16-7
Rye	NE 10-4-26W1	Canola									15-Sep	0.5"	Seedhawk	55-24-16-7
Barley	NE 27-3-27W1	W.Wheat	Glyphosate .75L/ac + Rival EC @ .65L/ac	Good	7.8	3.1	48	4	244	50	04-May	0.75"	Seedhawk	92-31-27-18
Wheat1	NE 27-3-27W1	W.Wheat	Glyphosate .75L/ac + Rival EC @ .65L/ac	Good	7.2	3	33	5	229	104	05-May	0.75"	Seedhawk	112-31-27-18
Wheat2	NE 27-3-27W1	W.Wheat	Glyphosate .75L/ac + Rival EC @ .65L/ac	Good	7.2	3	33	5	229	104	05-May	0.75"	Seedhawk	112-31-27-18
Durum	NE 27-3-27W1	W.Wheat	Glyphosate .75L/ac + Rival EC @ .65L/ac	Good	7.8	3.1	48	4	244	50	03-May	0.75"	Seedhawk	112-31-27-18
Oat	NE 27-3-27W1	W.Wheat	Glyphosate	Good	7.2	3	33	5	229	104	04-May	0.75"	Seedhawk	112-31-27-18
WFGDC	NE 27-3-27W1	W.Wheat	Glyphosate .75L/ac + Rival EC @ .65L/ac	Good	7.2	2.8	38	6	298	84	03-May	0.75"	Seedhawk	112-31-27-18
Pea	NE 27-3-27W1	W.Wheat	Glyphosate	Good	7.7	2.5	48	6	206	16	02-May	1.5"	Seedhawk	22-31-27-18 Gran Innoc
Lentil	NE 27-3-27W1	W.Wheat	Glyphosate	Good	7.7	2.5	48	6	206	16	16-May	0.75"	Seedhawk	22-31-27-18 Gran Innoc
Soybean	NE 27-3-27W1	W.Wheat	Glyphosate	fair	7.1	2.8	35	3	242	68	18-May	1.25"	Seedhawk	22-31-27-18 Gran Innoc
NR Bean	NE 27-3-27W1	W.Wheat	Glyphosphate .75L/ac and Aim @.15L/ac	fair	7.7	2.5	48	6	206	16	30-May	.75"	Seedhawk	60-31-27-18
Canola	NE 27-3-27W1	W.Wheat	Glyphosate	Dry	7.1	2.8	35	3	242	68	05-May	0.5"	Seedhawk	108-31-27-18
OP Canola	NE 27-3-27W2	W.Wheat	Rival and Glyphosphate @ 0.5L/ac and 1L/ac	Dry							16-May	0.5"	Seedhawk	117-31-27-18
Sunflower	SE 19-4-27 W1	Wheat	Authority @ 100 ml/ac, Aim @ 15 ml/ac, Glyphosphate @ 0.75 L/ac, Rival @ .65L/ac	Good							19-May	1.5"	Wintersteiger Planter	69-33-7
Hemp	NE 27-3-27W1	W.Wheat	1L/ac Glyphosphate+ Liberty @ 0.75L/ac	Wet							30-May	.75"	Seedhawk	107-31-27-18
Corn VT	SW 7-3-25W4	Wheat	0.75 L Roundup, 15 g/ac Heat, 0.2 L/ac Merge, 1.5 L/ac PrimeExtra II Magnum	Dry	7.5	3.8		6	315	56	19-May	2"	Wintersteiger Planter	95-45-10

	Topdressing	Chemistry	Swath Date	Dessication	Harvest Date
Winter Wheat	April 22 50 #/ac; May 10 60lbs/ac N	Achieve @ 0.2 L/ac + Turbocharge + Buctril M @ 0.4L/ac			26-Jul
Rye	April 22 50 #/ac; May 10 60lbs/ac N	Achieve @ 0.2 L/ac + Turbocharge + Buctril M @ 0.4L/ac	25-Jul		29-Jul
Barley		Attain AB + Axial and Adigor			11-Aug
Wheat1		Velocity, 0.4L/ac		12-Aug	22-Aug
Wheat2		Velocity, 0.4L/ac		12-Aug	22-Aug
Durum		Velocity, 0.4L/ac			22-Aug
Oat		Stampede @1.25lbs/ac + MCPA ester 500 @0.4L/ac		Aug 5, 1 L/ac	15-Aug
WFGDC		Velocity, 0.4L/ac		23-Aug	29-Aug
Pea		Odyessy @ 17 g/ac + equinox @ 67 ml/ac + Merge		02-Aug	10-Aug
Lentil		Sencor @ 111 g/ac		Aug 2 Reglone	10-Aug
Soybean		Maverick III @0.5 L/ac + Viper @0.4 L/ac			27-Sep
NR Bean		Basagran Forte @ .91L/ac and Select @ 75ml/ac			29-Sep
Canola		Clearfield - Odyssey17 g/ac, + equinox @67 ml/ac + Merge. Roundup - .75L/ac Maverick III.	08-Aug	08-Aug	16-Aug
OP Canola		Muster @ 12 g/ac + Assure II @.2L/ac + suremix	10-Aug	12-Aug	22-Aug
Sunflower		Assert.34L/ac + 150ml/ac. Pounce @158ml/ac for cutworms June 6th			20-Oct
Hemp		Koril @ 0.4 L/ac, Select @ 100 ml/ac + Amigo			Fibre Aug 4 - Grain Aug31 - Sept 12
Corn VT		Glyphosphate @ .75L/ac + Bromoxynil @.4L/ac			

# Nitrogen Management Strategies for High Yielding Spring Wheat in Manitoba

**Principal Investigators:** Don Flaten, University of Manitoba

**Contact Information:** Amy Mangin ([Amy.Mangin@Umanitoba.ca](mailto:Amy.Mangin@Umanitoba.ca))

**Support:** Manitoba Wheat and Barley Growers

**Duration:** 2016-2017

**Locations:** Carman, Brunkild, Melita, Carberry, (Roblin, Portage, Beausejour)

## Introduction

Manitoba producers are growing varieties of spring wheat with very high yield potential, which has brought out challenges in our nitrogen management strategies. Current provincial guidelines are based on much lower yielding varieties and these recommendations (2.5 lbs. N bu<sup>-1</sup> for milling quality wheat) indicate a large financial, agronomic and environmental risk for these high yielding varieties. Midseason N application may mitigate this risk but there is currently debate over the best method and timing for midseason application to best utilize fertilizer.

## Research Objectives

1. Determine appropriate N rates based on yield and protein goals for new high yielding spring wheat varieties.
2. Determine most effective and efficient combinations of rate, timing, placement and source, especially for midseason applications.
3. Evaluate soil tests for measuring potential mineralization of organic soil N that can be released during the growing season.
4. Develop decision tools for midseason evaluation of N sufficiency.

## Methods

Two-year field research project with sites conducted across Manitoba, including two intensive “Gold Sites” hosted by University of Manitoba (Carman and Brunkild), and four less intensive “Silver Sites” executed primarily by Manitoba’s Diversification Centres (Carberry, Melita, Portage, Roblin, Beausejour). Pre plant soil samples were taken at each site to 120 cm and due to excessively high residual nitrogen Portage (200 lbs.) and Roblin (132 lbs.) these sites were discontinued. Site characteristics as well as agronomy at each site completed can be found in Table 1.

Treatments were designed to address 4R N management for two high yielding spring wheat varieties: AAC Brandon (CWRS) and Prosper (CNHR) in a randomized complete block design. Treatments included rates of nitrogen from 0 to 200 (Gold) or 170 (Silver) lbs. N ac<sup>-1</sup> increasing by 30 lbs. N ac<sup>-1</sup> intervals. All N rate treatments were applied at seeding. Conventional urea was applied through midrow bands at Gold sites and Agrotain treated urea was broadcast to the soil surface shortly after seeding at Silver sites. At Gold sites, 80 lbs. N ac<sup>-1</sup> was also applied broadcast at planting and in Melita, 80 lbs. N/ac<sup>-1</sup> was banded at seeding as placement checks.



In season applications of N on top of the spring base rate (80 lbs. N ac<sup>-1</sup>) at stem elongation (T1, 30 or 60 lbs. N ac<sup>-1</sup>) and flag leaf (T2, 30 or 60 lbs. N ac<sup>-1</sup>) were compared to N applied entirely at seeding. One week after anthesis, UAN (and urea solution at Gold sites only) was applied at 30 lbs. N ac<sup>-1</sup> on top of the spring base rate. At the Gold sites only, two different blends of urea: ESN (40:40 and 40:100 lbs. N ac<sup>-1</sup>) were applied at seeding. A full list of treatments can be found in Table 2.

### Data Collection

To estimate potential organic N mineralized during the growing season three methods were evaluated: Sharifi's sodium bicarbonate extraction, Les Henry's sample incubation test, and Solvita CO<sub>2</sub> burst test on the 0-15cm portion of the soil profile sampled at seeding.

Throughout the growing season a number of measurement tools were used to help estimate if adequate N was present to obtain yield and protein goals. Greenseeker, an active NDVI sensor, and SPAD chlorophyll meter readings were taken before each in-season nitrogen application at stem elongation, flag leaf and anthesis. Flag leaf samples for N content and soil nitrate-N were also taken just before heading.

Biomass was taken at hard dough stage for total grain and straw N content from each treatment. Lodging, height, grain yield and protein were taken at harvest. Shortly after harvest, residual soil nitrate-N (0 – 120 cm) samples were taken from each plot as a nitrogen-auditing tool.

**Table 1:** Site Characteristics and field activity descriptions

	Location			
	Carman	Brunkild	Melita	Carberry
GPS	49.498, -98.031	49.592, -97.605	49.251, -101.032	49.917, -99.326
Organic matter (%)	5.9	4.8	3.7	6.2
pH	7.1	7.8	8.1	7.4
NO <sub>3</sub> <sup>-</sup> -N (0-60 cm) lbs ac-1	46.7	39.8	43.3	88.5
P ppm	18	11	5.5	17
K ppm	470	690	380	500
Growing Season Rainfall (May – Aug) (mm)	339	275	279	266
Previous Crop	Wheat	Canola	W. Wheat	Canola
Number of Rows	8	8	6	4
Row Spacing (cm)	20.32	20.32	24.13	30.48
Opener	knife	knife	dual knife	Disc
Opener Width	7.62	7.62	1.90	2.54
Seeding Date	April 28	May 5	May 6	May 5
T1 (Stem Elongation) N App Date	June 8	June 14	May 9	May 25
T2 (Flag Leaf) N App Date	June 21	June 29	June 23	June 17
PAN App Date	July 14	July 14	July 15	June 23
Harvest Date	Sept 1	Aug 29	Aug 22	Sept 2

**Table 2:** Full trial treatment list

Variety	N Rate (Lbs. N/ac)		Source		Timing/Placement	
	Spring	In Season	Spring	In Season	Spring	In Season
Brandon (CWRS) and Prosper (CNHR)	0		Urea (Gold), Agrotain treated urea (Silver)		Midrow band at seeding (Gold), Broadcast after seeding (Silver)	
	50					
	80					
	110					
	170					
	200					
	80		ESN:Urea (40:40)			
	140		ESN:Urea (100:40)			
	80	30	Urea, Agrotain treated urea	Agrotain treated urea		Stem elongation, broadcast
	80	60				Flag leaf, broadcast
	80	30				
	80	60				Post anthesis, foliar
	80	30		UAN		
	80	30		Urea Sol'n (Gold)		Post anthesis, foliar

## Results

The full trial was separated into two studies for analysis. Results are reported first for the rate response study followed by the rate, source and timing combination study. Due to trial establishment problems, which led to a high CV value (50-60%) the Beausejour site, is not included in the analysis. Only yield and protein data will be presented as in season nitrogen sufficiency measurements and mineralization data is still being processed.

## Rate Response Study

**Table 3. N Rate Study Yield (bu ac<sup>-1</sup>)**

Variety	N Rate	Site Year			
		Carman 2016	Brunkild 2016	Melita 2016	Carberry 2016
	-- Lbs. ac <sup>-1</sup>	----- Lbs. ac <sup>-1</sup> -----			
	1 --				
AAC Brandon	0	37.95	36.22	39.68	81.97
	50	40.51	46.51	49.19	85.85
	80	45.01	51.40	55.32	88.70
	110	49.50	62.71	58.19	93.75
	140	53.36	73.69	58.12	87.65
	170	59.17	63.29	61.73	90.83
	200	56.17	67.26		
Prosper	0	36.23	30.38	47.73	103.22
	50	50.61	53.46	56.02	102.93
	80	54.25	63.94	64.78	104.94
	110	63.12	70.50	70.29	104.80
	140	70.52	76.25	72.03	109.02
	170	69.84	76.40	71.18	107.82
	200	79.74	80.71		
AAC Brandon		48.86 b	57.30 b	53.71 b	88.13 b
Prosper		60.62 a	64.52 a	63.67 a	105.45 a
	0	37.09 d	33.30 d	43.71 d	92.60
	50	45.56 cd	49.99 c	52.61 c	94.39
	80	49.63 bc	57.67 bc	60.05 b	96.82
	110	56.31 abc	66.60 ab	64.24 ab	99.27
	140	61.94 ab	74.97 a	65.08 ab	98.33
	170	64.51 a	69.85 a	66.45 a	99.32
	200	68.13 a	73.98 a		
<b>ANOVA</b>	<b>df</b>	<b>Pr &gt; F</b>			
Variety	1	< 0.0001	0.0002	< 0.0001	<0.0001
N Rate	6	< 0.0001	< 0.0001	< 0.0001	0.5382
Variety * N Rate	6	0.0760	0.0684	0.5088	0.8864
Coeff Var (C.V.)		26.17	25.04	17.30	13.51



**Table 4. N Rate Study Protein (%)**

Variety	N Rate	Site Year			
		Carman	Brunkild	Melita	Carberry
		2016	2016	2016	2016
	Lbs. ac <sup>-1</sup>	Lbs. ac <sup>-1</sup>			
AAC Brandon	0	15.22	12.3263	15.24	15.65
	50	15.71	12.73	15.94	15.65
	80	16.15	13.59	16.14	15.28
	110	16.11	14.31	17.07	15.96
	140	17.07	14.14	17.34	16.46
	170	17.07	15.06	17.43	16.14
	200	17.17	15.83		
Prosper	0	12.62	11.44	14.73	13.81
	50	12.95	10.92	13.68	14.46
	80	13.53	11.86	15.05	14.64
	110	14.35	12.70	15.83	15.37
	140	14.62	12.58	15.97	14.92
	170	14.91	13.87	16.00	15.56
	200	15.52	14.08		
AAC Brandon		16.36 a	13.99 a	16.53 a	15.80 a
Prosper		14.07 b	12.49 b	15.22 b	14.79 b
	0	13.92 d	11.88 d	14.99 b	14.73
	50	14.32 dc	11.82 d	14.81 b	15.05
	80	14.84 bcd	12.73 dc	15.60 b	14.96
	110	15.23 abc	13.50 bc	16.45 a	15.67
	140	15.85 ab	13.36 c	16.66 a	15.54
	170	15.99 a	14.47 ab	16.72 a	15.85
	200	16.35 a	14.95 a		
<b>ANOVA</b>	<b>df</b>			<b>Pr &gt; F</b>	
Variety	1	<0.0001	<0.0001	<0.0001	0.0005
N Rate	6	<0.0001	<0.0001	<0.0001	0.0765
Variety * N Rate	6	0.5869	0.8061	0.0754	0.5693
Coeff Var (C.V.)		10.72	10.97	7.31	7.72

## Summary

### Variety

- Prosper had a significantly higher grain yield than AAC Brandon at each site ( $p < 0.05$ ). Grain yield increase ranged from 7.22 – 16.31 bu ac<sup>-1</sup>.
- AAC Brandon had higher grain protein content than Prosper at each site ( $p < 0.05$ ). Grain protein content increase ranged from 9.82 – 2.19 %.

### N Rate

- Maximum N rate to statistically increase grain yield ( $p < 0.05$ ) at Carman, Brunkild and Melita was 110 lbs. N ac<sup>-1</sup> (156, 150, 153 total N)
- Maximum N rate to statistically increase protein content was 110 lbs. N ac<sup>-1</sup> at Carman and Melita and 170 lbs. N ac<sup>-1</sup> at Brunkild
- At Carberry, increasing N rate did not have a significant effect on grain yield or protein content

## Rate, Source and Timing Combination Study

**Table 5.** Rate, Source, Timing Combination Study yield (bu ac<sup>-1</sup>)

Variety	Treatment			Site Year			
	Timing	Source	N Rate	Carman 2016	Brunkild 2016	Melita 2016	Carberry 2016
			lbs ac <sup>-1</sup>	----- lbs ac <sup>-1</sup> -----			
AAC Brandon	Seeding	Urea	80	45.01	51.40	55.32	88.70
	Seeding	Urea	110	49.50	62.71	58.19	93.75
	Seeding	Urea	140	53.76	72.78	58.12	87.65
	Seeding	ESN/Urea	80	47.27	58.28		
	Seeding	ESN/Urea	140	53.44	64.28		
	Seeding / T1	Urea	110	59.84	67.63	59.05	98.66
	Seeding / T1	Urea	140	59.62	73.47	61.45	90.18
	Seeding / T2	Urea	110	54.33	62.32	57.41	87.63
	Seeding / T2	Urea	140	51.81	61.26	63.43	91.39
	Seeding / PA	Urea/UAN	110	35.88	56.05	52.09	76.29
	Seeding / PA	Urea/urea soln	110	40.84	56.56		
Prosper	Seeding	Urea	80	54.65	63.09	64.78	104.94
	Seeding	Urea	110	63.52	70.50	70.29	104.80
	Seeding	Urea	140	70.94	76.25	72.03	109.02
	Seeding	ESN/Urea	80	63.57	66.95		
	Seeding	ESN/Urea	140	76.84	77.11		
	Seeding / T1	Urea	110	72.03	80.80	67.21	107.88
	Seeding / T1	Urea	140	71.60	70.65	71.94	107.34
	Seeding / T2	Urea	110	75.18	72.10	69.48	102.65
	Seeding / T2	Urea	140	73.19	75.80	72.60	109.88
	Seeding / PA	Urea/UAN	110	59.71	60.00	63.07	90.13
	Seeding / PA	Urea/urea soln	110	58.29	67.21		
AAC Brandon				51.08 b	62.37 b	58.05 b	89.28 b
Prosper				68.15 a	70.42 a	68.38 a	104.58 a
	Seeding	Urea	80	49.83 dc	57.27 c	60.05 dc	96.82 ab
	Seeding	Urea	110	56.51 bcd	66.60 abc	64.24 abc	99.27 ab
	Seeding	Urea	140	62.35 abc	74.49 a	65.08 abc	98.33 ab
	Seeding	ESN/Urea	80	55.42 bcd	62.61 bc		
	Seeding	ESN/Urea	140	65.14 ab	70.67 ab		
	Seeding / T1	Urea	110	65.93 ab	74.22 a	63.13 abcd	103.27 a
	Seeding / T1	Urea	140	65.61 ab	72.06 ab	66.69 ab	98.76 ab
	Seeding / T2	Urea	110	64.76 ab	67.21 abc	63.45 abcd	95.14 ab
	Seeding / T2	Urea	140	62.50 ab	68.52 abc	68.01a	100.64 ab
	Seeding / PA	Urea/UAN	110	47.79 d	58.02 c	57.58 d	83.21 b
	Seeding / PA	Urea/urea soln	110	49.56 d	61.89 bc		
<b>ANOVA</b>						<b>Pr &gt; F</b>	
Variety				<0.0001	<0.0001	<0.0001	<0.0001
N Rate				<0.0001	<0.0001	<0.0001	0.0411
Variety * N Rate				0.5781	0.3268	0.7627	0.9617
Coeff Var (C.V.)				21.91	14.63	11.16	13.57
<b>Contrasts</b>				<b>Probability value from linear contrast</b>			
Conventional Urea vs. ESN Blend				0.1088	0.7461		
Spring Application vs. Stem Elongation Split				0.0156*	0.2728	0.8586	0.5617
Spring Application vs. Flag Leaf Split				0.1052	0.2532	0.4618	0.8098
Stem Elongation vs. Flag Leaf Split				0.3839	0.0274*	0.5737	0.4164
UAN vs. Urea Source Post Anthesis Application				0.6109	0.2645		
Spring 80 vs Post Anthesis Split				0.7167	0.3648	0.2230	0.0174*
Spring 110 vs. Post Anthesis Split				0.0159*	0.0213*	0.0016*	0.0055*
Band vs Broadcast Spring Application				<0.0001*	0.0892	0.7497	

**Table 6. RST Study Protein (%)**

Variety	Treatment		N Rate	Site Year			
	Timing	Source		Carman 2016	Brunkild 2016	Melita 2016	Carberry 2016
			lbs ac <sup>-1</sup>	----- lbs ac <sup>-1</sup> -----			
AAC Brandon	Seeding	Urea	80	16.13	13.59	16.14	15.28
	Seeding	Urea	110	16.12	14.31	17.07	15.96
	Seeding	Urea	140	17.08	14.12	17.34	16.16
	Seeding	ESN/Urea	80	16.11	13.86		
	Seeding	ESN/Urea	140	16.90	15.03		
	Seeding	Urea (Place)	80	15.96	13.30	16.38	
	Seeding / T1	Urea	110	16.56	14.54	16.60	15.36
	Seeding / T1	Urea	140	17.37	15.52	17.44	16.04
	Seeding / T2	Urea	110	17.08	15.39	17.23	16.60
	Seeding / T2	Urea	140	17.38	16.24	17.33	16.32
	Seeding / PA	Urea/UAN	110	17.37	15.70	18.04	16.80
	Seeding / PA	Urea/urea soln	110	18.45	16.94		
Prosper	Seeding	Urea	80	13.54	11.87	15.05	14.63
	Seeding	Urea	110	14.36	12.70	15.83	15.37
	Seeding	Urea	140	14.63	12.58	15.97	14.92
	Seeding	ESN/Urea	80	13.43	11.42		
	Seeding	ESN/Urea	140	15.46	13.32		
	Seeding	Urea (Place)	80	13.69	11.44	14.99	
	Seeding / T1	Urea	110	14.47	12.58	15.96	15.15
	Seeding / T1	Urea	140	15.62	13.81	15.90	15.24
	Seeding / T2	Urea	110	14.57	13.97	15.56	15.36
	Seeding / T2	Urea	140	15.14	15.63	16.31	15.45
	Seeding / PA	Urea/UAN	110	15.80	14.12	16.30	15.78
	Seeding / PA	Urea/urea soln	110	15.48	15.03		
AAC Brandon				16.87 a	14.88 a	17.06 a	16.06 a
Prosper				14.68 b	13.21 b	15.76 b	15.24 b
	Seeding	Urea	80	14.84 dc	12.73 de	15.60 b	14.96
	Seeding	Urea	110	15.24 bcd	13.50 dc	16.45 ab	15.67
	Seeding	Urea	140	15.86 abcd	13.35 dce	16.66 a	15.54
	Seeding	ESN/Urea	80	14.77 d	12.64 e		
	Seeding	ESN/Urea	140	16.18 abc	14.17 bc		
	Seeding	Urea (Place)	80	14.83 d	12.37 e	15.69 b	
	Seeding / T1	Urea	110	15.51 bcd	13.56 dc	16.28 ab	15.25
	Seeding / T1	Urea	140	16.49 ab	14.67 b	16.67 a	15.64
	Seeding / T2	Urea	110	15.83 abcd	14.68 b	16.34 ab	15.98
	Seeding / T2	Urea	140	16.26 ab	15.93 a	16.82 a	15.88
	Seeding / PA	Urea/UAN	110	16.58 ab	14.91 ab	17.17 a	16.30
	Seeding / PA	Urea/urea soln	110	16.97 a	15.99 a		
<b>ANOVA</b>	<b>df</b>					<b>Pr &gt; F</b>	
Variety				<0.0001	<0.0001	<0.0001	0.1699
N Rate				<0.0001	<0.0001	<0.0001	0.0012
Variety * N				0.6796	0.5466	0.6383	0.9625
Rate							
Coeff Var (C.V.)				9.56	10.99	5.96	6.55
<b>Contrast</b>				Probability from Linear Contrast			
Conventional Urea vs. ESN Blend				0.6454	0.1109		
Spring Application vs. Stem Elongation Split				0.1215	0.0031*	0.6947	0.6452
Spring Application vs. Flag Leaf Split				0.0910	<0.0001*	0.7889	0.3330
Stem Elongation vs. Flag Leaf Split				0.8740	<0.0001*	0.5098	0.1595
UAN vs. Urea Source Post Anthesis Application				0.3149	0.0017*		
Spring 80 vs Post Anthesis Split				<0.0001*	<0.0001*	<0.0001*	0.0069*
Spring 110 vs. Post Anthesis Split				0.0001*	<0.0001*	0.0134	0.1921
Band vs Broadcast Spring Application				0.9831	0.2739	0.7429	



## *Summary*

### **Variety**

- Prosper had a significantly higher grain yield than AAC Brandon at each site ( $p < 0.05$ ). Grain yield increase ranged from 9.96 – 17.32 bu ac<sup>-1</sup>.
- AAC Brandon had higher grain protein content than Prosper at each site ( $p < 0.05$ ). Grain protein content increase ranged from 1.01 – 2.29 %.

### **Timing**

- Yield and protein content for all split N applications applied at seeding plus either stem elongation (T1) or flag leaf (T2) were similar to those for equivalent rates of N applied at seeding at Carman and Melita.
- At Brunkild, protein content was increased by splitting N applications between seeding and flag leaf (both rates) and stem elongation (high rate only); yields were similar for all equivalent rates of N.
- Post anthesis application of N lowered yield at all sites compared to equivalent rates of N at planting.
- Post anthesis applications of N increased grain protein content at all sites, compared to equivalent rates of N at planting.

### **Source**

- ESN: Urea blends produced grain yields and protein content that were similar to those for conventional urea when applied at planting.
- Urea solution significantly increased protein content over UAN when applied post anthesis at Brunkild but yields for the two sources were similar. Grain yield and protein content were similar for both sources at Carman.

# **On-Farm Nitrogen Management for High Yield Wheat**

## ***On-Farm-Tests for High Yield and High Protein Wheat – 2015-16 Summary***

In 2015-16 some 30 on-farm-tests were conducted to evaluate 3 different nitrogen (N) management strategies for increasing yield and protein of the newer high yield potential spring wheat varieties. These studies were prompted by the struggle to meet protein standards when producers grew high wheat yields in 2013-2014 crop years.

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

The 3 N management strategies are simultaneously being evaluated in traditional small plot studies through the University of Manitoba. The strategies selected for on-farm-test evaluation were:

1. Increased N rates. The selected rates were the farmer's base N rate (as determined themselves or with their agronomist), plus an additional 30 and 60 lb N/ac. Usually these rates were applied just before, at or shortly following seeding operations.
2. Use of the controlled release nitrogen fertilizer, ESN. The targeted rate was to be 50% of the farmer's standard fertilizer base rate.
3. Post anthesis nitrogen application. This approach uses a foliar broadcast spray of a UAN solution at 30 lb N/ac diluted 50:50 with water and applied about 7-10 days following anthesis. Most applied in the late evening or morning.

Studies were established using an on-farm-testing procedure with replication and randomization. The rigour of testing was increased in 2016 compared to 2015. The 2015 plots were generally replicated 2-3 times, but replication was increased to 4. In 2015 the yield measurements were done with the farmer's calibrated combine yield monitor and /or grain cart whereas in 2016 we insisted on using standard weigh wagons. The protein samples were taken from the combine hopper or as unloading in 2015 but in 2016 we adapted a sampling tube to the weigh wagon to pull continuous samples during the weigh-off procedure. This design was taken from the Minnesota Wheat On-Farm Research Network.

At most sites measures of N sufficiency were made:

- Flag leaf N: once Flag leaf had fully emerged the leaf was sampled. For example, in Montana 4.2% N is considered sufficient for full yield potential and good protein.
- NDVI as measured with the pocket GreenSeeker.
- UAV flights were intended for all participant fields, but were not all completed.

Data was analyzed using ANOVA and differences were considered statistically significant at the 90% confidence interval. Economics of strategies were calculated on mean values of yield and protein using prices from late February 2017 and spring 2016 fertilizer prices.

## Nitrogen Practice 1: Increasing Base N Rates

The farmer used their base N rate and supplemented with an additional 30 and 60 lb N/ac in replicated and randomized strips.

**Table 1:** Agronomic details for all sites evaluating supplemental N on wheat yield and protein (2015-16).

Farm	A	B	C	D	E	F	G	H	I	J	K	L	Ave CNHR	Ave CWRS
Plant		A 23	M 3	M 2			M 11	M 5			M 3	M 4		
Harvest		A	S 2	S 1				S		A 27	A 19	S 2		
Rain "	14.4	14.9	14.6	13.9	11.2	16.4	15.7	16.6	11.2	9.4	13.3	13.0		
Variety/ Class	Prosper CNHR	Prosper CNHR	Prosper CNHR	Faller CNHR	Prosper CNHR	Prosper CNHR	Prosper CNHR	Prosper CNHR	Brandon CWRS	Brando n CWRS	Cardale CWRS	Pasteur GP		
Prev crop		Dry beans	soys	soys			soys	canola			soys	canola		
Soil type	SI	Reinland sl	Osborne clay	R River clay	Clay	Clay	Clay	cl	Clay loam	New dale cl	Glen hope sl	Newdale cl		
Soil N OM	25	86	28	35	-	30	-	na	57	75		25 4.9%	41	66
Base rate N	140	74	145	160	105	125	120	90	85	70	90	110	120	82
Total N	165	160	173	195	105+	155	120+	90	142	145		135	156	144
N applied	Preplt band urea	Preplt Bcst urea	Topdress UAN	160 MRB NH3,& 60 ESN seedplace			Topdre ss UAN	Fall NH3 & 30 ESN at seeding	Topdress UAN dribbled	Sideba nd urea	Fall NH3 UAN drib	NH3 sideband		
Yield limiting factor*	lodging	lodging* 56 77 86	lodging* 72 71 90	Wetness, lodging		lodging	lodging							

- Rain is the total May-August rainfall from the closest MB Agriculture weather station.
- Where lodging differed among treatments it was rated according to a Lodging Index = 1/3 (% area leaning) + 2/3 (% area lodged) + (% area flat)

**Table 2:** Effect of supplemental N on wheat yield and protein (2015-16).

Farm	A	B	C	D	E	F	G	H	I	J	K	L	Average CNHR(8)	Average CWRS (3)
<b>Yield bu/ac</b>														
Base N	84	70.4	71.7	78.1	54	62.3	66.1	80.2	81.2	62a	84.5	85.4	70.9	75.9
&30	84	69.8	72.9		54	60.0	65.8	86.5	85.7	65b	83.0	85.2	70.4	77.9
& 60	85	70.0	72.3	75.6	56	62.3	66.0		83.3	65b	80.9	85.3	69.6	76.4
Sign	ns	ns	ns	ns	ns	ns	ns	ns	ns	*	ns	ns	nd	nd
<b>Protein %</b>														
Base N	14.2	14.3	13.2	13.7	14.5	15.2	15.0	13.3	15.0 a	14.9	13.3	11.9	14.2	14.4
&30	14.0	14.2	13.4		14.2	15.6	14.8	13.5	15.1ab	15	13.7	11.9	14.2	14.6
& 60	14.5	14.53	13.5	13.5	14.6	15.3	14.9		15.2 b	15.5	13.2	11.6	14.4	14.6
Sign	ns	ns	ns	ns	ns	ns	ns	ns	*	nd	ns	ns	nd	nd
<b>Test wt lb/bu</b>														
Base N	61.1	60.9	61.7	60.7				59.3	60.4	61.1	59.8	60.8	60.7	60.4
&30	61.1	61.1	61.1	-				59.0	60.2	61.3	59.9	60.6	60.6	60.5
& 60	61.2	60.6	60.6	60.5				-	60.2	60.8	59.6	61.0	60.7	60.2
Sign	ns	ns	ns	ns				ns	ns	ns	ns	ns	nd	nd
<b>Measures of N sufficiency and efficiency</b>														
FLN%	3.9%	4.8%	4.7%	4.42	3.6%	-	-	4.5%	4.3%	4.2%	4.53%a	4.46%		
	4.0%	4.85%	4.75%		3.8%			4.7%		4.4%	4.77%b	4.40%		
	4.0%	5.13%	4.8%		3.8%					4.3%	4.88%b	4.48%		
	ns	ns	ns		ns			nd		ns	*	ns		
NDVI	0.77	0.86	0.82	0.75	0.53				0.51	0.85	0.77	0.71		
	0.77	0.86	0.83		0.52				0.58	0.82	0.77	0.72		
	0.77	0.86	0.81		0.56				0.52	0.85	0.75	0.71		
	ns	ns	ns		ns				ns	ns	ns	ns		
NUE Lb N/bu	2.0	2.3	2.4	2.5	-	2.5		na	1.8	2.3		1.6	2.3	2.1

- Sign = statistical significance, ns = not significant, nd = not determined, \* = significant at 90% probability level and means followed by the same letter are not significantly different.
- FLN = Flag leaf N content at flag leaf emergence
- NDVI = near difference vegetation index as determined by the handheld GreenSeeker sensor at flag leaf emergence.

NUE = nitrogen use efficiency = the N supply divided by bushels produced

## *Results and Discussion*

Farmers were generally applying higher N rates to CNHR (120 lb N/ac) than to CWRS (82lb N/ac). Not all growers had soil test information to allow calculation of total N supply, but on average the N supply was 156, 144 and 135 lb N/ac for the CNHR, CWRS and GP wheat classes, respectively (Table 1).

Significant differences for yield and protein were only observed at 1 of 12 sites (Table 2). The yield increase at the site J was slight (only 3 bu/ac) but significant owing to the use of 4 replicates and low field variability. The significant protein increase was only 0.2% at site I. Other sites had greater differences in yield and protein, but they were not significant. Lodging was a yield limiting factor at several sites and was increased by N rate at sites B and C (Table 1).

Test weight was similar across N rates. Similarly the measures of N sufficiency – flag leaf N, SPAD and NDVI showed few differences between N treatments.

Since there was little yield or protein benefit, the added N costs reduced profitability substantially in all but 3 instances (Sites H, I, J in Table 3). At those sites the slight profitability was due to slightly higher yield, not a protein increase with a premium.

In general, for available yield potential in 2015 and 2016, the base N rates used were adequate to meet yield potential and provide high protein levels.



**Table 3:** Economics of supplemental N application\$/bu = late Feb. 2017 prices with protein

Farm	A	B	C	D	E	F	G	H	I	J	K	L	Average CNHR	Average CWRS
Variety /Class	Prosper CNHR	Prosper CNHR	Prosper CNHR	Faller CNHR	Prosper CNHR	Prosper CNHR	Prosper CNHR	Prosper CNHR	Brandon CWRS	Brandon CWRS	Cardale CWRS	Pasteur GP		
\$/bu														
Base	6.71	6.73	6.46	6.61	6.77	6.84	6.82	6.48	6.82	6.81	6.46	5.09	6.68	6.70
30N	6.39	6.45	6.16		6.45	6.84	6.63	6.19	6.83	6.82	6.58	5.09	6.44	6.74
60N	6.54	6.54	6.19	6.19	6.57	6.84	6.66		6.84	6.87	6.46	5.09	6.50	6.72
GR-N														
Base	563.64	473.79	463.18	516.24	365.58	426.13	450.80	519.70	553.78	422.22	545.87	434.69	472.38	507.29
30N	521.76	435.21	434.06		333.30	395.40	421.25	520.44	570.33	428.30	531.14	418.67	437.35	509.92
60N	525.90	427.80	417.54	437.96	337.92	396.13	409.56		539.77	416.55	492.61	404.18	421.83	482.98
R														
30N	-41.88	-38.58	-29.12		-32.28	-30.73	-29.55	0.74	16.55	6.08	-14.73	-16.02	-28.77	2.63
60N	-37.74	-45.99	-45.65	-78.28	-27.66	-30.00	-41.24		-14.01	-5.67	-53.26	-30.51	-43.79	-24.31

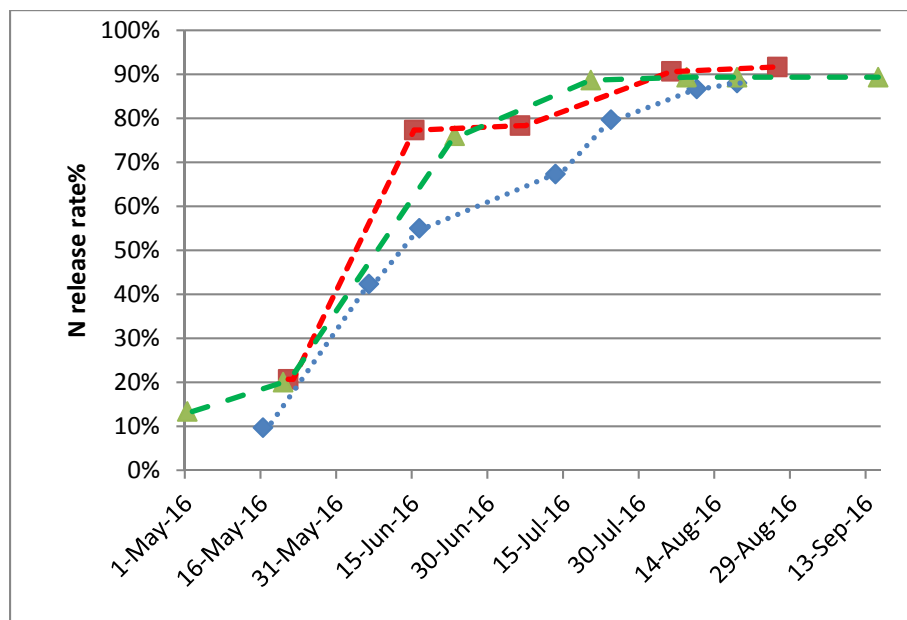
- GR-N = Gross revenue (yield x price/bu) less extra N cost, assumed 30 lb N/ac = \$15/ac and 60 lb N/ac = \$30/ac
- R = return above base N rate, in \$/ac.

## Nitrogen practice 2: Using ESN as a portion of base N rate

In an attempt to better match N supply with grain protein accumulation and to minimize lodging, the controlled release fertilizer, ESN (44-0-0) was applied as a sizable portion of the base N rate.

**Table 4:** Agronomic details for all sites evaluating ESN on wheat yield and protein (2015-16).

Farm	M	N	O
Pl date	May 1	May 5	May 3
Harv	Aug 27	Sept 15	Sept 1
Rain "	13.9	12.4	13.8
Variety/Class	Penhold/CPS	Prosper CNHR	Faller CNHR
Prev crop	soys	canola	Soys
Soil type	Newdale cl	Sigmund cl	Red River c
Soil N	17	17	45
OM	5.5%	5.1%	
Base rate N	130	98	160
Total N	147	115	205
N:ESN blend	Urea65:ESN65	UAN 49:ESN 49	NH3 100:60 ESN
Placement	Sideband SeedHawk	Sideband Seedmaster	JD 1895 MRB NH3, seedplace ESN
Other placements	80 U sideband& 50 dribble 80 U sideband & 50 coulter		
Yield limiting factors		wetness	Dry early, lodging, wetness



**Table 5:** Effect of ESN on wheat yield and protein (2016).

Farm	M	N	O
	Yield bu/ac		
Base N	78.0	84.6	66.5
ESN blend	79.7	86.9	70.0
UAN drib	78.1		
UAN coulter	78.3		
Sign	ns	ns	ns
	Protein %		
Base N	13.7 a	12.4	13.1 a
ESN blend	13.9 ab	12.5	13.5 b
UAN drib	14.0 b		
UAN coulter	13.8 ab		
Sign	*	ns	*
	Test wt lb/bu		
Base N	62.1	60.3	60.1
ESN blend	62.1	60.4	60.0
UAN drib	62.1		
UAN coulter	62.2		
	Measures of Sufficiency		
FLN%	5.0	4.42	4.42
	5.2	4.53	4.43
	5.0		
	5.2		
NDVI	ns	ns	ns
	0.73	0.77	0.75
	0.74	0.75	0.75
	0.73		
NUE Lb N/bu	ns	ns	ns
	1.9	1.4	3.1

Sign = statistical significance, ns = not significant, \* = significant at 90% probability level and means followed by the same letter are not significantly different.

FLN = Flag leaf N content at flag leaf emergence

NDVI = near difference vegetation index as determined by the handheld GreenSeeker sensor at flag leaf emergence.

NUE = nitrogen use efficiency = the N supply divided by bu produced.

**Table 6:** Economics of ESN applications.

Farm	M	N	O
Variety/Class	Penhold /CPS	Prosper CNHR	Faller CNHR
	\$/bu		
Base	5.17	5.86	6.07
ESN blend	5.17	5.89	6.19
	GR-N (\$/ac)		
Base	333.1	440.9	328.5
ESN blend	333.4	451.6	346.1
	0.3	10.7	17.6

\$/bu = late Feb. 2017 prices with protein

GR-N = Gross revenue (yield x price/bu) less total N costs, with urea @ \$0.54/lb N, NH<sub>3</sub> @ \$0.47/lb N, UAN @ \$0.56/lb N and ESN @ \$0.67/lb N (spring 2016 prices)

R = return above base N source in \$/ac

## Results and Discussion

Nitrogen release from ESN was determined using the buried bag method through the growing season, with about 10% released at placement (seeding), 30-45% by end of May, 60-80% by end of June and 80-90% by end of July. Yields with ESN were numerically greater but not significantly higher than the standard practice N (Table 5). Wheat protein was significantly increased at one of the sites. The UAN dribble in-season produced significantly higher protein than the standard urea sideband treatment at farm M.

Test weight was similar between N sources and placement/timings. Similarly other measures of N sufficiency – flag leaf N and NDVI did not differ.

The use of ESN produced positive returns, more due to the effect on yield than protein premium (Table 6).

### Nitrogen Practice 3: Post Anthesis Nitrogen

The farmer applied their base N rate and some 7-10 days after anthesis, applied another 30 lb N/ac as UAN (28-0-0), diluted 50:50 with water and applied with spray nozzles. Temperatures in 2015 were generally hot during this period and so leaf burn was greater than observed previously.

**Table 7:** Agronomic details for all sites evaluating post anthesis N (PAN) on wheat yield and protein (2015-16).

Farm	P	Q	R	S	T	U	V	W	X	Y	Z	a	b	c	d
Pl date					M4			M 5	M 5		M3	M7	M2	M6	
Harv					A20	A 13	A 27		A 28	A26	A31	S14	A22	S 14	
Rain	13.9	16.5	15.1	9.7	11.4	15.6	12.9	12.9	16.6	13.8	11.2	9.7	13.9	11.0	15.0
Variety/Class	Prosper CNHR	Prosper CNHR	Prosper CNHR	Prosper CNHR	Prosper CNHR	Faller CNHR	Brando n CWRS	Brando n CWRS	Brando n CWRS	Brando n CWRS	Brando n CWRS	Brando n CWRS	Brando n CWRS	Penhold CPS	Penhold CPS
Prev crop					beans		soys			peas	canola	soys	soys	canola	millet
Soil type	clay	clay	clay	clay loam	Gnaden thal l	loam	clay loam	clay loam	clay loam	Newdal e cl	Newdal e cl	Two Creeks l	Neuenb erg sl	Sperling loam	clay
Soil N	25	30	-	20	62	-	20	-	19	57	11	22	60	21	52
OM					4.3%					5.1%	4.7%	4.6%	4.3%	6.2%	
Base rate N	143	125	135	116	117	132	146	100	82	89	105	90	95	110	50
Total N	168	155	135+	136	179	132+	166	100+	101	146	116	112	155	131	102
PAN applied	am				JL11		pm	JL 21 midday	JL 14 pm	JL7	JL11	JL6	JL7	late	midday
PAN N rate	30	30	30	30	30	30	30	30	30	35	30	30	30	30	30
Yield limiting factor	Lodging		Lodging			Lodging	lodging	lodging	Excess rain	No lodging	No lodging	No lodging			Leaf burn

**Table 8:** Effect of post anthesis N (PAN) N on wheat yield and protein (2015-16).

Farm	P	Q	R	S	T	U	V	W	X	Y	Z	a	b	c	d
<b>Yield bu/ac</b>															
Base N	74	62	59	87	66.5	86	74	80.5	51	74.6	59.0	66.3	67.1	71.5	66
&PAN	73	61	57	86	66.2	82	79	79.3	49	77.0	58.6	65.5	67.9	70.5	60
sign	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*
<b>Protein %</b>															
Base N	13.9	15.2	13.7	10.9	14.3	13.7	13.8	15.0	13.9	14.7	13.4	13.9	14.8	13.9	13.7
&PAN	15	15.7	14.6	12.4	14.5	14	14.8	14.8	14.4	15.0	13.4	14.7	15.2	13.7	14.4
sign	*	*	*	*	ns	ns	*	ns	ns	*	ns	*	*	ns	*
<b>Test wt lb/bu</b>															
Base N	59.9		56.2	61.6	59.3		61.0	60.1	59.8	62.1	62.7	59.8	60.8	58.0	
&PAN	59.3		56.0	61.8	59.2		60.7	60.5	59.1	62.0	63.2	59.9	60.9	58.0	
sign	ns		ns	ns			ns	ns	ns						
<b>Measures of N sufficiency and efficiency</b>															
PAN leaf burn	15%	-	-	12%	4.5%	12%	12%	15%	5%	21%	13%	8%	10%		31%
FLN%	3.8%	-	4.1%	4.3%	4.6%	4.1%	4.7%	4.7%	4.5%	4.89%	4.1%	4.2%	4.4%		-
NDVI					0.81					0.83	0.72	0.80	0.77		
NUE	2.3	2.5	-	1.6	2.7	-	2.2	-	2.0	1.96	1.97	1.7	2.3	1.8	1.5

Lb N/bu

Sign = statistical significance, ns = not significant, \* = significant at 90% probability level.

PAN leaf burn = % of flag leaf damaged by UAN.

FLN = Flagleaf N content at flagleaf emergence

NDVI = near difference vegetation index by the handheld GreenSeeker sensor at flagleaf emergence.

NUE = nitrogen use efficiency = the N supply divided by bu produced.

**Table 9:** Effect of post anthesis N (PAN) on wheat class yield and protein (2015-16).

	CNHR (6)	CWRS (7)	CPS (2)
<b>Yield bu/ac</b>			
Base N	80	68	69
Base N & PAN	78	68	65
<b>Protein %</b>			
Base N	13.0	14.2	13.8
Base N & PAN	13.6	14.6	14.1



**Table 10:** Economics of PAN applications.

Farm	P	Q	R	S	T	U	V	W	X	Y	Z	a	b	c	d
Variety/Class	Prosper CNHR	Prosper CNHR	Prosper CNHR	Prosper CNHR	Prosper CNHR	Faller CNHR	Brando n CWRS	Brando n CWRS	Brando n CWRS	Brando n CWRS	Brando n CWRS	Brando n CWRS	Brando n CWRS	Penhold CPS	Penhold CPS
<b>\$/bu</b>															
Base	6.35	6.75	6.27	5.52	6.48	6.27	6.61	6.82	6.64	6.79	6.50	6.64	6.8	5.17	5.17
PAN	6.69	6.84	6.57	5.86	6.54	6.39	6.8	6.8	6.75	6.82	6.50	6.79	6.84	5.17	5.17
<b>GR-N</b>															
Base	469.90	418.50	369.93	480.24	430.92	539.22	489.14	549.01	338.64	506.53	383.50	440.23	456.28	369.66	341.22
PAN	488.37	417.24	374.49	503.96	432.95	523.98	537.20	539.24	330.75	525.14	380.90	444.75	464.44	364.49	310.20
R-PAN	-1.53	-21.26	-15.44	3.72	-17.97	-35.24	28.06	-29.77	-27.89	-1.39	-22.60	-15.49	-11.84	-25.17	-51.02

- \$/bu = late Feb. 2017 prices with protein
- GR-N = Gross revenue (yield x price/bu) less extra PAN cost of \$20/ac @ 30 lb N/ac = \$15/ac and \$5 application.
- R -PAN= return of PAN above base N rate in \$/ac

### Results and Discussion

In spite of substantial leaf burn, yields were only significantly reduced in one instance, a location where PAN had been applied in the mid-day heat (site d in Table 8). The impact on protein was largely positive and significant at 9 of 15 sites. There was no effect on test weight. The average protein increase was 0.5%. Based on wheat class, protein generally increased in the order CNHR >CRWS>CPS (Table 9). Although the protein increase was generally positive and price premiums were obtained, it was largely insufficient to pay for the treatment. Only 2 of the 15 sites would have positive returns– one with a 5 bu yield increase and 1% protein increase (site V) and another with a 1.5% protein increase (site S).

## Summary

Also of interest are the general N practices for the different wheat classes. Table 11 summarizes the base treatments of the 30 trials. In this study, farmers fertilized the CNHR greater than the CWRS. The average nitrogen supplied was 2.3 lb N/bu for CNHR, 2.0 for CWRS and 1.7 for CPS.

Yields were often lower than expectations. Rainfall was generally more than adequate and contributed to severe lodging at many sites. Several additional sites did not receive scheduled PAN treatments in 2016 due to excessively wet soil conditions.

**Table 11:** Overall summary of crop fertility, yield and protein performance.

	CNHR (16 sites)	CWRS (10 sites)	CPS (3 sites)	GP (1)
Soil N lb N/ac	37	40	30	25
Fertilizer N applied lb N/ac	124	95	97	110
Total N supply lb N/ac	158	135	127	135
Yield bu/ac	72	70	72	85
Protein %	13.8	14.3	13.8	11.9
NUE	2.3	2.0	1.7	1.6
lb N/bu	(1.4 – 3.1)	(1.7-2.3)	(1.5-1.9)	

## On Farm Testing Lessons

### 1. Suitability of grain carts and yield monitors for on-farm-tests.

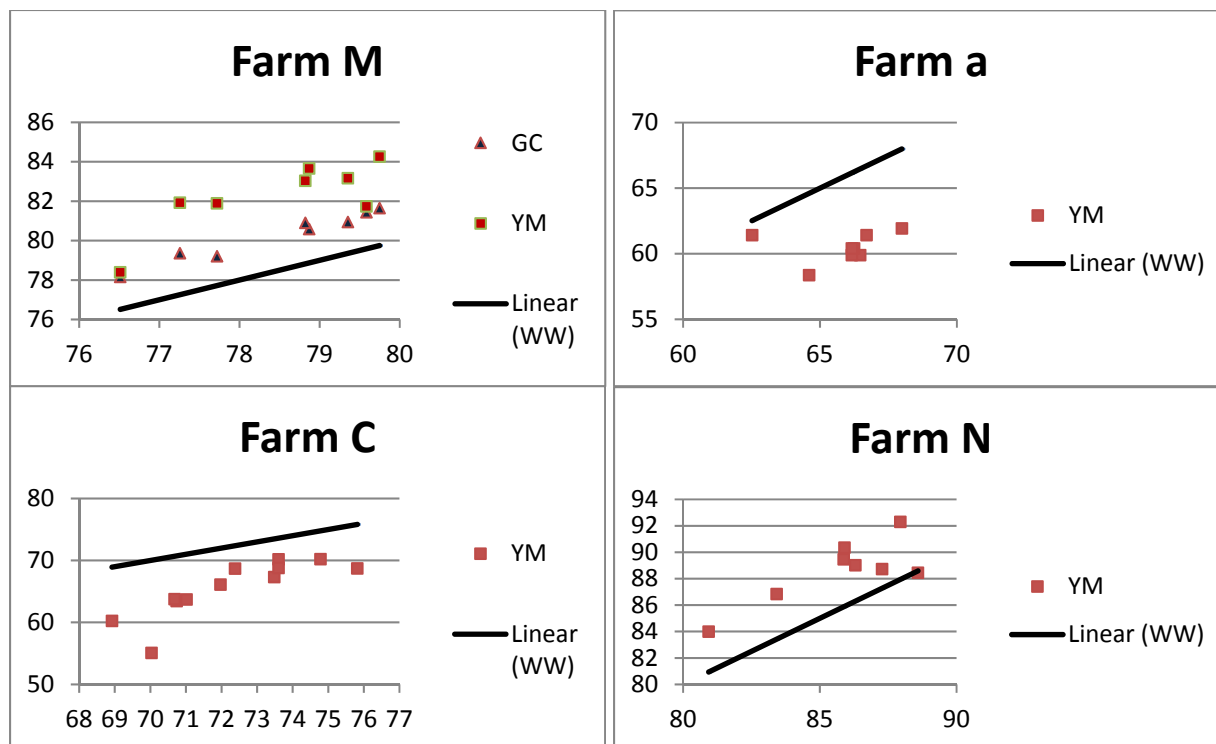
At many sites we tried to collect yield comparisons using a standard weigh wagon (Pioneer Hybrid or ANTARA) versus the farmer's scaled grain cart or calibrated yield monitor (Table 13).

In general weigh wagon and grain cart yield measurements were well related with little difference between measures (Table 13). Yield monitor yield was generally less related to the weigh wagon than the grain cart. The farmer's grain cart and yield monitor yields were generally similar, as they should be since this is the scale commonly used to calibrate the yield monitors.

It is difficult to numerically express the differences observed. Graphs for some of the less accurate measures are shown below (Figure 2). Since yields differed only slightly with the treatments this may not be an appropriate evaluation of these systems. Testing over a wider range of yields may be required.

Scaled grain carts should be suitable for on-farm-test plots (providing they are calibrated with a truck scale). Yield monitors may require some additional calibration rigour before being used for on-farm-tests.

**Table 13:** Relationship of yield measuring techniques – weigh wagon (WW), scaled grain carts (GC) and combine yield monitors (YM).



## 2. Wheel tracks

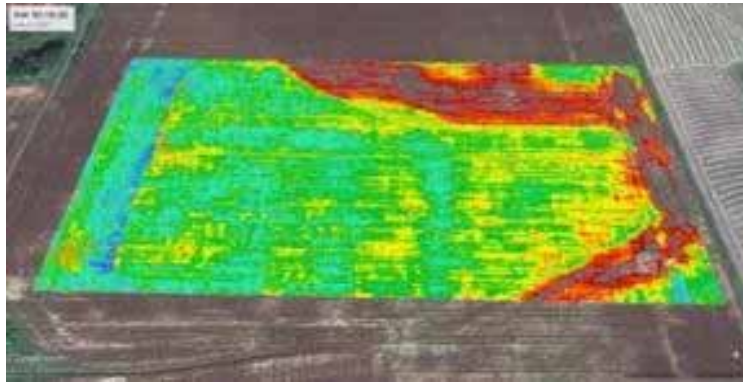
Wheel tracks produced when spraying wheat should either be avoided, or included in all passes. In many instances yield variability was added to the strips by the inclusion of wheel tracks in some passes and not in others. The impact of tracks may have been greater than the treatments we were expecting from nitrogen (Table 12).

**Table 12:** Impact of wheel tracks on combine yield in bu/ac (% loss)

Farm	No sprayer tracks	1 spray track	2 Spray tracks
Z 36' header	62.7		53.5 (-14.8%)
a 35' header	60.9	57.9 (-4.9%)	55.8 (-8.4%)

### 3. UAV or aerial images.

These images should be taken in season, preferably after the treatments are applied. These should be able to indicate those poor areas of the field that should have replicates trimmed back and not harvested as part of the plot. In many cases plot variability was increased due to wet areas affecting only certain strips. This is a problem with field equipment with such wide strips (100-120') that may contain variability within an individual strip and not consistent across the replicate. GIS should also be used to place the applied strips over the aerial images.



### Acknowledgements

The farmer cooperators were critical to the success of these studies. Other contributors were:

- Manitoba Wheat and Barley Growers Association
- Growing Forward 2's Growing Innovation On-Farm
- ANTARA Research
- Pioneer Hybrid – for use of weigh wagon
- Richardson Pioneer – for protein analysis
- AgVise Laboratories
- Agrium
- Manitoba Agriculture staff – for field scouting, UAV flights
- Summer students Laura Runne (2015) and Dane Creith (2017)
- Amy Mangin – University of Manitoba – for statistics



Thank you to the cooperating farmers in this 2-year on-farm-testing project of nitrogen management strategies for high yield and quality of hard red spring wheat. Special thanks is extended to consulting agronomist Brunel Sabourin of ANTARA Research who aided in record keeping and protocol development, organizing the summer in-field tour and weighing of many of the sites.

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# WFGD Coop Registration Trial

## Cooperators

- WFGD Coop

**Research Site:** Melita, MB

**Cooperator:** Bert Kirkup

**Soil Texture:** Waskada Loam

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

**Previous Crop:** Winter Wheat

## Soil Test

Depth	pH	N	P	K	S	Organic Matter
		ppm	ppm Olsen	ppm	lbs/ac	%
0-6"	7.2	14	6	298	64	2.8
6-24"		24			360	

## Methods

The trial consisted of 24 entries in plots that were 1.44m wide by 9m long. The experimental design of the trial was a triple lattice with 6 blocks and 5 entries per block. Plots were seeded with a Seedhawk opener on 9.5" spacing and soil moisture was good at the time of seeding. Plots were harvested with a Wintersteiger plot combine.

## Agronomy

Seeding Date	Seeding Depth	Fertility	Herbicide	Spray Date	Desiccation	Desiccation Date	Harvest Date
May 3	0.75"	112-31-27-18	Velocity @ 0.4L/ac	June 2	Glyphosate	August 23	August 29

## Description of the Trial

The trial consisted of 24 entries: the three official check varieties for the Special Purpose Wheat Coop (AC Andrew, Pasteur and GP151), three internal checks (WFT603, WFT914 and WFT1001), three lines in Public Coop testing (WFT1104, WFT1109 and WFT1111), two repeating lines and 13 new lines (Table 1). Among the new entries, two were selected from CIMMYT nurseries and the rest came from internal crosses and selection. The experimental design of the trial was a triple lattice with 6 blocks and 5 entries per block.

In addition to the Melita site, the trial was grown at 8 other locations across western Canada: Minto (two trials: early and late), Elm Creek, and Dauphin in Manitoba, Saskatoon, Pike Lake and Swift Current in Saskatchewan, plus Taber (dry), Taber (irrigated) and Lacombe in Alberta. Each trial was randomized independently.

Disease reaction data on leaf rust, stem rust, FHB and leaf spots were obtained through disease nurseries which were grown in 1-m plots spaced 30 cm apart at Minto and at Elm Creek following the PGDC guidelines. Disease spreaders with susceptible and resistant checks were included in each nursery, which was in a randomized complete block design with 3 replicates. The stem rust, leaf rust and FHB nurseries were inoculated. Stripe rust and common bunt resistance were evaluated at Taber and Kipp,



which have more suitable conditions conducive to growth and development of the two diseases. Seeds were inoculated with bunt before seeding but no artificial inoculation was carried out for stripe rust.

## Results

The trial at Melita, which had a very low coefficient of variation (CV), gave promising results. WFT1204 and WFT1203 were the highest yielding entries (3930 and 3875 kg/ha, respectively) in the trial (Table 1), out yielding AC Andrew by 30% and 28%, respectively. GP151, which ranked 3<sup>rd</sup> in the trial, was the highest yielding check. The yield of the other two checks was relatively low: Pasteur 3146 kg/ha (rank 18) and AC Andrew 3033 kg/ha (rank 19).



Photo taken July 29, 2016 at Melita site

Across sites, WFT1111 and WFT1109 were the highest yielding [5043 kg/ha (75.0 bu/acre) and 4969 kg/ha (73.9 bu/acre), respectively]. They were higher yielding than the three official checks and they out yielded AC Andrew significantly by 19% and 17%, respectively (data not presented). The two lines had consistent high performance across zones. WFT1104 (rank 5<sup>th</sup>) and WFT1101 (rank 6<sup>th</sup>) also had significant higher yield than AC Andrew but their performance across zones was less consistent than WFT1111 and WFT1109. Mean yield across sites illustrates yield improvement that has been made by the WFGD breeding program in addition to disease resistance. WFT603, the first WFGD line approved for release, had a yield similar to AC Andrew. Yield of WFT1001, the 2<sup>nd</sup> line approved for release, was higher than AC Andrew non-significantly. WFT1111, WFT1109 and WFT1104, which could be approved for release in 2017, out yielded AC Andrew significantly. Details of the trials at different sites and performance across sites can be obtained from the WFGD publication: 2016 WFGD Co-op Report to PRDC.

**Table 1:** Entry with pedigree of the WFGD Coop Trial and yield (kg/ha, rank and percentage of AC Andrew) at Melita.

Ent#	Entry	Cross/Nursery	kg/ha	%
15	WFT1204	WFT603/M-321	3930	130
10	WFT1203	WFT603/M-321	3875	128
22	GP151	Official check	3863	127
4	WFT1205	WFT603/M-321	3819	126
20	WFT1109	24HRWSN	3762	124
5	WFT1210	WFT601/Brick	3727	123
2	WFT1206	WFT603/M-321	3705	122
21	WFT1111	24HRWSN	3634	120
9	WFT914	Hoffman/Unity	3546	117
19	WFT1208	WFT603/'18/370'	3529	116
7	WFT1207	WFT630/Pasteur	3469	114
3	WFT1211	WFT630/Pasteur	3417	113
1	WFT1104	WFT504/5602HR	3391	112
14	WFT1101	30SAWSN	3344	110
23	WFT1212	SWS416/Hoffman//Pasteur	3275	108
16	WFT603	HY644/Ac Vista	3268	108
24	WFT1001	23HRWSN	3177	105
17	Pasteur	Official check	3146	104
18	AC Andrew	Official check	3033	100
12	WFT1201	15 FHBSN	3012	99
6	WFT1213	Sadash/Cadillac//Pasteur	3001	99
11	WFT1108	24HRWSN	2914	96
8	WFT1209	WFT601/Brick	2887	95
13	WFT1202	15 FHBSN	2484	82
LSD ( $p=0.05$ )			307	
CV			5.45	
Grand Mean			3384	
P			0.0001	

# Advanced Six-Row Forage Barley Grain Trial

## Cooperators

- AAFC Brandon – Dr. Ana Badea – Barley Breeder
- AAFC Brandon – Rudy Von Hertzberg – Research Technician

**Research Site:** Melita, MB

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

**Cooperator:** Bert Kirkup

**Previous Crop:** Winter Wheat

**Soil Texture:** Waskada Loam

## Soil Test

Depth	pH	N	P	K	S	Organic Matter
		ppm	ppm Olsen	ppm	lbs/ac	%
0-6"	7.2	12	5	229	104	3
6-24"		21			360	

## Methods

The trial consisted of 10 entries in plots that were 1.44m wide by 9m long. The experimental design of the trial was a randomized complete block design replicated 3 times. Plots were seeded with a Seedhawk opener on 9.5" spacing and soil moisture was good at the time of seeding. Plots were harvested with a Wintersteiger plot combine.

## Agronomy

Seeding Date	Seeding Depth	Fertility	Herbicide	Spray Date	Harvest Date
03-May	0.75"	92-31-27-18	Attain A+B and Axial @ Rec rates	02-Jun	15-Aug

## Background

Forage barley varieties produce high total biomass but usually have insufficient grain yield to compete with regular varieties when only grain production is desired. Thus, the barley breeding effort at AAFC Brandon is aiming to develop new varieties of dual purpose six-row forage-feed barley well-suited to western Canada with improved disease resistance and agronomic performance combined with enhanced quality.

## Objective

To test the top barley forage-feed breeding lines from the barley breeding program at AAFC-Brandon for grain yield.

## Plant material

Two registered feed varieties, AC Ranger and Vivar, were grown at Melita this year, as well as eight numbered breeding lines under evaluation for possible advancement to the 2017 registration trial as forage, feed or forage-feed entries.

## Results and Discussion

The trial had a good %CV (coefficient of variation) of 6.2 for grain yield. In the testing conditions at the Melita site, only one of the barley lines, A515-04-148, had higher yield than both check cultivars, AC Ranger and Vivar. This line also presented higher values for test weight, plumpness and protein content in grain than both check cultivars. If it will show consistency at the other testing locations with respect to grain and forage yield, grain parameters and good forage and feed quality, which at the moment are unknown, then it could be entered for extensive evaluation in the 2017 Western Cooperative Forage Barley Registration Test or 2017 Western Cooperative Six-Row Barley Registration Test.

**Table 1:** 2016 Advanced Six-Row Forage Barley Trial (grain part) Results - Summary of Agronomic Factors at Melita, MB

ENTRY #	ENTRY NAME	YIELD KG HA <sup>-1</sup>	YIELD RANK	YLD AS %RANGER	DAYS TO HEAD	DAYS TO MATURITY	HEIGHT CM	KERNEL WEIGHT g M <sup>-1</sup>	TEST WEIGHT KG HL <sup>-1</sup>	%PLUMP >6/64	GRAIN PROTEIN (%)	VISUAL DISEASE SCORE RATED 1-9
1	AC Ranger	5124	3	100	56.0	91.0	93.0	42.5	61.6	75.7	10.9	3.0
2	Vivar	4752	4	93	54.7	88.3	86.0	41.2	62.1	77.2	10.5	4.7
3	A515-03-032	4618	8	90	53.0	90.0	86.0	38.3	64.1	87.1	10.7	4.0
4	A515-01-120	4638	5	91	56.0	89.3	89.7	37.4	62.9	82.7	10.4	4.0
5	A515-03-106	5131	2	100	53.3	89.0	85.0	39.2	63.8	87.1	10.7	4.0
6	A515-04-148	5251	1	103	51.3	89.7	86.3	39.3	63.7	86.7	11.3	3.7
7	A515-05-011	4626	6	90	48.0	85.0	87.3	36.7	66.2	89.5	11.3	4.7
8	SM131441	4134	10	81	52.7	88.7	86.7	39.9	63.3	90.1	11.1	4.3
9	SM131678	4533	9	89	50.0	88.3	85.7	38.8	63.3	89.0	10.9	5.0
10	SM131620	4619	7	90	52.7	89.3	87.3	37.3	63.7	90.5	10.9	4.0
	GRAND MEAN	4743			52.8	88.9	87.3					4.1
	CV	6.2			3.0	1.1	3.9					14.7
	LSD	502			2.7	1.6	5.8					1.0
	No. of Reps	3			3	3	3	1	1	1	1	3

\* Numbered entries are advanced breeding lines with potential advancement to the cooperative testing system.

## Take home messages

Relative recently, Nikkhah 2012 *J Anim Sci Biotechnol* 3(1): 22 reported the following findings: besides greater protein, barley grain is richer in methionine, lysine, cysteine, and tryptophan than corn. Barley grain is considered highly degradable in the rumen. Owing to its more rapid and extensive rumen starch and nitrogen fermentation compared with ground corn, barley may provide more synchronous energy and nitrogen release, which can improve microbial and host nutrient assimilation. Proper barley feeding management may reduce expensive undegradable protein requirements.

## Acknowledgements

This research is part of the Barley Cluster project led by Alberta Barley with funding from Western Grains Research Foundation and Agriculture and Agri-Food Canada (AAFC) under the Growing Forward 2 program. We gratefully thank R. Von Hertzberg and Bryan Graham from AAFC Brandon Research and Development Centre, for technical assistance and WADO for continued support in growing and caring for the trials.

## Advanced Six-Row Malt Barley Trial

### Cooperators

- AAFC Brandon – Dr. Ana Badea – Barley Breeder
- AAFC Brandon – Rudy Von Hertzberg – Research Technician

**Research Site:** Melita, MB

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

**Cooperator:** Bert Kirkup

**Previous Crop:** Winter Wheat

**Soil Texture:** Waskada Loam

### Soil Test

Depth	pH	N	P	K	S	Organic Matter
		ppm	ppm Olsen	ppm	lbs/ac	%
0-6"	7.2	14	6	298	64	2.8
6-24"		24			360	

### Methods

The trial consisted of 40 entries in plots that were 1.44m wide by 9m long. The experimental design of the trial was a randomized complete block design replicated 3 times. Plots were seeded with a Seedhawk opener on 9.5" spacing and soil moisture was good at the time of seeding. Plots were harvested with a Wintersteiger plot combine.

### Agronomy

Seeding Date	Seeding Depth	Fertility	Herbicide	Spray Date	Harvest Date
03-May	0.75"	92-31-27-18	Attain A+B and Axial @ Rec rates	02-Jun	15-Aug

### Background

The barley breeding effort at AAFC Brandon is aiming to develop new varieties of six-row malting barley well-suited to western Canada with improved disease resistance and agronomic performance, combined with enhanced quality traits to expand market opportunities at home and abroad.

## ***Objective***

To evaluate different breeding lines of six-row barley for malting and feed.

## ***Plant Material***

Three registered malting varieties, Tradition, Celebration and CDC Mayfair, and two registered feed varieties, AC Ranger and Vivar, were grown at Melita this year, as well as 35 numbered breeding lines under evaluation for possible advancement to the 2017 registration trial as malting or feed entries.

## ***Results and Discussion***

As observed in Table 1, in the testing conditions at the Melita site, only one of the barley lines, SM131589, had higher yield than both feed check cultivars, AC Ranger and Vivar, while three more lines, SM131676, A515-04-105 and A515-04-073, had higher yield only than the feed check cultivar Vivar. Compared to the malting checks, Tradition, Celebration and CDC Mayfair, 27 of the 35 lines tested had higher yield, than all three of them.

Photo: August 15, 2016  
harvesting barley





**Table 1:** 2016 Advanced Six-Row Malt Barley Trial Results - Summary of Agronomic Factors at Melita, MB

ENTRY #	ENTRY NAME	YIELD KG HA <sup>-1</sup>	YIELD RANK	YLD AS %RANGER	YLD AS %MAYFAIR	DAYS TO HEAD	DAYS TO MATURITY	HEIGHT CM	KERNEL WEIGHT g M <sup>-1</sup>	TEST WEIGHT KG HL <sup>-1</sup>	%PLUMP >6/64	VISUAL DISEASE SCORE RATED 1-9
1	Tradition	3730	40	82	91	53.0	88.3	77.7	40.4	64.6	95.6	4.7
2	Celebration	3806	39	83	93	51.0	86.7	80.3	40.1	64.9	94.7	5.7
3	CDC Mayfair	4090	30	89	100	50.3	89.7	85.0	41.7	63.4	97.5	6.3
4	AC Ranger	4579	2	100	112	54.7	90.3	80.3	44.1	62.0	88.5	3.7
5	Vivar	4365	6	95	107	54.7	90.7	78.0	43.7	62.0	90.5	3.7
6	SM131573	4279	16	94	105	52.0	90.0	75.7	40.9	63.7	94.2	4.0
7	SM131694	4171	24	91	102	50.3	89.7	70.3	39.4	63.1	94.4	4.7
8	SM131457	4116	29	90	101	51.0	90.3	79.0	42.3	63.8	95.3	5.0
9	SM131448	4324	9	94	106	51.0	88.3	77.3	41.0	64.6	95.3	5.7
10	SM131678	4033	31	88	99	51.0	90.0	78.7	40.5	63.4	93.5	6.3
11	SM131600	4294	12	94	105	52.0	88.7	79.3	41.4	65.6	95.6	5.3
12	SM131611	4166	25	91	102	51.0	87.7	76.3	40.0	64.0	94.3	4.0
13	SM131674	4226	20	92	103	53.3	89.0	78.7	41.5	62.7	96.5	5.0
14	SM131589	4738	1	104	116	54.3	90.0	79.3	38.7	64.0	91.8	3.3
15	SM131593	3924	36	86	96	54.3	90.3	84.3	40.2	63.3	95.8	4.0
16	SM131665	4252	18	93	104	54.3	90.7	75.0	40.3	64.2	95.6	4.0
17	SM131670	3895	37	85	95	52.0	88.3	78.0	40.1	64.7	92.9	5.0
18	SM131435	4127	28	90	101	55.0	90.3	82.0	41.4	62.9	95.0	4.0
19	SM131454	3968	32	87	97	54.7	89.0	85.0	42.7	64.4	97.1	3.7
20	SM131488	4211	22	92	103	54.0	90.7	82.0	40.3	61.6	92.5	3.7
21	SM131565	4350	7	95	106	54.0	90.0	78.3	40.2	63.7	93.1	4.0
22	SM131602	4257	17	93	104	52.0	91.0	77.3	41.2	65.3	95.3	4.3
23	SM131628	4230	19	92	103	51.0	89.0	78.0	40.7	61.5	95.7	5.3
24	SM131661	3838	38	84	94	52.0	89.0	80.3	44.5	65.4	95.8	5.3
25	SM131669	3951	33	86	97	52.0	91.0	81.3	43.4	64.1	97.0	5.0
26	SM131676	4423	3	97	108	50.0	88.0	75.3	43.6	65.4	96.7	5.3
27	A515-03-060	4280	15	94	105	54.3	91.0	77.7	40.8	64.8	92.4	4.7
28	A515-03-079	4347	8	95	106	53.0	89.3	80.0	38.7	63.5	93.1	4.3
29	A515-04-073	4388	5	96	107	54.3	90.0	81.7	40.7	65.6	94.2	4.3
30	A515-04-105	4408	4	96	108	51.3	89.7	82.0	40.4	66.1	95.3	4.3
31	A515-04-119	4304	10	94	105	53.0	90.3	79.0	42.5	66.8	92.8	4.3
32	A515-05-048	4164	26	91	102	50.3	88.0	81.0	39.4	64.4	95.8	5.0
33	A515-05-057	3930	35	86	96	51.0	87.0	79.3	42.3	66.0	95.1	5.3
34	A515-05-092	4210	23	92	103	52.0	88.0	83.0	40.9	64.4	97.0	5.0
35	A515-05-107	4214	21	92	103	54.3	90.3	74.3	40.5	63.8	94.7	4.7
36	A515-05-108	4297	11	94	105	50.0	90.3	76.7	43.0	65.1	96.9	4.0
37	A515-05-113	4281	14	94	105	51.0	89.3	80.3	39.5	64.1	93.8	5.0
38	A515-05-116	4291	13	94	105	49.7	88.3	81.0	39.1	64.0	94.2	6.0
39	A515-05-122	4140	27	90	101	52.0	87.7	81.0	44.3	64.3	97.6	4.7
40	A515-05-152	3941	34	86	96	51.0	89.0	80.7	40.6	64.2	94.9	4.3
GRAND MEAN		4188				52.3	89.4	79.3				4.7
CV		6.4				2.0	1.7	4.6				17.3
LSD		434				1.7	2.5	5.9				1.3
No. of Reps		3				3	3	3	1	1	1	3

\* Numbered entries are advanced breeding lines with potential advancement to the cooperative testing system.

Among the four lines mentioned above, SM131676, A515-04-105 and A515-04-073 presented a significant yield increase (7 to 8%) over the malting check cultivar CDC Mayfair, higher test weight, while kernel weight and plumpness was in the range of the malting checks. If they will show consistency at the other testing locations with respect to yield, grain parameters and good malting quality, which at the moment are unknown, then they will be entered for extensive evaluation in the 2017 Western Cooperative Six-Row Barley Registration Test. As for the highest yielding line in the test, SM131589, that presented 16% yield increase over the malting check cultivar, CDC Mayfair, the value for the grain parameters (kernel weight, test weight and plumpness ) recorded at Melita site do not recommend it

for malting since they are all lower than those recorded for the malting checks. If the yields will continue to be high at the other testing sites than it can be advanced to the cooperative testing as a feed line. As a general observation, the %CV (coefficient of variation) reported for yield at Melita is 6.4% (Table 1). 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.

### ***Conclusions***

WADO will continue to play an important role with the field evaluation of the barley breeding lines developed at AAFC-Brandon.

### ***Acknowledgements***

This research is part of the Barley Cluster project led by Alberta Barley with funding from Western Grains Research Foundation and Agriculture and Agri-Food Canada (AAFC) under the Growing Forward 2 program. We gratefully thank R. Von Hertzberg and Bryan Graham from AAFC Brandon Research and Development Centre, for technical assistance and WADO for continued support in growing and caring for the trials.

## **Screening for Waterlogging Tolerance in Barley**

### ***Cooperators***

Ana Badea, Bill Legge, Min Zhu  
AAFC Brandon, Manitoba  
Scott Chalmers – WADO Melita, Manitoba

### ***Site Information***

Location: Brandon, MB  
Collaborator: Scott Chalmers – Diversification Specialist, WADO Melita

### ***Background***

Barley is more susceptible to waterlogging than other cereals. Waterlogging is a state in which excess water in the root zone affects the oxygen concentration in the soil which negatively impacts plant growth causing yield losses.

### ***Objective***

To test a large collection of barley for tolerance to waterlogging in Manitoba growing conditions.

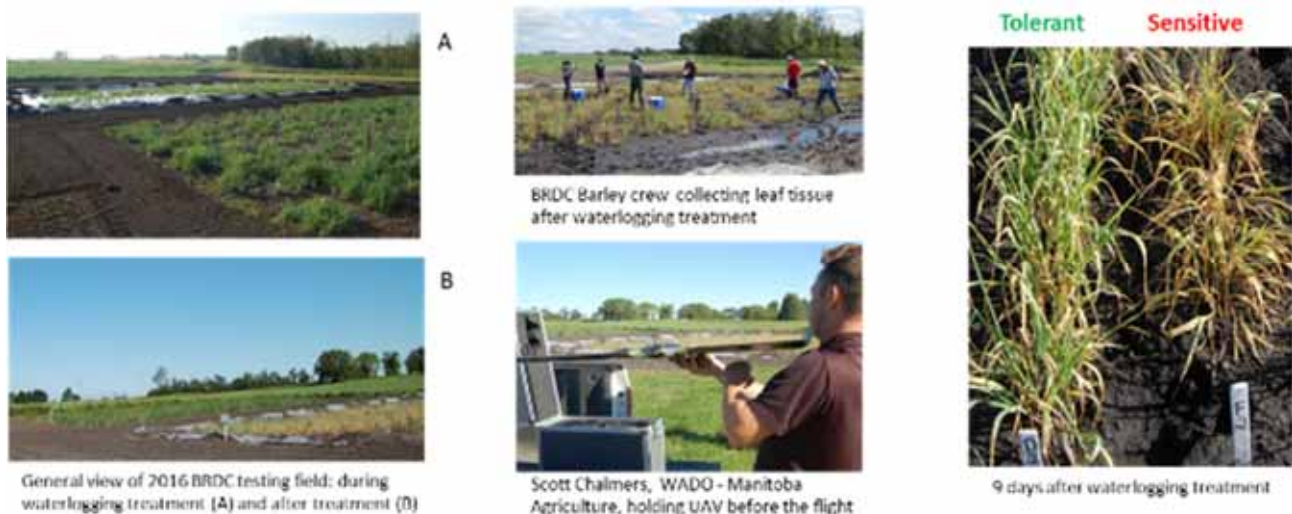
### ***Plant Material and Methodology***

In summer 2016, at Agriculture and Agri-Food Canada, Brandon Research and Development Centre a barley waterlogging experiment was conducted. A large collection of barley genotypes from around the

world (n=341) were tested among other parameters for chlorophyll fluorescence using UAV technology. The data collection was conducted prior, during and after waterlogging treatment in both, treated and control parts. Drone field data collection began in middle of July and continued on a weekly basis until early September, when harvesting of the material started. This activity was conducted in collaboration with Mr. Scott Chalmers – Diversification Specialist, WADO Melita. Using a drone is a much faster way of monitoring the amount of stress induced in plants. Information and data such as Enhanced Normalized Difference Vegetation Index (ENDVI) and Green Normalized Difference Vegetation Index (GNDVI) could be collected to help determine the stress levels caused by excess moisture.

### *Work in Progress*

Currently, analysis of the data collected by the drone, individually threshing and weighing of plants harvested and genotyping are in progress. This data will provide preliminary information about: the usefulness of UAV technology as a quick screening tool for chlorophyll fluorescence, the barley genotypes response to waterlogging stress in Manitoba growing conditions, the waterlogging tolerant genotypes to be used in the barley breeding programs and the molecular markers that could be identified to be linked to this trait.



### *Future Work*

Some of the immediate and future work will be focusing on:

- continuation of the field screening of the barley genotypes in 2017 and 2018
- preparation for seeding in the field in spring 2017
- continuation of use of UAV technology for quick data collection if deemed useful
- conduct association mapping analysis in 2018/2019, to identify the waterlogging tolerant Quantitative Trait Loci (QTL) and the markers linked to them.

## Acknowledgements

This research is part of the Barley Cluster project led by Alberta Barley with funding from Western Grains Research Foundation and Agriculture and Agri-Food Canada (AAFC) under the Growing Forward 2 program. We gratefully thank to Bryan Graham, B. Rathwell and R. Von Hertzberg from AAFC Brandon Research and Development Centre, for technical assistance and Scott Chalmers from WADO Melita, Manitoba Agriculture for drone data collection and analyses. The hard work and support of the 2016 summer students with the Six-row and Hulless Barley Breeding Program at AAFC Brandon Research and Development Centre with this experiment is also acknowledged.

## 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. (Source: <https://en.wikipedia.org/wiki/Oatmeal> )

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 Quaker 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 five of this partnership.

## Methods

Nineteen varieties were arranged in a randomized complete block design and replicated three times. The trial area was treated with 1 l/ac Roundup for pre-emergent weed control prior to seeding. Plots were desiccated with 1 REL of Glyphosate on August 9<sup>th</sup> after maturity was reached. Plots were harvested with a Wintersteiger Classic plot combine. Data collected throughout the season included heading date, days to maturity, crop height, lodging, test weight, sample moisture, and grain yield. Plot samples were combined by variety and sent to PepsiCo for milling and beta-glucan content analysis (results confidential).

Seeding Date	Seeding Depth	Fertility	Herbicide	Spray Date	Harvest Date
May 4 2016	0.75"	92-31-27-18	Stampede EDF@1.25lbs/ac + MCPA ester 500@.5L/ac - 20gal/ac water	June 2 2016	August 17 2016

## Spring Soil Test

Legal Land Location	Depth	pH	N ppm	P ppm Olsen	K ppm	S lbs/ac	Organic Matter %
NE 27-3-27 W1	0-6"	7.8	9	4	244	50	3.1
	6-24"		39			360	

Data was analyzed with two-way analysis of variance (ANOVA) using Analyze-it 2.03 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:** Test weight, maturity, heading, lodging, height, disease, and grain yield of various oat varieties grown in Melita in 2016.

Variety	Heading days	Height cm	Lodge 1-9 (9=flat)	Maturity days	Yield	
					kg/ha	bu/ac
8	61	118	2.0	97.0	6209	173
12	61	120	1.0	95.3	5995	167
15	60	108	1.0	97.0	5951	166
6	58	112	1.0	93.0	5923	165
9	61	116	1.0	93.0	5897	164
7	60	120	1.0	95.3	5863	163
14	58	112	1.3	97.0	5829	162
17	59	119	1.0	92.3	5826	162
18	57	118	1.0	90.0	5698	158
19	60	129	2.7	92.3	5692	158
13	58	110	1.7	95.3	5655	157
5	60	117	1.0	97.0	5596	156
1	58	116	1.0	90.0	5587	155
16	54	109	1.0	93.7	5509	153
2	57	115	1.0	97.0	5449	152
3	57	120	1.0	93.7	5443	151
11	62	128	1.3	97.0	5429	151
4	61	125	2.3	92.3	4978	138
10	55	121	1.7	90.0	4817	134
CV%	1	4	43	2	5	5
LSD (p<0.05)	1	7	0.9	3.7	487	14
P value	<0.0001	<0.0001	0.0084	0.0002	0.0002	0.0002
R-squared	0.93	0.75	0.57	0.69	0.67	0.67
Significant	Yes	Yes	Yes	Yes	Yes	Yes

## 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.

# La Coop fédérée Oat Variety Trial

## Cooperator

- La Coop fédérée, Christian Azar, Agr. M.Sc. Plant Breeder

## Background

La Coop fédérée's oat breeding program aims to develop food and feed spring oat cultivars adapted for the Canadian market. The program originates from early breeding efforts that started during the 90's. Objectives of the program include improving agronomic traits, milling qualities and disease tolerance of the cultivars offered to Canadian farmers. The breeding station is located in Saint-Hyacinthe, 50 km east of Montréal. They contracted agronomic trials in eastern and western Canada to evaluate the adaptation and stability of their most advanced material. The program started trials in Melita in the spring of 2016. Their breeding center employs 15 people during the winter and 25 during the summer.

## Methods

Thirty-six varieties (identity confidential) were grown near Melita in a RCBD and replicated 3 times. The trial area was treated with 1 l/ac Roundup for pre-emergent weed control prior to seeding. Plots were direct seeded into winter wheat stubble with a target seeding rate of 250 plants/m<sup>2</sup>.

## Agronomy

Seeding Date	Seeding Depth	Fertility	Herbicide	Spray Date	Harvest Date
May 4 2016	0.75"	92-31-27-18	Stampede EDF@1.25lbs/ac + MCPA ester 500@.5L/ac - 20gal/ac water	June 2 2016	August 17 2016

Plots were desiccated with 1 REL of Glyphosate on August 9<sup>th</sup> after maturity was reached. Plots were harvested with a Wintersteiger Classic plot combine. Data collected throughout the season included days to maturity, crop height, lodging, test weight, seed weight, sample moisture, and grain yield. Plot samples were combined by variety and sent to La Coop fédérée for milling and beta-glucan content analysis (results confidential).

## Spring Soil Test

Legal Land Location	Depth	pH	N ppm	P ppm Olsen	K ppm	S lbs/ac	Organic Matter %
NE 27-3-27 W1	0-6"	7.2	12	8	234	30	3.2
	6-24"		24			360	

Data was analyzed with a two-way analysis of variance (ANOVA) using Analyze-it 2.03 statistical software (Microsoft).



## Results

There were significant differences in leaf disease, maturity, crop height, seed weight, bushel weight and yield (Table 1). Subsamples were sent to La Coop fédérée for quality testing.

**Table 1:** Performance of oat varieties grown in Melita, MB in 2016.

Variety No.	Leaf Disease 0-9	Lodging 0-9 (9 flat)	Maturity days	Crop Height cm	Seed Weight g/1000	Bushel Weight lbs/bu	Yield kg/ha	Yield bu/ac
8	5.7	0	92	115	36	37	6411	154
10	4.3	0	91	116	34	36	6278	154
7	3.7	0	94	108	37	39	6574	149
1	4.0	0	95	113	35	37	6088	147
12	5.0	0	93	112	35	37	6096	145
32	6.7	0	92	122	36	38	6096	142
21	6.0	0	91	109	34	36	5719	140
30	6.3	0	91	109	36	37	5787	140
35	5.0	0	94	110	37	38	5911	140
31	3.3	0	92	119	35	38	5934	139
13	6.3	3	90	121	33	37	5781	138
36	6.0	0	92	106	35	35	5480	138
20	3.3	0	91	112	33	38	5773	136
9	4.7	0	95	113	31	37	5587	135
2	5.0	0	97	116	35	40	5951	132
4	4.0	0	95	119	38	38	5585	132
5	3.3	0	91	122	30	39	5806	132
11	6.0	0	95	115	35	37	5469	131
19	6.0	0	91	120	32	39	5742	130
14	2.7	0	90	124	36	36	5064	127
28	2.3	0	92	120	34	38	5330	126
3	3.0	0	95	129	36	38	5425	126
29	3.3	0	92	132	34	39	5368	124
34	3.3	0	95	111	35	39	5385	123
27	5.3	0	91	129	32	39	5291	122
17	4.0	0	93	120	34	40	5340	119
16	8.0	0	97	116	36	38	4991	118
33	4.0	0	92	124	35	39	5124	118
15	2.7	0	91	129	34	38	4961	118
24	3.0	0	91	132	36	38	4941	117
23	4.7	0	91	119	37	39	5123	117
6	6.3	0	91	131	37	40	5160	115
18	3.7	0	92	115	39	40	5076	113
26	5.0	0	91	131	36	40	5006	113
25	3.7	0	89	123	36	39	4886	112
22	2.7	0	97	124	42	40	4776	108
CV%	28	-	0.0	3.1	3.9	1.6	6.0	6.5
LSD (p<0.05)	2.0	-	3	6	2	1	543	14
P value	<0.0001	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

# Flax Council of Canada Agronomy Trials 2016 Report

**Cooperator:** Rachel Evans, Flax Council of Canada

## **Background**

Flax is an important crop for improving or maintaining on-farm diversity and sustainability in Manitoba. It has scientifically proven value as a rotational crop providing a break for disease, insect and weed populations. It is relatively lower input cost crop making it a competitive alternative oilseed crop on a net return basis. However, flax has not kept pace with yield improvements of most major crops in western Canada. Commercial flax yields have increased 0.5% per year for the last 30 years, compared to canola (1.7%/year), corn (2.4%/year) and soy (2.5%/year). Flax yields in Manitoba have increased the least (0.38% yield increase/year) compared to Saskatchewan (0.53%/year) and Alberta (2.27%/year). The genetic potential for flax yield is much higher than the average commercial yields (21 bushels/acre). For example, Seed Manitoba 2014 yield comparison table for flax states that the highest yielding flax cultivar at Rosebank was 76 bushels/acre equivalent. This is corroborated by the 2013 Annual Report of the Parkland Crop Diversification Foundation (Roblin) where the overall average yield of flax in field trials was 61 bushels/acre with the range being 41 to 73 bushels/acre. However, average flax yield for the five year period from 2008-2012 was 23.5 bushels/acre- Manitoba, 23.3 bushels/acre-Saskatchewan and 34.3 bushels/acre-Alberta.

It is critical to identify the factors that have caused Manitoba producers to dramatically reduce their flax production, identify current production tools available that can lead to a resurgence of flax acreage, communicate those best management practices (BMP's) to new and existing growers, and identify the gaps that exist in current agronomic research.

The findings from consultations with industry experts, the grower survey, and literature review were used to develop and implement an annual field demonstration program. The objective of this program is to provide data on the validity and priority of select BMPs and to illustrate these BMPs to growers. These field demos will be the basis of annual field days. The data collected from these replicated demo plots will be statistically analyzed and reported annually. BMPs will be identified that have the most merit in improving commercial flax yields and will support messaging in future agronomic extension activities.

## **Methodology**

The BMP program has been broken down into four projects:

- A. Herbicide and fungicide
- B. Fertilizer and seed treatment
- C. Seeding rate, date, depth and row spacing
- D. Crop rotation

Data collected will include emergence, plant population, days to maturity, date to first flower, weed control ratings, disease ratings, vigour ratings, and yield (Appendix A). The trials were established at five locations in the Southwest, Interlake, South Central Parklands, North Central Manitoba regions to evaluate and demonstrate select BMP's.

Locations were:

1. Prairies East Sustainable Agriculture Initiative (Arborg, MB)
2. Canada-Manitoba Crop Diversification Centre (Carberry, MB)
3. Westman Agricultural Development Organization (Melita, MB)
4. Integrated Crop Management Services (Portage la Prairie, MB)
5. Parklands Crop Diversification Foundation (Roblin, MB)

Each demo project includes an “ideal plot” treatment which incorporates an optimal combination of agronomic inputs and management practices. The other treatments in each project will have one factor removed from the ideal plot combination, to measure the yield impact of each individual BMP.

The factors associated with the “ideal” plot are as follows:

1. Choose well drained soil with very little salt
2. Soil tested for macro and micro nutrients
3. Sown on pulse or cereal stubble
4. Pre-plant glyphosate/Authority® (Authority – 118 ml/acre, glyphosate – recommended rate for corresponding formulation)
5. 9.6” row spacing or similar ‘regular’ commercial row spacing
6. Seed treatment - Insure Pulse® (300 ml per 100 kg of seed)
7. Fertilizer target of 45 bushels/acre
8. Optimum start-up fertilizer (seed placed - 15 lbs/acre actual phosphate as MAP 11-52-0 or 12-51-0). Side-band or mid band the rest of the fertilizer if possible
9. Optimum seeding date target May 15<sup>th</sup>
10. Seeding rate 45 pounds/acre
11. Seeding depth < 1 “
12. High yielding variety: CDC Glas
13. Priaxor® (Headline EC® + Xemium) (120 ml/acre) for pasmo control
14. All recommended herbicides as required (regardless of cost)
15. Desiccate at maturity with glyphosate (360 grams active ingredient per acre) or Reglone®

Due to herbicide drift from a neighboring field and deer damage at harvest, data from the site in Arborg could not be included in this report.

### ***Summary of Growing Season Climate***

The 2016 growing season saw a drier than normal start in April at Melita and Roblin, which transitioned into a wetter than normal May at all locations. Excess moisture did delay seeding at most locations and resulted in seeding dates that were later than protocols in Trial B. Temperatures were warmer than long term data, particularly early in the season. July and August saw many storm systems with high precipitation and high winds that contributed to lodging at Portage la Prairie.

**Table 1:** Growing season mean monthly temperature (°C) and total monthly precipitation (mm) for each location in 2016.

		April	May	June	July	August	September
-----Mean monthly temperature <sup>1</sup> (°C)-----							
Arborg		5.0	12.9	16.7	18.9	18.0	13.4
	<b>Long-term</b>	<b>3.0</b>	<b>10.0</b>	<b>15.8</b>	<b>18.6</b>	<b>17.5</b>	<b>11.5</b>
Carberry		5.6	13.1	17.1	18.7	17.7	13.3
	<b>Long-term</b>	<b>4.5</b>	<b>11.4</b>	<b>16.6</b>	<b>19.2</b>	<b>18.2</b>	<b>12.2</b>
Melita		6.5	13.5	17.8	19.5	19.2	13.6
	<b>Long-term</b>	<b>4.4</b>	<b>11.5</b>	<b>16.4</b>	<b>19.2</b>	<b>18.4</b>	<b>12.2</b>
Portage la Prairie		6.2	14.2	17.4	19.8	19.1	14.2
	<b>Long-term</b>						
Roblin		5.1	13.1	16.6	17.8	16.0	11.7
	<b>Long-term</b>	<b>3.6</b>	<b>10.5</b>	<b>15.7</b>	<b>18.7</b>	<b>17.7</b>	<b>11.7</b>
-----Total monthly precipitation <sup>2</sup> (mm)-----							
Arborg		43.6	87.7	42.6	66.8	79.7	20.7
	<b>Long-term</b>	<b>25.9</b>	<b>55.4</b>	<b>80.9</b>	<b>70.3</b>	<b>68.9</b>	<b>53.4</b>
Carberry		35.6	73.6	92.9	59.8	39.8	43.5
	<b>Long-term</b>	<b>24.9</b>	<b>56.5</b>	<b>79.6</b>	<b>68.2</b>	<b>65.5</b>	<b>41.9</b>
Melita		18.3	96.7	72.6	78	32	79.8
	<b>Long-term</b>	<b>28.6</b>	<b>54.1</b>	<b>82.2</b>	<b>66.7</b>	<b>62.1</b>	<b>40.5</b>
Portage la Prairie		39.5	65.8	105	82.7	108.5	51.6
	<b>Long-term</b>	<b>28.3</b>	<b>58.4</b>	<b>90</b>	<b>78.4</b>	<b>68.3</b>	<b>50.1</b>
Roblin		7.2	55.6	97	71.5	72.7	59.1
	<b>Long-term</b>	<b>29.6</b>	<b>54.9</b>	<b>82</b>	<b>73.1</b>	<b>61.3</b>	<b>58.2</b>

<sup>1</sup> Manitoba Agriculture Ag Weather program

<sup>2</sup> Agriculture and Agri-Food Canada Canadian Climate Normals 1981-2010 Station Data. Note: Next nearest station used when necessary.

## Flax Council of Canada Trial A – Fertility and Seed Treatments

### Description

Flax typically receives moderate fertilizer applications in Manitoba. According to Manitoba Agriculture Services Corporation (MASC) crop insurance data, over the last 10 years Manitoba flax acres received an average of 60 lbs N/ac, 17 lbs P/ac, 2.3 lbs K/ac and 2.9 lbs S/ac. Not taking into account soil nutrients, this roughly meets the nutrient requirements of a 22 bushel/acre flax crop. However, estimated nutrient removal based on a 32 bushel/acre flax yield target will remove 80 lbs N/acre, 22 lbs P/acre, 19 lbs K/acre and 6 lbs S/acre. Research has shown that banding nitrogen is the ideal placement for flax due to seedling sensitivity. Many producers still prefer to broadcast N which takes less time than banding nutrients. Seed-placed P can be beneficial for canola in cold, wet soils in Manitoba but so far there has been little investigation into any benefit for flax. Although there is evidence that flax can be sensitive to seed-place P as well, with as little as 13 lbs/acre of seed-placed P<sub>2</sub>O<sub>5</sub> (MAP) having been shown to have

negative effects on crop establishment. This trial also includes Insure Pulse®, a new seed treatment for evaluation. Flax is rarely treated, due to mucilage on the seed coat which historically has made it difficult to treat.

The objective of this experiment is to demonstrate and quantify yield differences from varying fertilizer management practices. This trial was conducted at:

1. Parkland Crop Diversification Foundation (PCDF) in Roblin, Manitoba
2. Integrated Crop Management Services (ICMS) in Portage la Prairie, Manitoba
3. Canada-Manitoba Crop Diversification Centre (CMCDC) in Carberry, Manitoba
4. Westman Agricultural Diversification Organization (WADO) in Melita, Manitoba

**Table 2:** 2016 Spring Soil Nutrient Analysis from 0-24" Depth at all sites (Analyses by Agvise Laboratories)

	Carberry	Melita	Portage la Prairie	Roblin
<b>Nitrate (lbs/ac)</b>	9	46	80	65
<b>Phosphorus (ppm)</b>	10	7.6	12	22
<b>Potassium (ppm)</b>	178	371	315	239
<b>Sulfur (lbs/ac)</b>	n/a	313.2	54	42
<b>Magnesium (ppm)</b>	n/a	492.3	472	454
<b>Calcium (ppm)</b>	n/a	2625.9	4754	2903
<b>Organic Matter (%)</b>	2.5	3.5	4.3	4.8
<b>Carbonate (CCE) (%)</b>	n/a	n/a	3.1	0.2
<b>Soluble Salts (mmos/cm)</b>	n/a	n/a	1.02	0.62
<b>Soil pH (0-6")</b>	8.1	7	7.8	6.8
<b>Cation Exchange Capacity (meq)</b>	n/a	18.2	28.6	19.1

**Table 3:** Fertility rates (lbs/acre) by treatment at low soil test sites (Carberry and Melita).

	Carberry				Melita			
	Nitrogen (NO <sub>3</sub> )	Phosphorus (P <sub>2</sub> O <sub>5</sub> )	Potassium (K <sub>2</sub> O)	Sulphur (S)	Nitrogen (NO <sub>3</sub> )	Phosphorus (P <sub>2</sub> O <sub>5</sub> )	Potassium (K <sub>2</sub> O)	Sulphur (S)
Ideal Plot	123	45	0	0	82	31	27	18
No Seed Treatment	123	45	0	0	82	31	27	18
No Fertilizer	0	0	0	0	0	0	0	0
Fertilize 25 bu/acre	67	24	0	0	22	31	27	18
No Start-up P	123	45	0	0	82	31	27	18
Broadcast Application	123	45	0	0	82	31	27	18

**Table 4:** Fertility rates (lbs/acre) by treatment at high soil test sites (Portage la Prairie and Roblin).

	Portage la Prairie				Roblin			
	Nitrogen (NO <sub>3</sub> )	Phosphorus (P <sub>2</sub> O <sub>5</sub> )	Potassium (K <sub>2</sub> O)	Sulphur (S)	Nitrogen (NO <sub>3</sub> )	Phosphorus (P <sub>2</sub> O <sub>5</sub> )	Potassium (K <sub>2</sub> O)	Sulphur (S)
Ideal Plot	55	27	0	5	70	10	0	7
No Seed Treatment	55	27	0	5	70	10	0	7
No Fertilizer	0	0	0	0	0	0	0	0
Fertilize 25 bu/acre	5	15	0	0	10	10	0	7
No Start-up P	55	27	0	5	70	0	0	7
Broadcast Application	55	27	0	5	70	10	0	7

## Results

Fertility rates were based on soil test information and are shown by treatment at low fertility sites (Table 3) and high fertility sites (Table 4). Treatments had a significant effect on yield at two of four locations.

At Carberry, applying no fertilizer and broadcasting fertilizer resulted in significantly lower yield than the ideal treatment fertilized to a 45 bushel/ac yield target using spring banding (Figure 1). There was no significant difference in yield when no seed treatment was used, when rates were applied based on a 25 bushel/acre yield target and when no starter P was applied in the seed row. No measurements of seedling vigor or lodging were taken at Carberry. At Melita, treatments that decreased the rate of fertilizer significantly decreased yield (Figure 1). Similarly, seedling vigor at Melita was also negatively affected in low fertilizer rate treatments (Table 6). Yield at Portage la Prairie and Roblin were unaffected by the treatments (Figure 1).

The seed treatment evaluated did not have a significant effect on yield at any sites, however, vigor was significantly reduced without seed treatment at Roblin. Lodging was also unaffected by treatments (Table 5), but as observed, was much higher at Portage la Prairie than at any other location. High soil test N and excessive winds during flowering were likely contributing factors.

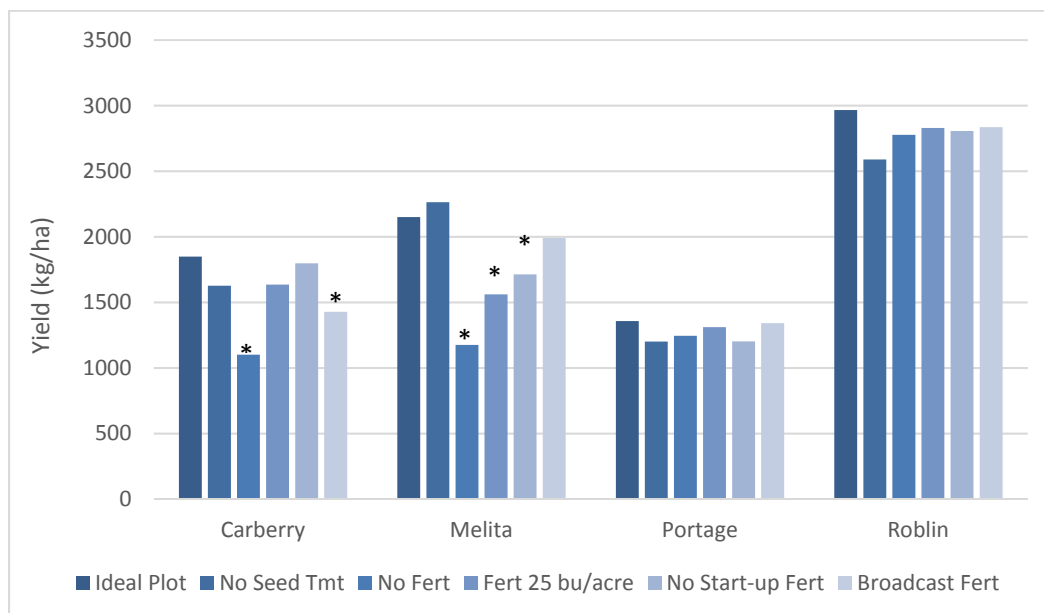


Figure 1. The effect of fertilizer treatment on flax yield (kg/ha) in 2016. Asterix (\*) indicates a treatment that is significantly different (higher or lower) than the ideal treatment.

**Table 5:** Coefficient of variation, least significant difference (LSD) and p-values for treatment effect on yield.

	Carberry	Melita	Portage	Roblin
CV	15.6	13.7	8.4	6
LSD	324.2	373.5	163.4	255
p>value	0.0012	<0.0001	0.2099	0.1222

**Table 6:** Lodging and vigor ratings at three locations: Melita, Portage la Prairie, Roblin. No data was collected from Carberry.

	Melita		Portage la Prairie		Roblin	
	Lodging	Vigor	Lodging	Vigor	Lodging	Vigor
Ideal Plot	1	6	6	6	0	7
No Seed Treatment	1	6	7	6	0	6*
No Fertilizer	1	5*	6	6	0	7
Fertilize to 25 bu/acre	1	6	5	6	0	7
No Start-up Fertilizer	1	5*	7	6	0	7
Broadcast Fertilizer	1	5*	8	6	0	7
CV	na	11.9	16.8	10.0	na	6.9
LSD	na	0.9	1.6	0.9	na	0.7
p > value	na	0.039	NS	NS	na	0.045

Plant population at Melita, Portage la Prairie and Roblin locations were above the recommended minimum plant population of 300 plants/ m<sup>2</sup>, exceeding the recommended upper limit (400 plants/m<sup>2</sup>) at Melita and Portage la Prairie. Seeding rate calculations were made base on seed lot germination, seed size and assuming 50% seedling survival. Seedling survival at Melita and Portage la Prairie were upwards of 70%, resulting in higher plant populations.

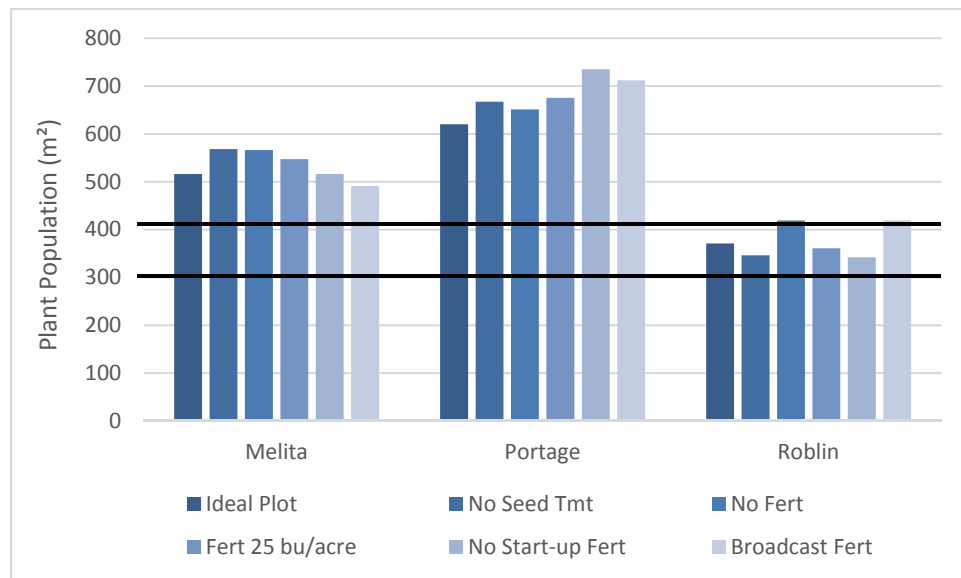


Figure 2: The effect of fertilizer and seed treatment on plant population at three locations in 2016. There were no significant differences among treatments. No data was collected from Carberry.

### Conclusions and Recommendations

Preliminary results from this trial indicate that flax does respond to increasing fertilizer applications; however the effect was site dependent. Treatments which were fertilized to a 45 bushel/ac yield target had significantly higher yields at Melita, where soil test nitrogen was low at the beginning of the season. Treatments which reduced fertilizer rates saw a decrease in yield. Similarly, no fertilizer applications significantly reduced yield compared to the ideal treatment at Carberry. Broadcast placement also decreased yield at Carberry, which is in contrast to results from Melita. There were no treatment effects



at Portage or Roblin sites, likely due to moderate to high background soil fertility levels at the site which resulted in relatively small application rates. As a result, high degree of lodging was observed at the Portage site, which may have also masked any treatment effects. Results indicate the merits of soil testing prior to flax production, and suggest that when soil nitrate-N is moderately high to high, there may be little yield benefit to N applications. Plant population was above recommended thresholds, which suggests variability in seedling survival by location. This could warrant further investigation as seed costs are one of the larger costs associated with growing flax.

### ***Acknowledgements***

The Flax Council of Canada would like to acknowledge SeCan for providing the variety CDC Glas, especially Brad Pinkerton for treating seed. We would also like to thank ICMS, who provided space and equipment for seeding preparations. James Frey and Susan Mceachern for assistance during seed preparation. Thanks to BASF Canada Inc. who supplied the Insure Pulse® and Priaxor and FMC Canada who supplied the Authority herbicide. Finally, thanks to Bayer, NorthStar Genetics, Dauphin Plain Seeds and R. & S. Stevenson Farms for their seed contributions.

### ***Flax Council of Canada Demo B – Seeding Dates, Seeding Depth and Row Spacing***

#### ***Description***

Flax is a relatively long season crop, requiring anywhere from 90 – 125 days to maturity depending on cultivar and environmental conditions. However, flax also tends to be a crop that Manitoba producers will seed in the latter half of May. Manitoba Agricultural Services Corporation crop insurance long-term data indicates that when flax is seeded in the first three weeks of May, producers achieve above average yields compared to when flax is seeded in the fourth week of May and later. Flax is small seeded with limited ability to overcome poor seedbed conditions, therefore shallow seeding depths are usually recommended. Deeper seeding depths may result in poor or delayed emergence. Flax is also a poor competitor with weeds; recent research has shown that row spacing is an important tool for integrated weed management. However, wider equipment used for other rotational crops may mean a shift towards seeding flax in wider rows.

The objective of this trial is to demonstrate and quantify the effect of changes to seeding date, seeding depth and row spacing on yield. This trial was conducted at:

1. Parkland Crop Diversification Foundation (PCDF) in Roblin, Manitoba
2. Integrated Crop Management Services (ICMS) in Portage la Prairie, Manitoba
3. Canada-Manitoba Crop Diversification Centre (CMCDC) in Carberry, Manitoba
4. Westman Agricultural Diversification Organization (WADO) in Melita, Manitoba

**Table 7:** Trial B treatment list at 2016 locations.

Treatments	Melita	Portage	Roblin	Carberry
Ideal plot	30-May-16	16-May-16	17-May-16	20-May-16
	45 lbs/ ac seeding rate	45 lbs/ ac seeding rate	45 lbs/ ac seeding rate	45 lbs/ ac seeding rate
	0.5" seeding depth	1" seeding depth	1" seeding depth	1" seeding depth
	9.5" row spacing	7.5" row spacing	9.5" row spacing	12" row spacing
1 week earlier than ideal	24-May-16	9-May-16	9-May-16	16-May-16
	45 lbs/ ac seeding rate	45 lbs/ ac seeding rate	45 lbs/ ac seeding rate	45 lbs/ ac seeding rate
	0.5" seeding depth	1" seeding depth	1" seeding depth	1" seeding depth
	9.5" row spacing	7.5" row spacing	9.5" row spacing	12" row spacing
1 week later than ideal	6-Jun-16	24-May-16	24-May-16	6-Jun-16
	45 lbs/ ac seeding rate	45 lbs/ ac seeding rate	45 lbs/ ac seeding rate	45 lbs/ ac seeding rate
	0.5" seeding depth	1" seeding depth	1" seeding depth	1" seeding depth
	9.5" row spacing	7.5" row spacing	9.5" row spacing	12" row spacing
2 weeks later than ideal	13-Jun-16	30-May-16	02-Jun-16	n/a
	45 lbs/ ac seeding rate	45 lbs/ ac seeding rate	45 lbs/ ac seeding rate	
	0.5" seeding depth	1" seeding depth	1" seeding depth	
	9.5" row spacing	7.5" row spacing	9.5" row spacing	
Low seeding rate	30-May-16	16-May-16	17-May-16	20-May-16
	25 lbs/ac seeding rate	25 lbs/ac seeding rate	25 lbs/ ac seeding rate	25 lbs/ ac seeding rate
	0.5" seeding depth	1" seeding depth	1" seeding depth	1" seeding depth
	9.5" row spacing	7.5" row spacing	9.5" row spacing	12" row spacing
High seeding rate	30-May-16	16-May-16	17-May-16	20-May-16
	70 lbs/ac seeding rate	70 lbs/ ac seeding rate	70 lbs/ ac seeding rate	70 lbs/ ac seeding rate
	0.5" seeding depth	1" seeding depth	1" seeding depth	1" seeding depth
	9.5" row spacing	7.5" row spacing	9.5" row spacing	12" row spacing
	Table 6 (continued.)			
2" seeding depth	30-May-16	16-May-16	17-May-16	20-May-16
	45 lbs/ ac seeding rate	45 lbs/ ac seeding rate	45 lbs/ ac seeding rate	45 lbs/ ac seeding rate
	1" seeding depth	21" seeding depth	2" seeding depth	2" seeding depth
	9.5" row spacing	7.5" row spacing 2"	9.5" row spacing	12" row spacing
3" seeding depth	30-May-16	16-May-16	17-May-16	20-May-16
	45 lbs/ ac seeding rate	45 lbs/ ac seeding rate	45 lbs/ ac seeding rate	45 lbs/ ac seeding rate
	1.5" seeding depth	3" seeding depth	31" seeding depth	3" seeding depth
	9.5" row spacing	7.5" row spacing	9.5" row spacing	12" row spacing
15" row spacing	30-May-16	16-May-16	17-May-16	20-May-16
	45 lbs/ ac seeding rate	45 lbs/ ac seeding rate	45 lbs/ ac seeding rate	45 lbs/ ac seeding rate
	0.5" seeding depth	1" seeding depth	1" seeding depth	1" seeding depth
	15" row spacing	15" row spacing	15" row spacing	12" row spacing

## Results

There was a significant effect of seeding date at two of four locations in 2016. At Roblin, seeding early (two weeks prior to the ideal date) resulted in significantly higher yields than the ideal seeding date (Table 7). Seeding two weeks after the ideal seeding date (June 2) resulted in significantly lower yields. At Carberry, seeding late also resulted in significantly lower yields. However, it should be noted that due to challenging spring conditions there are just four days between the first and second seeding dates, the third seeding date was in the first week of June (Table 7). There was no effect of seeding date at Portage la Prairie, despite having sufficient time between seeding dates. Due to a high CV (=26) yield data from Melita cannot be interpreted. Seeding date had a significant effect on the number of days to maturity at all locations except at Portage la Prairie. Early seed treatments matured significantly sooner than treatments seeded later (Table 9).

The response to seeding rate was variable between locations. At Roblin and Carberry, there were no yield differences between seeding rates when seeded on the same date. In contrast, highest yields at Portage la Prairie were achieved with the low (25 lbs/acre) seeding rate likely due to high soil N at the site and high incidence of lodging. Coefficients of variation for plant population were higher than the industry standard at Melita and Portage la Prairie, which means no statistical differences can be drawn. Although numerically, all treatments resulted in plant populations of at least 300 plants/ m<sup>2</sup>, the recommended lower limit. In some case plants count are much higher (>1000 plants/ m<sup>2</sup> at the high seeding rate in Portage la Prairie), which implies a seedling survival rate of 70% or higher. The current industry assumption is a 50-60% seedling survival rate. It should be noted that all treatments received seed treatment. Interestingly, seeding rate did not have a significant effect on days to maturity (Table 9). In other crops, high seeding rates are known to hasten maturity.

Seeding at a 2" seeding depth and 15" row spacing at Roblin had the highest and lowest yields, respectively. While seeding depth did not have a significant effect on yield at other locations. High precipitation in May and June meant ample soil moisture for emerging seedlings which could have contributed to the lack of response. However, seeding depth impacted days to maturity at three of four locations (Table 9). Flax seeded at 3" seeding depth significantly delayed maturity compared to flax seeded at 1" or 2" seeding depth. Flax is a small-seeded crop, and previous research has shown that shallow seeding is ideal.

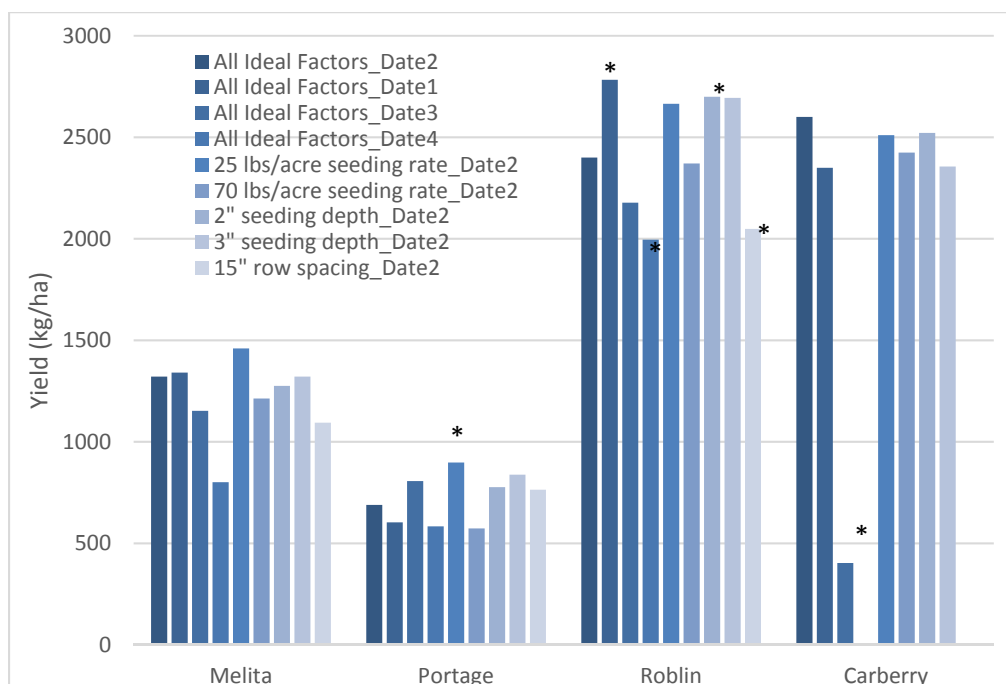


Figure 3: The effect of treatment on flax yield (kg/ha) in 2016. Asterix (\*) indicates a treatment that is significantly different (higher or lower) than the ideal treatment.

**Table 8:** Coefficient of variation, least significant difference (LSD) and p-values for treatment effect on yield.

	Carberry	Melita	Portage	Roblin
CV	21.3	12.2	8.3	10.5
LSD	379.9	129.1	295.1	338.6
p>value	0.070	<0.0001	<0.0001	<0.0001

**Table 9:** The effect of seeding date, seeding rate, seeding depth and row spacing on days to maturity and plant density (plants/ m<sup>2</sup>). No plant density data at Carberry.

	Melita		Portage la Prairie		Roblin		Carberry	
	DTM	Density	DTM	Density	DTM	Density	DTM	Density
All Ideal Factors_Date2	82.0	518.0	95.0	863.6	108.0	592.0	98.0	-
All Ideal Factors_Date1	80.0	423.0	95.0	732.4	116.0	615.0	100.0	-
All Ideal Factors_Date3	84.0	489.0	94.0	698.3	103.0	633.0	102.0	-
All Ideal Factors_Date4	99.0	439.0	94.0	417.4	109.0	684.0	n/a	-
Low seeding rate_Date2	83.0	328.0	97.0	433.1	108.0	386.0	98.0	-
High seeding rate_Date2	81.0	717.0	94.0	1026.4	108.0	779.0	98.0	-
2" seeding depth_Date2	83.0	373.0	96.0	619.5	108.0	558.0	98.0	-
3" seeding depth_Date2	85.0	334.0	99.0	435.8	108.0	525.0	100.0	-
15" row spacing_Date2	81.0	910.0	96.0	778.1	108.0	633.0	n/a	-
CV	1.2	24.0	1.6	17.1	2.9	26.1	0.009	-
LSD	1.5	176.1	2.2	166.2	0.00000	228.6	0.0126	-
Prob. Entry	<0.0001	<0.0001	0.002	<0.0001	<0.0001	0.101	<0.0001	-

## Conclusions and Recommendations

Preliminary results indicate that seeding date does effect the number of days to maturity in flax, however, yield response was more variable. Highest yields were achieved at Roblin when seeded in the first week of May. At two of four locations, seeding flax very late resulted in low yields. This is consistent with MASC long term data which shows that flax yields 80% of the average yield in Manitoba when it is seeding in the first week of June, but is relatively insensitive to seeding date if seeded before the fourth week of May. This flexibility could be an advantage of having flax in rotation, as other crops are considerably more sensitive to seeding date. Although there may be an advantage seeding flax early if this results in earlier maturity. Flax harvest is generally late, and is a source of frustration for flax growers. The effect of seeding rate and depth were inconsistent which could be attributed to excellent seedling survival at all sites, which could reflect the use of treated seed and/or ample soil moisture. Low seeding rates under excess soil N resulted in highest seed yields at Portage la Prairie.

## Acknowledgements

The Flax Council of Canada would like to acknowledge SeCan for providing the variety CDC Glas, especially Brad Pinkerton for treating seed. We would also like to thank ICMS, who provided space and equipment for seeding preparations. James Frey and Susan Mceachern for assistance during seed preparation. Thanks to BASF Canada Inc. who supplied the Insure Pulse® and Priaxor and FMC Canada who supplied the Authority herbicide. Finally, thanks to Bayer, NorthStar Genetics, Dauphin Plain Seeds and R. & S. Stevenson Farms for their seed contributions.

## Flax Council of Canada Demo C – Herbicide and Fungicide

### Description

Flax is a relatively poor competitor with weeds, which can cause as high as 50% yield loss when left uncontrolled. Relatively few herbicide options and increasing proportions of herbicide resistant weeds, specifically group 1 and 4, contribute to weed management challenges in flax. New pre-emergent herbicide options (Group 14) offer additional tools for controlling weeds are demonstrated in this trial. In addition, fungicide management of pasmo (*Septoria linicola*) is also evaluated. Pasm is a ubiquitous disease of flax in the Prairies, affecting close to 100% of surveyed fields each year. Yield losses associated to the disease range from 5 – 30% according to previous research.

The objective of this experiment is to demonstrate and quantify yield differences from varying weed and disease management practices. This trial was conducted at:

1. Parkland Crop Diversification Foundation (PCDF) in Roblin, Manitoba
2. Integrated Crop Management Services (ICMS) in Portage la Prairie, Manitoba
3. Westman Agricultural Diversification Organization (WADO) in Melita, Manitoba

Due to rotational constraints, no trial could be conducted at Carberry.

### Results

There were no significant treatment effects of varying weed or disease management on flax yield in 2016. Low weed pressure was observed at all three locations, which likely explains the lack the response to the treatments. Consistent with this finding, there was no significant impact of treatments on days to maturity, vigor or plant population. However, weed control ratings were significantly different at 28 days post application and 7 and 14 days post application at Melita and Portage la Prairie, respectively.

Table 10: **The effect of herbicide on weed ratings days post application (DPA). Ratings were given 1 – 10 (10 indicating 100% control). Asterix (\*) indicate significant differences greater or less than the ideal treatment.**

	Melita			Portage la Prairie	
	7 DPA	14 DPA	21 DPA	7 DPA	14 DPA
All Ideal Factors	9.9	9.8	9.6	7	8
No Authority applied	9	9.1	9	6.3*	7.3*
No Glyphosate applied	8.9	8.8	8.8	5.8*	7*
No Priaxor applied	9.8	9.7	9.7	2.8*	5*
No post-emerge broadleaf herbicides	8.6	8.3	8.1*	3*	5*
No post-emerge grassy herbicides	9.6	9.5	9.4	6*	7.3*
CV	7.5	7.4	6.6	13.11	4.5
LSD	1.0	1.0	0.9	1.0	0.4
Prob. Entry	0.1	0.05	0.019	<0.0001	<0.0001

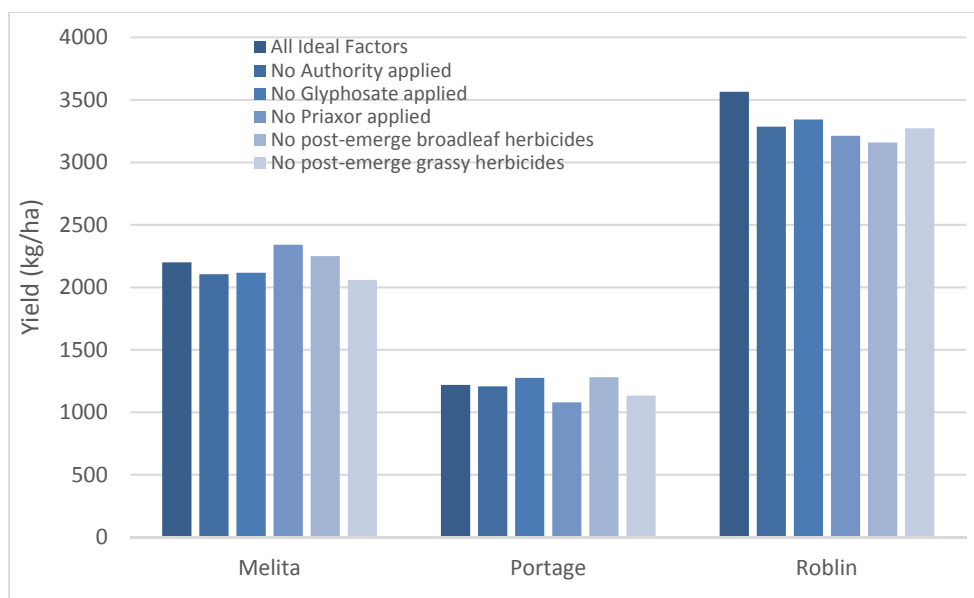


Figure 4: The effect of herbicide and fungicide treatment on flax yield in 2016. Asterisk (\*) indicates a treatment that is significantly different (higher or lower) than the ideal treatment.

### Conclusions and Recommendations

No significant preliminary conclusions can be drawn from 2016. Although herbicide and fungicide treatments had an effect on weed and disease control, there was no significant impact on yield.

### Acknowledgements

The Flax Council of Canada would like to acknowledge SeCan for providing the variety CDC Glas, especially Brad Pinkerton for treating seed. We would also like to thank ICMS, who provided space and equipment for seeding preparations. James Frey and Susan Mceachern for assistance during seed preparation. Thanks to BASF Canada Inc. who supplied the Insure Pulse® and Priaxor and FMC Canada who supplied the Authority herbicide. Finally, thanks to Bayer, NorthStar Genetics, Dauphin Plain Seeds and R. & S. Stevenson Farms for their seed contributions.

### Flax Council of Canada Demo D – Crop Rotation

#### Description

Flax relies heavily on symbiotic associations with arbuscular mycorrhizal fungi (AMF) to take up nutrients like phosphorus, which make it sensitive to previous crop stubble. Manitoba flax yields are lower (83% of check) when flax is planted on *Brassica* stubble. Canola does not rely on AMF to access phosphorus in the soil, so in canola years AMF are not supplied with their food source and populations decline. This results in fewer fungi populations for flax to associate with if seeded on canola stubble and causes a decrease in phosphorus uptake by flax. Cereals and pulses do associate with AMF, so they are a better stubble seeding option. A study by AAFC researchers found that flax grown on wheat stubble had greater establishment, early season biomass, phosphorus accumulation and higher yield than flax grown on canola.

The objective of this trial is to demonstrate and quantify yield differences from varying previous crop stubble on flax yield. This trial was conducted at:

1. Parkland Crop Diversification Foundation (PCDF) in Roblin, Manitoba
2. Integrated Crop Management Services (ICMS) in Portage la Prairie, Manitoba
3. Canada-Manitoba Crop Diversification Centre (CMCDC) in Carberry, Manitoba
4. Westman Agricultural Diversification Organization (WADO) in Melita, Manitoba

## **Results**

Since this trial was in the crop establishment year at two of four locations, no data was analyzed in 2016. Four locations will be seeded to flax in 2017.



## **Acknowledgements**

The Flax Council of Canada would like to acknowledge SeCan for providing the variety CDC Glas, especially Brad Pinkerton for treating seed. We would also like to thank ICMS, who provided space and equipment for seeding preparations. James Frey and Susan Mceachern for assistance during seed preparation. Thanks to BASF Canada Inc. who supplied the Insure Pulse® and Priaxor and FMC Canada who supplied the Authority herbicide. Finally, thanks to Bayer, NorthStar Genetics, Dauphin Plain Seeds and R. & S. Stevenson Farms for their seed contributions.

## **APPENDIX A. Sampling Procedures**

### **All Experiments (Baseline)**

1. Emergence
  - a. Julian date/ experiment when two full rows are visible in majority (75%) of plots.
  - b. Note only if there are significant differences between treatments. If substantial differences are noticed record emergence by plot.



2. Plant Population
  - a. Randomly select 2 locations, excluding outside rows, per plot and count a 25 cm length per count. Counts are multiplied by 4 to achieve a meter length count. Alternatively, plant counts per 1m of row (2 x per plot) is also suitable practice.
3. Vigour Ratings
  - a. Ratings must be done prior to post-emergent herbicide application
  - b. Visual rating of 1 to 9 where 1 = poor vigour and 9 = excellent. The ideal plot would be rated a 6.5 benchmark rating for a plot to compare vigour ratings with. 6.5 is above average but leaves room for other treatments to be better if that was the case. The rating for the "ideal" plot might be less than 6.5 if growing conditions were not good. For example, it may be 5 and all the other treatments would be compared to that.
4. Days to Maturity
  - a. Julian days from seeding date to 75-80% brown bolls
5. Lodging Ratings
  - a. Visual rating of 1 to 9 where 1 = upright and 9 = completely flat; assess prior to harvesting
6. Yield
  - a. Yield weight (combined)
  - b. Yield weight (clean)
  - c. Adjust yield for 10% moisture
  - d. % dockage

### **Experiment Specific Parameters**

#### **Experiment A.**

1. Emergence
  - a. Record Julian date of plant emergence per treatment

#### **Experiment B.**

2. Emergence
  - a. Record Julian date of plant emergence per treatment

#### **Experiment C.**

3. Crop Phytotoxicity
  - a. Visual rating of 1 to 9 where 1 = mild leaf burn to 9 = severe leaf burn
4. Weed Control Rating
  - a. Visual rating for % control of target species at 7, 14, and 28 days after post emergent herbicide application
5. Disease Rating
  - a. Randomly select 25 plants per plot and record incidence (Yes or No) and severity (percent disease on plant, where 1=10% and 9=90%) at -1, 14 and 21 days after fungicide application
  - b. Note disease type
  - c. Note if disease severity is more or less than ideal treatment

#### **Experiment D.**

#### **Year 1: Stubble Establishment**

6. Disease Rating

- a. Randomly select 25 plants per plot and record incidence (Yes or No) and severity (percent disease on plant, where 1=10% and 9=90%) at -1, 14 and 21 days after fungicide application
  - b. Note disease type
  - c. Note if disease severity is more or less than ideal treatment
7. Soil Test in Spring
  - a. Soil test 0 – 60 cm prior to seeding (N-P-K-S, add micros if no additional cost)
    - i. Composite sample of one cores/ rep/ stubble type for a total of 6 soil samples

## **Year 2: Flax Production**

8. Baseline parameters (1 – 6)

# **WADO Flax Fibre Project 2016**

## ***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)

## ***Location and Soil Characteristics***

**Research Site:** Melita, MB

**MCIC Soil Zone:** G

**Location:** SW 27-3-27 W1

**Soil Texture:** Waskada Loam

## ***Soil Test***

Legal	Depth	pH	N lbs/ac	P ppm Olsen	K ppm	S lbs/ac	Organic Matter %
NE 27-3-27 W1	0-6"	7.2	14	6	306	79	2.8
	6-24"		29			322	

## 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 2 acres).
2. Pull the large plots of each variety and leave to ret over the fall of 2016.
3. Bale and ship back to Europe for quality and fibre yield assessment.

## Methods

Two varieties of flax were seeded in 275 meter x 30 meter plots at a speed of 3.5 mph with a Seedhawk opener on 9.5" spacing. Soil moisture was good at the time of seeding. This site was harrowed on May 1<sup>st</sup> to condition soil lumps and make a level seed bed. The site was also rolled immediately after in case of rocks impeding any of the harvest operations. We seeded both varieties, Eden and Melina, at 75lbs/ac. Fall weather conditions during retting (after pulling and prior to baling) – see Appendix A.

## Agronomy

Seeding Date	Seeding Depth	Fertility	Herbicide	Spray Date	Pull Date	Flip Date	Bale Date
			Basagran @.91L/ac + Assure II @.2L/ac + Sure Mix. 20imp gal/ac				
May 6 2016	0.5"	78-31-27-18 1lb Zinc	water	June 13 2016	Aug 5 2016	Aug 24 2016	Sept 14 2016

2014 Chem-fallow, 2015 winter wheat

**Pre-seed Herbicide application (burnoff):** Authority (sulfentrazone) @ 100 mL/ac + Roundup (glyphosate) @ 0.5 L/ac + Aim (carfentrazone) @ 15 mL/ac + Rival (trifluralin) @ 0.5 L/ac ---all tank mixed applied at 10 gal/ac applied May 6, 2016 just after seeding. Weeds burned off included: Wild Oats [*Avena sativa* L.], Wild Mustard [*Sinapis arvensis* L., Brassica kaber (DC.) L.C. Wheeler var. pinnatifida (Stokes) L.C. Wheeler], Volunteer canola [*Brassica napus* L.], Cleavers [*Galium aparine* L.]

## Comments

Seeding was successful and plots were visually impressive. Seeding was accomplished using GPS guidance which kept rows straight and easy to pull at fibre harvest. Plots were seeded longer to help the equipment operations as there would not be as many turn.

Photo (right): Melina on left and Eden on right on July 12, 2016 near the end of flowering.



## Results

**Table 1:** Results of yield after baling of fibre flax in Melita, MB in 2016.

Variety	Eden	Melina
Area (ha)	0.38	0.35
Total Field Weight (kg)	1942	1592
Yield (kg/ha)	5111	4549
Est. Fibre* Yield kg/ha	1533	1365
Number Usable	13	11
Bales per Hectare	34	31
Bale Properties		Value
Bale width	1.19	meters
Bale Volume	1.35	m3
Bale Weight	260	kg
Bale Density	193	kg/m3
*Assuming 30% fibre content		

Basagran herbicide was used for volunteer canola control due to its relative crop safety. During bolting stage, the nearby crop was sprayed with glyphosate which drifted onto the flax plots. Moderate injury resulted, however the crop was able to recover over two weeks.

Photo (right): Glyphosate injury on flax fiber. Taken June 16, 2016.



There was no lodging this year regardless of variety.

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

When pulling occurred, plants were 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. The unit travelled about 4-5 mph and it took about 3 hours to pull 2 acres.



### Order of Fibre Harvest Operations:



Pulling Date – Aug 5, 2016

Cam from PAMI operated the unit.



Turning Date: Aug 24, 2016

Cam from PAMI operated the unit.



Baling Date – Sept 14, 2016

Used a Verhaeghe 504 VE baler. Baling took 1 full day and was done by Cam Kliever of PAMI. Bales were also loaded and transported on this

Bales had to be baled in such a way that the stems were aligned in the same direction so that the bale was formed with roots on one side and seed bolls on the other. Sisal twine was used during baling and had to be strung between the layers of straw during the bale making process so that it will unwind in the factory as a single continuous later as it was in the field. Bales were wrapped with sisal during the final wrapping stage before being ejected from the baler.

Baling was cumbersome due to the complicated pickup system involved with this baler model. Steel fingers on the baler pickup would scratch the ground, sometimes hitting rocks. Sometimes flax straw would bunch and plug the pickup. This happened over a dozen times.



**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 makeup of the bale making process. The driver must be careful to keep the direction of the flax correct after every turn.

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



**Photo (left):** Fibre would wrap on the intake bar due to a snag in the belt stitching.

### ***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.

See Appendix A – Weather Variable Data during the growing season at Melita site in 2016 for in depth weather information at the trial site.



# SeCan Soybean Variety Trial

## Cooperators

- SeCan Seeds – Brad Pinkerton

## Objective

To grow and compare new soybean varieties, against industry standard varieties, in prospect for distribution by SeCan Seeds.

## Introduction

The success of soybean varieties during their northwesterly expansion on the prairies is depends 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 for the region. SeCan brought several varieties to the trial that were not available in the traditional MCVET trials.

## Methods

The trial consisted of 8 entries in plots that were 1.44m wide by 9m long. The experimental design of the trial was a randomized complete block design replicated 3 times. A pre-seeding burnoff was applied at a rate of 1 l/ac REL glyphosate and 15 ml/ac Aim. Plots were seeded with a Seedhawk opener on 9.5" spacing and soil moisture was good at the time of seeding. Soybean plots were rolled with a land roller just after seeding. Plots were harvested with a Hege 140 plot combine.

## Agronomy

Seeding Date	Seeding Depth	Fertility	Herbicide	Spray Date	Harvest Date
May 30 2016	0.75"	22-31-27-18 + Granular Innoculant	Glyphosate 1L REL + Viper 0.4L/ac	June 15 2016	September 29 2016

## Results

There were significant differences in days to maturity, plant height, yield and seed weight in Melita at the 0.05 level of significance (Table 1).



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

Variety	Plant Height cm	Maturity days	Pod Height cm	Yield kg/ha	Green Seed %	Seed Size g/100
Hero R2	61.3	115.7	7.8	2327	0.3	14.1
Dekalb 24-10	52.7	112.0	6.2	2145	0.0	16.4
Dekalb 23-60	74.5	112.0	6.8	2108	0.0	13.7
SC16-2425R2X	75.5	115.0	7.2	2032	1.3	13.2
Mahony R2	59.7	112.0	7.3	2031	0.0	15.6
McLeod R2	67.8	112.3	8.2	1886	0.3	14.5
Bishop R2	73.0	112.0	8.0	1678	0.7	12.1
SC2250R2X	70.8	112.0	6.2	1622	1.0	10.4
CV	7.2	0.4	18.2	8.2	NA	3.5
LSD	8.4	0.8	2.3	282	1.4	0.8
P value	0.0003	<0.0001	0.4364	0.0015	0.3321	<0.0001
Grand Mean	67	113	7	1979	0.5	14

## Discussion

All varieties matured prior to fall frosts in Melita.



**Photo :** July 29, 2016

# Accidental Soybean Trial

## Cooperators

- Scott Day – Treelane Farm, Deloraine MB
- Minto Coop

## Introduction

This was initially a basic field scale variety trial. When Scott Day's seeder malfunctioned and left strips where no granular inoculant was applied, it turned into an inoculant and variety trial.

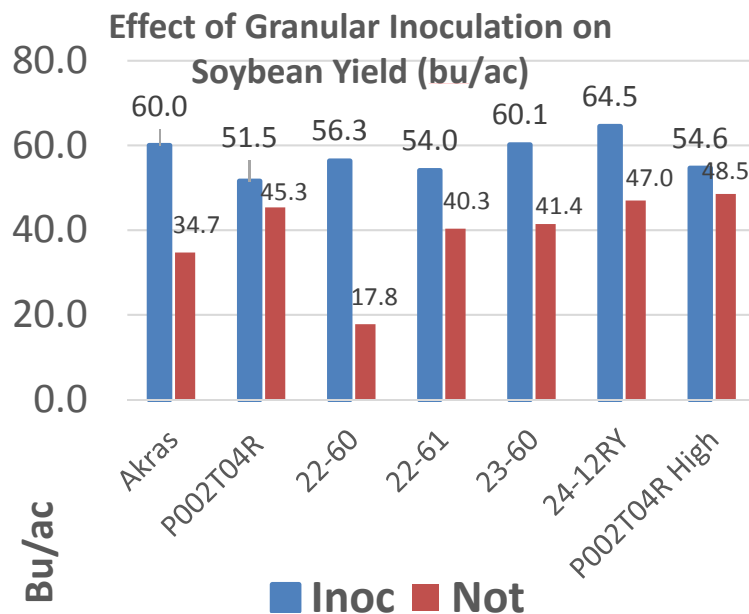
## Methods

The trial consisted of 6 entries in plots that were replicated 4 times in a row. Plots were seeded with a Seedhawk opener on 10" spacing on May 20<sup>th</sup> 2016 at a depth of 1 inch. Plots were seeded into wheat stubble and soil moisture was good at the time of seeding. Seed population was set for 210,000 seeds. Only granular inoculant was applied as the land had adequate fertility. Soybean plots were rolled with a land roller just after seeding. Two applications of .75 REL of glyphosate were applied. Plots were harvested with a Hege 140 plot combine.



## Results

**Chart 1:** Yield comparison each variety with both inoculated and not granular inoculation. Note that 22-60 had no liquid inoculant on the seed.



### *Discussion*

In the process of seeding, a manifold, which should have been distributing granular inoculant, was accidentally shut off. This resulted in 10 foot strips that did not receive inoculant. This gave us an excellent chance to verify the importance of proper inoculation on virgin soybean ground.



**Photo Above** (taken by Scott Day): Visible difference between the properly inoculated soybeans on the left of the picture versus the right side where no inoculant was applied.

# Corn Nitrogen Rate Study

## Cooperators

- John Heard, CROPS Manitoba Agriculture

**Research Site:** Melita, MB

**Cooperator:** Prince Farms

**Soil Texture:** Ryerson Loam

**Location:** SW 7-3-25W1

**Previous Crop:** Wheat

## Soil Test

Depth	pH	N	P	K	Organic Matter
		ppm	ppm Olsen	ppm	%
0-24"	8	57	7	341	4

## Background

Manitoba Agriculture nitrogen rate guidelines for corn were developed before 1990 and are out-of-date for current yield levels. Recently NDSU has released N rate guidelines for corn and a number of in-crop scouting measures can be used to assess sufficiency and need for more N. The following study was initiated to evaluate a number of N decision guides for suitability in fertilizing corn in Manitoba.

## Methods

Three locations were located near Melita, Carberry and Arborg and were managed by Crop Diversification staff. Additional sites were at St Adolphe (Kelburn farm) and a farm field north of Morden and were managed Crops Branch, University of Manitoba staff and Richardson staff.

Nitrogen rates were 0-200 lb N/ac applied as post plant surface broadcast SuperU (46-0-0). To simulate the Y-drop application of side-dress stage N, liquid UAN (28-0-0) was applied at the 6 leaf stage of corn on each side of the corn plant (treatments 7 and 8)





**Table 1:** Site cropping history, soil characteristics and 2016 growing conditions.

Site	Kelburn	Carberry	Arborg	Morden	Melita
Soil type	Scanterbury clay	Ramada clay loam	Peguis clay	Neuenberg sand loam	Ryerson loam
Prev crop	Soybean	Canola	Wheat	Potatoes, rye cover crop	Wheat
Nitrate-N lb/ac in 0-24"	71	55	106	35	57
PSNT nitrate-N lb/ac in 0-12"	170	74	254	63	95
OM%	7.70%	4.90%	8.60%	2.90%	4.00%
P ppm Olsen	28	8	47	33	7
K ppm	507	225	480	179	341
pH	7.1	6	8	7.8	8
May-Sept weather					
Crop Heat Units	3050	2775	2779	3110	2903
% of normal	112%	109%	106%	107%	108%
Precipitation (in)	16.1	12.2	11.7	18.1	14.2
% of normal	122%	101%	93%	139%	106%

**Table 2:** Field Practices.

Site	Kelburn	Carberry	Arborg	Morden	Melita
Planting Date	May 13/16	17-May	20-May	04-May	13-May
Hybrid	DKC 26-28	DKC 26-28	DKC23-17	Pioneer 7958AM	DKC 26-28
Population ('000/ac)	32	32	32	31	32
Sidebanded fertilizer					
MAP lb P2O5/ac	40	54	90	40	40
Potash lb K2O/ac	0	0	0	10	0
Pest management					
Herbicide1	<i>post plant</i>	14-Jun	10-Jun	09-May	21-May
Product	Glyphosate Heat & Merge	Glyphosate	Glyphosate	Glyphosate Heat & Merge	Glyphosate Heat & Merge PrimeExtra II
Herbicide 2	June 14/16		15-Jul	10-Jun	17-Jun
Product	Glyphosate		Glyphosate	Glyphosate	Glyphosate
Herbicide 3	July 08/16			20-Jun	
Product	Basagran			Glyphosate	
Harvest	11-Oct	09-Nov	04-Nov	04-Oct	21-Oct

**Table 3:** Treatment applications and crop observations.

Site	Kelburn	Carberry	Arborg	Morden	Melita
Nitrogen Tmts					
Tmts 1-6	20-May	15-Jun	08-Jul	09-May	13-May
Tmts 7-8	27-Jun	08-Jul	14-Jul	27-Jun	29-Jun
Observations					
PSNT	27-Jun	08-Jul	14-Jul	27-Jun	11-Jul
SPAD	nd	08-Jul	14-Jul	28-Jun	29-Jun
GreenSeeker1	27-Jun	08-Jul	14-Jul	28-Jun	29-Jun
GreenSeeker2	nd	18-Jul	nd	nd	20-Jul
N Deficiency Leaf rating	03-Aug	09-Aug	04-Aug	28-Jul	nd
Stalk N	11-Oct	nd	nd	nd	03-Oct

- nd = not determined at this site
- PSNT (pre sidedress nitrate-N test) soil sample is taken between the rows to a depth of 12" (values reported in Table 1)
- SPAD chlorophyll readings are taken mid-leaf of the earliest leaf with a developed collar. SPAD values are referenced as an index of those measured at full N rates.
- GreenSeeker readings of NDVI are taken with the pocket GreenSeeker.
- N deficiency ratings are the number of lower corn leaves with visible N deficiency (yellowing of the midrib). The value is the number of deficiency leaves observed in 10 plants.
- Stalk N is the end of season stalk nitrate test as an index of N sufficiency/excess.

## Results

Results are reported by location

**Table 4:** St. Adolphe corn response.

Treatments			Moisture	Yield	Test wt
lb N/ac	NDVI	Vis def	%	Bu/ac	Lb/bu
1=0N	0.69	9 a	26.8	202	52
2=40N	0.7	7 ab	26.6	201	52
3=80N	0.7	4 bc	26.7	211	51
4=120N	0.68	3 c	27	202	51
5=160N	0.69	3 c	26.8	203	52
6=200N	0.71	1 c	26.6	206	51
7=40N+40N	0.7	5 bc	25.8	204	50
8= 40N+80N	0.7	5 bc	26.1	204	51
Mean	0.7	5	26.5	204.1	51.1
Pr>F	0.9917	<.0001	0.0763	0.9321	0.6441
CV	6	60	2	5	2

Values in columns followed by different letters are significantly different at the 5% probability level (according to Tukey-Kramer).

**Table 5:** Carberry corn N response

Treatments	SPAD	SPAD Index	NDVI	Vis def	Yield Bu/ac	Green Snap
lb N/ac						
1=0N	49.3	87%	0.38	5:00 AM	120	1
2=40N	56.3	100%	0.44	1 b	115	1.5
3=80N	53.8	95%	0.41	1 b	111	1.5
4=120N	52.5	93%	0.48	0 b	123	1.8
5=160N	52.8	94%	0.44	0 b	119	2.3
6=200N	53	94%	0.39	0 b	123	2.3
7=40N+40N	49	87%	0.35	0 b	123	2.3
8= 40N+80N	56.3	100%	0.42	1 b	122	2
Mean	52.8		0.41		119	1.8
Pr>F	0.6484		0.1535	<.0001	0.7197	0.4312
CV	14		22	89	3	115

Values in columns followed by different letters are significantly different at the 5% probability level (according to Tukey-Kramer).

1. Volunteer wheat was not controlled until mid-June and competed for N and early season corn growth.
2. Severe wind caused green snap of plants. Values in table are the number of 10 plants that snapped.
3. Deer damaged several of the plots adding variability to yield results.

**Table 6:** Arborg corn N response

Treatments	SPAD	SPAD Index	NDVI	Vis def	Moisture %	Yield Bu/ac	Weed growth lb/ac	N in weeds lb/ac
lb N/ac								
1=0N	47.0 b	87	0.78	10 a	26.5	154 c	858	23
2=40N	50.0 ab	93	0.79	8 a	26.1	169 bc	444	13
3=80N	50.5 ab	94	0.78	5 b	25.5	186 ab	605	25
4=120N	54.3 a	100	0.8	3 bc	25.1	194 a	327	17
5=160N	54.1 a	100	0.81	2 bc	25.2	191 a	480	14
6=200N	53.2 a	98	0.79	1 c	25.7	193 a	599	19
7=40N+40N	50.0 ab	93	0.8	4 b	26.2	187 ab	616	19
8= 40N+80N	49.7 ab	93	0.8	3 b	25.7	194 a	911	37
Mean	51			4	25.8	183.4		
Pr>F	0.0014		0.4293	<.0001	0.1661	<.0001		
CV	7		3	70	3	9		

Values in columns followed by different letters are significantly different at the 5% probability level (according to Tukey-Kramer).

1. The broadcast N application was not applied until early July. A second flush of weeds was not controlled and biomass and N uptake was measured and reported in Table 6.



**Table 7:** Morden corn N response

Treatments					Moisture	Yield	Test wt	Stalk N
lb N/ac	SPAD	SPAD Index	NDVI	Vis def	%	Bu/ac	Lb/bu	pm NO3
1=0N	41.9 c	88	0.64	9 a	23	178	49	46
2=40N	46.7 ab	98	0.65	7 ab	24	194	52	502
3=80N	45.1 bc	94	0.69	6 bc	24	196	52	4102
4=120N	47.3 ab	98	0.7	4 cd	23	199	51	2234
5=160N	48.5 a	100	0.66	3 de	24	199	51	4234
6=200N	47.6 ab	100	0.69	1 e	23	197	50	3885
7=40N+80N	45.9 ab	96	0.67	5 bcd	24	186	51	2173
8= 40N+120N	46.7 ab	98	0.7	4 cd	23	184	51	3931
Mean	46		0.7	5	23	191	51	2638
Pr>F	<.0001		0.15	<.0001	0.2183	0.1856	0.7873	
CV	6		5	54	4	7	5	

Values in columns followed by different letters are significantly different at the 5% probability level (according to Tukey-Kramer).

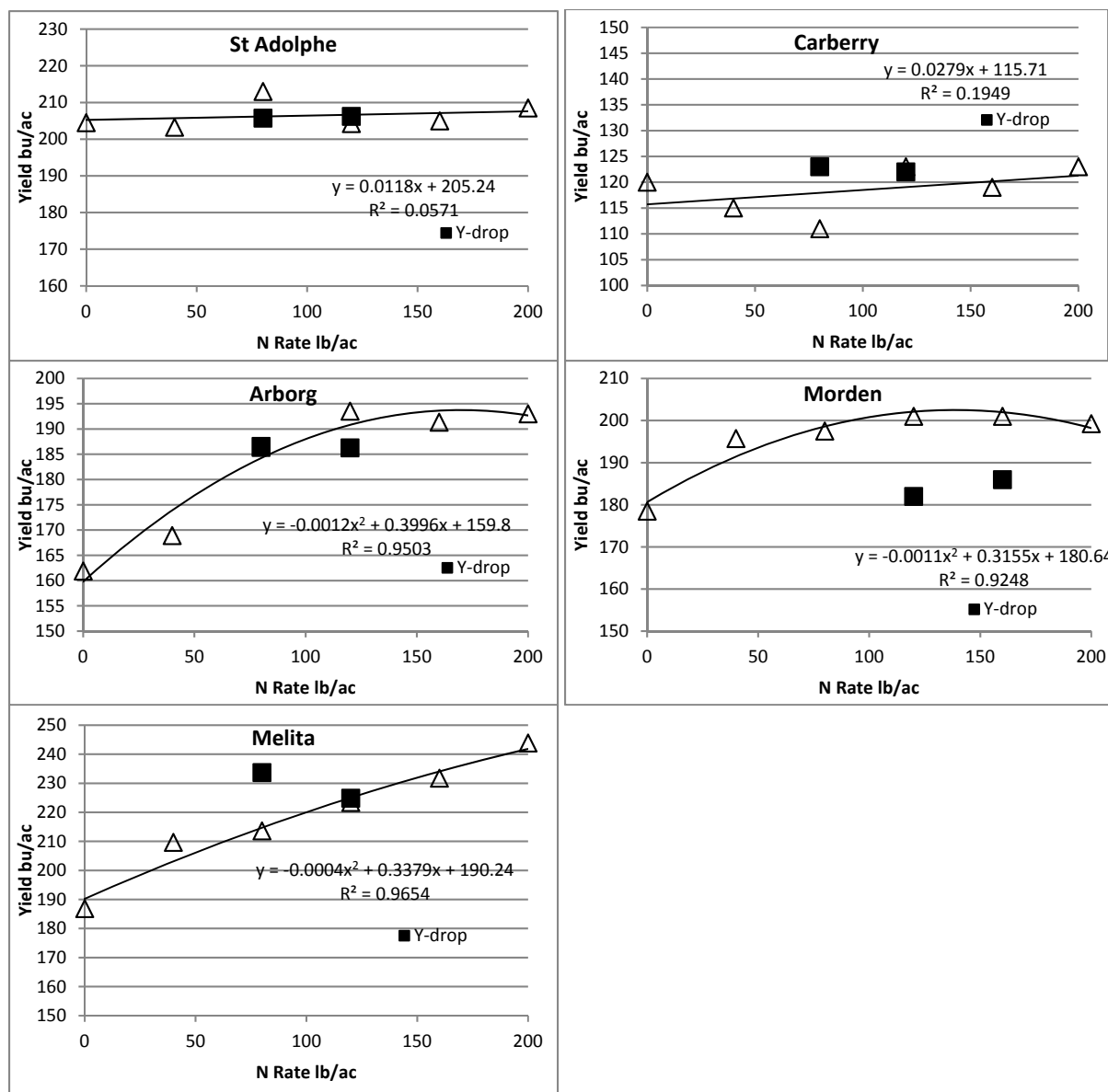
**Table 8:** Melita corn N response

Treatments				Moisture	Yield	Test wt
lb N/ac	SPAD	SPAD Index	NDVI	%	Bu/ac	Lb/bu
1=0N	41.4 bc	89	0.46	27.2 a	187 b	52
2=40N	42.4 abc	91	0.5	24.6 ab	210 ab	54
3=80N	42.6 abc	93	0.51	24.7 ab	214 ab	53
4=120N	45.6 a	100	0.52	23.7 b	223 ab	54
5=160N	42.8 abc	93	0.49	24.4 b	232 ab	53
6=200N	44.2 ab	96	0.53	24.5 ab	244 a	54
7=40N+40N	40.1 c	87	0.51	23.4 b	230 ab	54
8= 40N+80N	41.8 bc	91	0.56	23.8 b	228 ab	54
Mean	42.6		0.51	24.5	221	53
Pr>F	0.0039		0.6096	0.0064	0.015	0.2933
CV	6		13	6	11	2

Values in columns followed by different letters are significantly different at the 5% probability level (according to Tukey-Kramer).

## Discussion

Corn did not respond to applied N at St Adolphe or Carberry, but responded significantly at Arborg and Melita and tended to increase at Morden (Figures 1-5).



Figures 1-5. Nitrogen response of corn at St Adolphe, Carberry, Arborg, Morden and Melita.

The post plant applications to simulate the Y-drop applicator did not produce different yield than post plant surface applications of SuperU. The exception was at Morden where the UAN application inadvertently splashed onto bottom leaves causing leaf burn and slightly lower yields (but ns). The application technique was modified to prevent such splash at other locations.

Few of the N decision methods or guides (Table 9) matched well with the actual N rate producing the most economic yield (Table 10). And even though visual N deficiency symptoms matched well with N rate at St Adolphe, Carberry, Arborg and Morden, they were not a particularly good guide for nitrogen sufficiency. Even where there was no yield response to N at St Adolphe, 9 of 10 plants had leaves with N deficiency symptoms (Table 4).

**Table 9:** Decision criteria for N rate recommendations for corn.

Source	
MERN	Determined using \$5/bu corn and \$0.50 /lb N and by fitting a quadratic function to yield response (where applicable).
Manitoba Agriculture	Using N recommendations from soil fertility Guide for 130 bu/ac corn and soil test N. <sup>1</sup>
NDSU	Using N calculator based on soil texture, historic yields less than 160 bu/ac, soil test N and OM, \$5/bu corn and \$0.50 /lb N. <sup>2</sup>
AgVise	Using yield goal of 150 bu/ac for Morden and 125 bu/ac for other locations and soil test N.
SPAD	Sufficiency is the N rate when SPAD index is >95%.
NDVI	Using NUE web-based N rate calculator for Minnesota corn. <sup>3</sup>
PSNT	Measured on plots with base rate of 40 and using AgVise criteria for supplementation and yield goal of 150 bu/ac for Morden and 125 bu/ac for others. See Table 1 for PSNT amounts.
Stalk nitrate	Low (<250 ppm) = N was deficient, Marginal (250-700 ppm) = possible that N shortage limited yield, Optimal (700-2,000 ppm) = yield not limited by N shortage, Excessive (>2,000 ppm) = N rates was high or some other factor reduced yield.

**Table 10:** Observed N response and predicted N needs.

Site	St Adolphe Lb N/ac	Carberry	Arborg	Morden	Melita
MERN	0	0	125	98	200+
Mb Ag	95	130	0	170	120
NDSU	0	95	0	112	93
AgVise	79	95	44	144	93
SPAD	-	40	120	40	120
NDVI	0	120	0	0	0
PSNT	10	75	10	128	55
Stalk N	80	-	-	80	-

The lack of agreement between N guidelines and actual response may be caused by:

- Higher yields than we have previously experienced.
- Higher mineralization of N from organic matter.

Soil mineralization of OM obviously contributed greatly to the high check yields. A very crude calculation of N mineralization is shown in Table 11. The estimate is based on using a 1.12 lb whole plant N uptake/bu<sup>4</sup> less soil nitrate, less starter fertilizer N. The estimated mineralization values of 56 – 160 lb n/ac are much greater than normally anticipated. Unfortunately measurements were not taken to allow consideration of nitrate-N from deeper depths or residual N at harvest.

**Table 11:** Crude estimate of nitrogen mineralization

Site	St				
	Adolphe	Carberry	Arborg	Morden	Melita
	Lb N/ac				
Check Yield bu/ac	202	120	154	178	187
Est .N uptake <sup>4</sup>	226	134	172	199	209
Soil nitrate 0-2'	71	55	106	35	57
Starter fertilizer N	4	6	10	4	4
Mineralized N est.	151	73	56	160	148
Measured OM%	7.70%	4.90%	8.60%	2.90%	4.00%

Such high corn yields and large N mineralization rates challenge N recommendations developed with current preplant planning techniques. A next step would be to use combined models of soil N dynamics and crop growth adjusted with real-time weather information.

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- <sup>2</sup> Franzen. 2014. Soil Fertility Recommendations for Corn. NDSU SF722
- <sup>3</sup> <http://www.nue.okstate.edu/SBNRC/mesonet.php>
- <sup>4</sup> Bender et al. 2013. Better Crops. Vol.97 No. 1 p7-10.

### Acknowledgements

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- Southern Potato Farms and Eric Unrau

# Responses of Pea and Canola Intercrops to Nitrogen and Phosphorous Applications (year 1 of 2 interim report)

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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 exclusive members in a population but rather are usually found as a diverse mix of different species. The potential benefits of intercropping can lead to greater than expected yields compared to the monocrop. 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 (peaola). Research by WADO (Chalmers, 2014) from a three year field plot study suggested an approximate 28% yield increase was possible by intercropping peaola and that row orientation was the main influence for this yield increase compared to nitrogen applications which did not make a significant impact. Similar research was found by Bartley *et al.* (2016) where additions of nitrogen fertilizer made no impact on total yield of peaola, despite a response in canola yield. In addition, WADO has surveyed crop inputs from 30 producer fields of peaola over Manitoba and Saskatchewan and found that nitrogen applications, despite having a positive influence on canola, had a greater negative influence on the pea yield, thus reducing total combined yield to be in a negative trend in relation to greater nitrogen application. This is likely due to supplied nitrogen fertilizers inhibiting the nodulation process between rhizobia and pea. These observations are supported by 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. It is suspected that fixed nitrogen is supplied in credit to the soil rhizosphere and that canola may be using this nitrogen, driving the fixation process even greater. Fustec *et al.* (2013) described the sharing of nitrogen between fababean and rapeseed illustrating that rapeseed accumulated 20% more nitrogen than in monocrops. Intercropping systems with pulses summarized by Xue *et al.* (2016) suggest multiple mechanisms through which nitrogen fixation drives soil chemistry processes in alkaline calcareous soils to mobilize inorganic and organic forms of phosphorus to more active forms.

WADO's survey of producer fields indicated that increasing phosphorous fertilizer rates corresponded with greater overall yield. However in this survey, only a few fields were fertilized with more than a traditional phosphorus rate. WADO hypothesises that since peaola is generally over yielding, demand and extraction of phosphorus from soils must be greater than in the monocrop of pea or canola. Despite phosphorus being complementary to canola and pea, the source, and mechanism of uptake is not understood in an intercropping system.

A simple nitrogen and phosphorus trial (Table 1) was set up near Melita MB. This report focuses on the first year of a two year small plot field trial. This trial had several objectives including:

1. To determine if intercrops of pea and canola require additional fertilizer applications such as phosphorous (a nutrient in demand by both crops) by crop yield and land equivalent ratio responses.
2. To determine response of pea and canola intercrops to nitrogen application and examine the effect of pea-nodulation on yield of crop components and total yield and land equivalent ratio.
3. To examine if any relationship (interaction) exists between combined nitrogen and phosphorous applications in pea canola intercrops in terms of yield, land equivalent ratio or nodulation in pea.

## Methods

Trials were grown on a strongly calcareous soil (~20%) near Melita MB. Plot treatments were seeded in a randomized complete block design and replicated three times.

**Table 1:** List of treatments and their respective cropping system, nitrogen and phosphorus applied fertility rates.

Treatment	Crop	Fertilizer Applied (lbs/ac actual)	
		Nitrogen	Phosphorous
1	Pea (Check)	0	30
2	Canola (Check)	90	30
3	Pea Canola	0	0
4	Pea Canola	45	0
5	Pea Canola	90	0
6	Pea Canola	0	30
7	Pea Canola	45	30
8	Pea Canola	90	30
9	Pea Canola	0	60
10	Pea Canola	45	60
11	Pea Canola	90	60

A spring soil test was taken as a composite of samples taken over the trial area prior to seeding (Table 2) to determine residual fertility levels.

**Table 2:** Pea canola intercropping trial 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 lbs/ac	P ppm Olsen	K ppm	S lbs/ac	pH	OM %
2016	Melita	NE 27-3-27W1	Waskada Loam	33	6	245	480	7.5	~2.8

Plot area was sprayed prior to seeding with Rival (0.5 L/ac), Roundup Transorb (1 L/ac) and Aim (15 ml/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 9.5" spacing. Plots were 1.44 m wide by approximately 8.5 meters long. Plots were land rolled after seeding for stones.

**Table 3:** Agronomic/field operation dates and rates

Seeding Date	Seeding Depth	Fertility	Herbicide	Water Volume	Spray Date	Harvest Date
May 6 2016	0.625	Various Rates of N+P & 27K+18S	Odyssey 17g/ac + Equinox 67ml/ac +Merge	20gal/ac	June 2 2016	August 22 2016

Target seeded plant stand for canola was 80 p/m<sup>2</sup> in the monocrop treatments. For monocrop peas, a target plant density of 80 p/m<sup>2</sup> was used. Target seeding rates for mixed row intercrops was 40 p/m<sup>2</sup> for canola and 40 p/m<sup>2</sup> for pea. Varieties used in this trial were '2020CL' for canola and 'CDC Striker' (green type) for peas.

Plots were kept weed free using a single application of Odyssey, Equinox and Merge adjuvant, at spray rates listed in table 3, when both crops reached three nodes of plant growth. Plots were desiccated with Reglone herbicide at a rate of 0.91L/ac at an application volume of 20 U.S. gal/ac at maturity (canola reached 80% 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.

Data collected on plots included emergence, grain yield, grain moisture, seed weight. In addition, pea nodules counts (5 random plants per plot), percent seed bleaching (n=50) and percent diseased seed (n=50) information was collected. Canola plots were sampled (n=10) July 10<sup>th</sup> with a SPAD 502 Plus Chlorophyll Meter [Spectrum Technologies, Aurora, IL] at mid flower as a covariate to plant health. Grain samples were separated into individual crops using a small bench seed cleaner (Eclipse Model 324, Seedbuero 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 mono crop was the inoculated check and the canola mono crop used was the 90 lbs/ac N rate check.

Soil moisture content was taken as an average of five 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 on July 12<sup>th</sup>.

Grain yield, land equivalent ratio, and pea nodule count data sets were analyzed with AgroBase Gen II statistical software using a Residual Maximum Likelihood (REML) variance components analysis also tested with interaction between nitrogen and phosphorous rate components. Least significant difference (LSD) was calculated at the 0.05 level of significance. A Pearson correlation was used to determine any relationships between nodulation values to either pea yield, pea land equivalent ratio, or total land equivalent ratio using Analyze-it 2.03 (Microsoft) statistical software.

For this interim report, only nodule counts, grain yield and land equivalent ratio results are being reported.



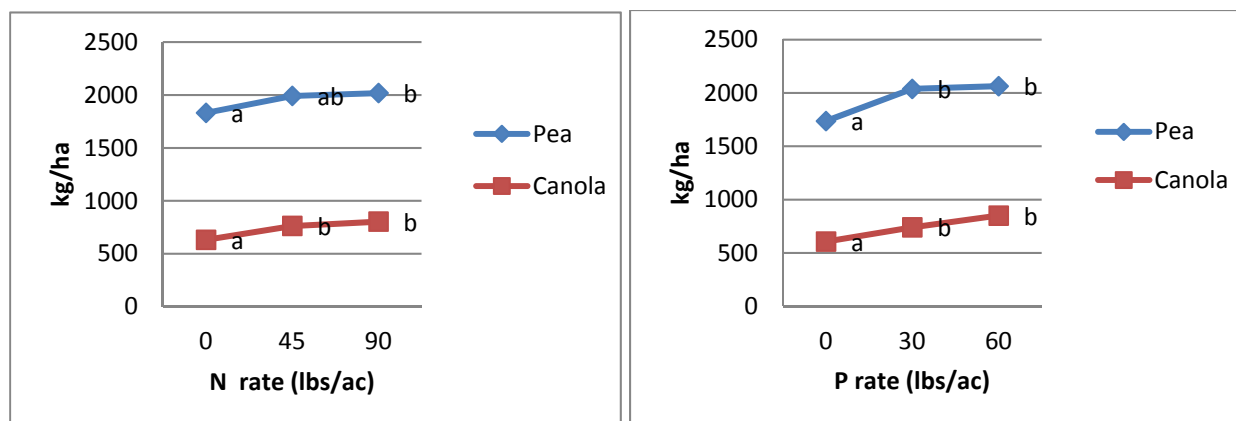
## Results

There were statistical differences among grain yield, land equivalent ratio and pea nodule counts (Table 3). Responses to only nitrogen or phosphorous was found, and there was no apparent interaction among these factors between nitrogen and phosphorous.

**Table 3:** REML analysis of pea nodulation, pea and canola yield (inclusive of monocrop check means) and land equivalent ratios (LER) in response to combinations of nitrogen and phosphorous fertilizer rates in intercropped pea and canola in 2016 for Melita, MB.

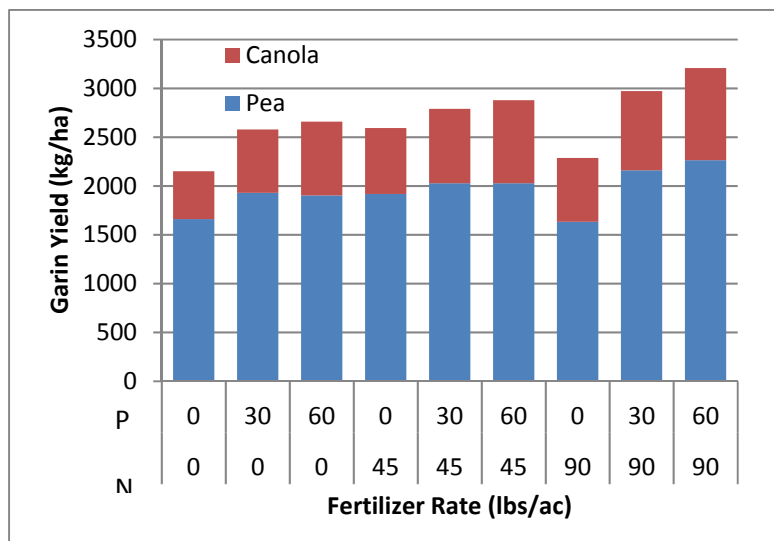
Fertilizer Rate (lbs/ac)		Pea Nodules per plant	Pea Yield kg/ha	Canola Yield kg/ha	Pea LER	Canola LER	Total LER
N	P						
0	0	29.5	1661	490	0.57	0.20	0.77
0	30	33.7	1930	648	0.67	0.27	0.94
0	60	28.7	1903	756	0.66	0.31	0.98
45	0	17.9	1918	675	0.66	0.28	0.94
45	30	24.3	2028	761	0.71	0.32	1.03
45	60	31.2	2027	851	0.71	0.36	1.07
90	0	9.5	1633	654	0.58	0.27	0.84
90	30	22.9	2160	811	0.77	0.34	1.10
90	60	22.0	2263	944	0.80	0.40	1.19
0		30.64	1831	631	0.64	0.26	0.90
45		24.49	1991	762	0.70	0.32	1.01
90		18.13	2018	803	0.71	0.33	1.05
	0	18.96	1737	606	0.60	0.248	0.85
	30	27.00	2039	740	0.72	0.307	1.03
	60	27.31	2064	850	0.72	0.355	1.08
P value	N	<b>0.002</b>	<b>0.095</b>	<b>0.019</b>	<b>0.049</b>	<b>0.022</b>	<b>0.010</b>
	P	<b>0.020</b>	<b>0.002</b>	<b>0.002</b>	<b>&lt;0.001</b>	<b>0.002</b>	<b>&lt;0.001</b>
	N x P	0.227	0.128	0.924	0.145	0.929	0.306
Approx. LSD (p<0.05)	N	6.4	177	121.3	0.06	0.05	0.09
	P	6.4	177	121.3	0.06	0.053	0.09
	N x P	10.6	293.2	200.9	0.10	0.09	0.15

Increases in nitrogen or phosphorus rates resulted in increased grain production in both pea and canola (Figure 1) compared to check values of no fertilizer applied. There was no statistical difference between nitrogen rates of 45 to 90 lbs/ac nor in phosphorus rates between 30 and 60 lbs/ac.



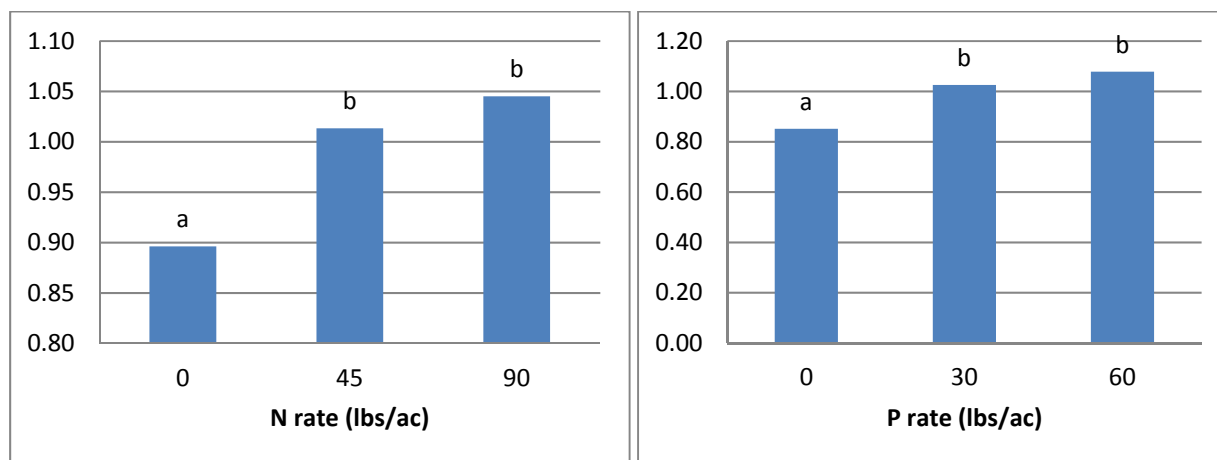
**Figure 1:** Yield response of pea and canola intercrops to nitrogen or phosphorus

There were no interactions in both crops by using a combination of nitrogen and phosphorus fertilizer together, despite a steady increase trend in total yield as rates increased (Figure 2). It appeared that when nitrogen was fully supplied at 90 lbs/ac, total grain yield was held back by lack of phosphorus when none was applied (0 P + 90 N treatment).



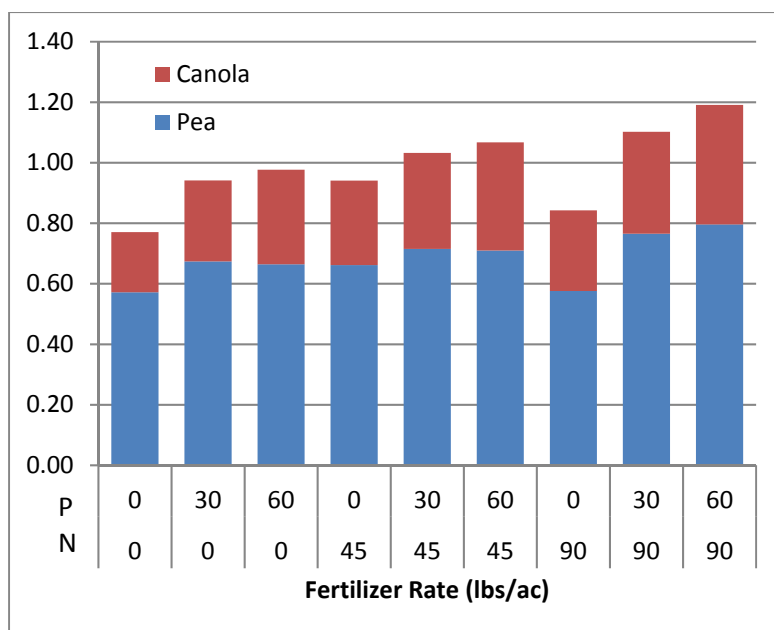
**Figure 2:** Combined REML mean yield responses of pea and canola to interactions of nitrogen and phosphorus application in 2016 from Melita, MB.

Increases in nitrogen or phosphorus rates resulted in increased land equivalent ratio (LER) in both pea and canola (Figure 1) compared to check values of no fertilizer applied. There was no statistical difference between nitrogen rates of 45 to 90 lbs/ac nor in phosphorus rates between 30 and 60 lbs/ac.



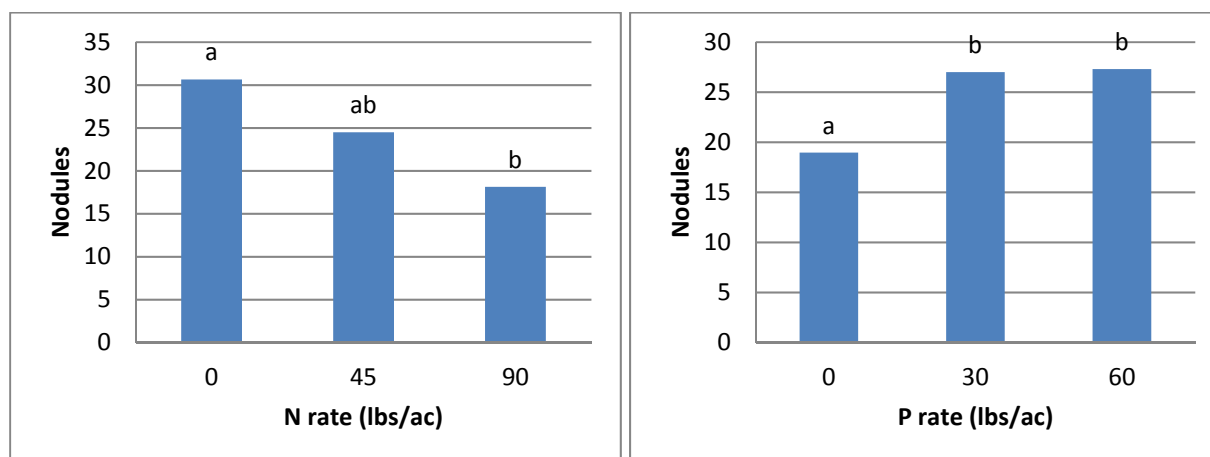
**Figure 3:** REML Total Land equivalent ratio means of pea canola intercrop response to either nitrogen or phosphorous applications in 2016 from Melita, MB.

There were no interactions in both crops by using a combination of nitrogen and phosphorus fertilizer together, despite a steady increase trend in total LER as rates increased (Figure 4). Again, it appeared that when nitrogen was fully supplied at 90 lbs/ac, total land equivalent ratio was held back by lack of phosphorus when none was applied (0 P + 90 N treatment).



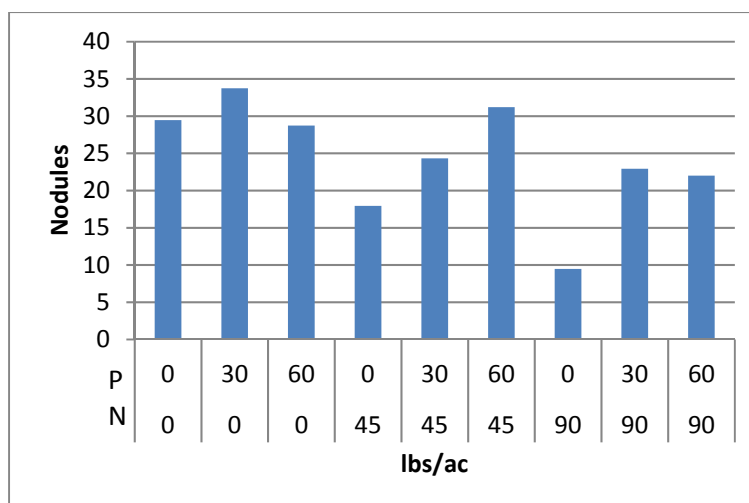
**Figure 4:** Combined REML mean land equivalent ratio (LER) responses of pea and canola to interactions between nitrogen and phosphorus application in 2016 from Melita, MB.

A significant decline in pea nodulation was observed with increased rates of nitrogen fertilizer application (Figure 5). In contrast, significant increases in pea nodulation were observed with increased rates of phosphorous. However nodulation was statistically similar between rates of 30 and 60 lbs/ac applied phosphorus.



**Figure 5:** REML mean Responses to nitrogen and phosphorous fertilizer applications in pea plant nodulation (nodules per plant) in 2016 from Melita, MB.

Despite wide swings in nodule counts (Figure 6) there was no interaction between fertilizer rates. A trend supports individual rates of nitrogen or phosphorous being inhibiting and promoting to nodulation respectively.



**Figure 6:** Combined REML mean nodulation responses of pea and canola to interactions between nitrogen and phosphorus applications in 2016 from Melita, MB.

Correlation between nodulation and pea yield, pea land equivalent ratio, or total yield was not found to be significant (Table). This suggests that benefits of intercrop yield performance are more related to the applied fertilizers than with any sort of nodulation interaction or nutrient interaction between crops as the results of nodulation.

**Table 4:** Correlation relationships of pea nodulation to pea yield, pea land equivalent ratio and total land equivalent ratio in 2016 for Melita, MB (n=26)

Relationship	r statistic	P value (two-tailed)
Nodules x Pea Yield	0.09	0.661
Nodules x Pea LER	0.07	0.738
Nodules x TLER	0.07	0.731

## Discussion

Unlike previous research in peaola with nitrogen (Holzophil et al. (2011), Chalmers (2014), Bartley et al. 2015) there was a crop yield response to applied fertilizer in both pea and canola resulting in significant increases in total yield and land equivalent ratios. As well, there was a phosphorus yield response in both crops. However, this response did not increase past 30 lbs/ac. Phosphorous responses can be difficult to achieve and this is further compounded in strongly calcareous soils such as in this soil association.

Nodulation was inhibited by applied nitrogen fertilizer and promoted by the addition of phosphorus fertilizer. It appeared that the addition of phosphorus fertilizer reduced the inhibitory effect of applied nitrogen fertilizer on nodulation however no significant interaction was found. Nodulation did not contribute to greater pea yield or land equivalent ratios, nor to total land equivalent ratios. Another site year of data may contribute further insight into the behavior of intercropping pea and canola and shed light into the role of nodulation and its contribution in pea canola intercrops. Perhaps further understanding of crop behavior with increased rates of phosphorous will be understood to help explain field survey observations collected by WADO.

Canola emergence in this trial was an issue with only 35% of a normal stand (14 plants/m<sup>2</sup>). It is possible that a different outcome may have resulted overall if canola stands were near more normal densities of 40 plants/m<sup>2</sup>. Lack of stand may have been attributed to both the use of three year old seed in addition to poor vigor and crusted post seeding soil conditions.

Final report after site year 2 will have full economic analysis of peaola intercropping complete with costs of production and net incomes based on fertility variations of each crop. Interesting dynamics should emerge while previous research from Chalmers (2014) and Bartley et al. (2016) have shown great promise growing peaola at low nitrogen rates. Moreover, when peaola is grown on somewhat phosphorous deficient calcareous soils, perhaps intercropping will promise a slightly lower need for applied phosphorus fertilizers and still provide over yielding results as summarized by Xue et al. (2016).



**Photo:** Peaola research trial. Monocrop pea on left in early flower vs intercrop peaola on right, canola also in early flower. Taken July 12, 2016 near Melita, MB.

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## Establishment Seeding Methods of Alfalfa or Sweet Clover in Spring Wheat Stands

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## Introduction

With the new interest in companion crops and soil health, producers are interested in ways to increase soil organic matter and build soil nutrient profiles for greater overall farm success. Relay crops such as clover or alfalfa with spring wheat may offer benefits such as saline soil remediation, greater water use in excessive moisture conditions, soil to tire traction control during wet condition and increased soil health benefits such as boost in nitrogen from fixation and organic matter. However, little information is available on how to best establish small seeded crops, or to adapting them in conventional systems which may use herbicides capable of injury to companion crops like alfalfa or clover. A small field trial was set up to shed light on this topic.

## Objective

To determine which establishment seeding method of alfalfa or sweet clover (pre-seed broadcast, post-seed broadcast, in furrow with wheat seed) is best suited to grow a relay crop of alfalfa or sweet clover in spring wheat stands

## Soil test

Depth	pH	N	P	K	S	Organic Matter
		ppm	ppm Olsen	ppm	lbs/ac	%
0-6"	7.8	9	4	244	50	3.1
6-24"		39			360	

## Methods

Plots were seeded into a Waskada loam near Melita, MB on June 7. Treatments were arranged in a randomized complete block design and replicated 3 times. Trial area was initially harrowed and treated with a pre-seed burnoff using glyphosate (Maverick III) applied at 1 REL/ac and 2,4-D (Ester 700) applied at 0.5L/ac, just prior to seeding.

Crop variety and seeding rate information is as follows:

Crop	Variety	Seed Weight	Target Seed Rate	Germination %	Seeding Rate
		g/1000	plants/m <sup>2</sup>		lbs/ac
Wheat	Glenn	32.1	250	90	79
Alfalfa	Ranglander	2.89	267	90	8
Sweet Clover	Norgold	1.95	267	90	5

Emergence counts on sweet clover and alfalfa were conducted June 28. Two counts of 0.25 m<sup>2</sup> were taken per plot. Mean emergence counts were converted to a plants per square meter value. A two-way analysis of variance of mean emergence was calculated using Analyze-it 2.03 statistical software (Microsoft).

**Table 1:** Mean emergence of alfalfa or sweet clover of various establishment methods such as in furrow, pre-seed broadcast, post-seed broadcast and drilled as a monocrop (without wheat).

Method	Alfalfa	Sweet Clover	Method Mean
	plants/m <sup>2</sup>		
In furrow with wheat	123	62	56
Pre-Seed Broadcast	81	45	72
Post-Seed Broadcast	109	34	63
Drilled (monocrop)	76	36	92
Grand Mean	97	44	71
CV%	21	35	51
P value	0.088	0.203	0.363
Significant?	No	No	No



## Results

There were no significant differences between seeding methods for establishing alfalfa or clover with spring wheat (Table 1). Coefficient of variation was rather high indicating more emergence counts may have been necessary to achieve more accurate values.

## Discussion

Results suggest that any method tested in this trial was equivalent in success to each other. A moderate rainfall event just after seeding (8.8 mm on June 9) was conducive to exceptional surface to subsurface germination conditions which often is a less successful seeding method in dry conditions.

The initial intent of the trial was to determine fall final emergence and better understand the grain yield dynamics of spring wheat with relay crops of alfalfa or sweet clover. However, due to an in crop herbicide product error, the plots had to be terminated mid-way through the field experiment. This trial will be repeated in 2017 to verify emergence data and investigate the viability of alfalfa and clover as cover crops in spring wheat.



**Photos:** (Left) Organic farmer near Napinka in 2016 grew Glenn spring wheat with sweet clover (pre-seed broadcast at 5 lbs/ac). Note the sweet clover growing in the saline low spots without suffering from excessive moisture. (Right) Same field during swath stage, sweet clover still growing in the understory of wheat, straight cutting would have been an option if the wheat was dry. Wheat yield was 40 bu/ac. Clover will likely yellow under the swath windrow prior to harvest, however entire field will grow clover well after harvest. Photos were taken Aug 22, 2016)

## Appendices

### *Appendix A – Weather Variable Data during the growing season at Melita site in 2016.*

Date	Max Temp *C	Min Temp *C	Average Temp *C	Precipitation (mm)	Accum. GGD
May 1 2016	18.9	-1.9	8.5	0.0	48.3
May 2 2016	21.2	5.5	13.4	0.6	56.7
May 3 2016	22.6	3.6	13.1	0.0	64.8
May 4 2016	29.5	2.4	16.0	0.0	75.8
May 5 2016	33.3	7.6	20.5	0.0	91.3
May 6 2016	21.3	4.2	12.8	0.0	99.1
May 7 2016	20.7	1.3	11.0	0.0	105.1
May 8 2016	25.2	6.6	15.9	0.0	116.0
May 9 2016	25.4	9.6	17.5	0.0	128.5
May 10 2016	13.7	5.9	9.8	1.8	133.3
May 11 2016	9.8	2.4	6.1	1.9	134.4
May 12 2016	7.5	2.0	4.8	0.0	134.4
May 13 2016	10.9	-1.1	4.9	0.2	134.4
May 14 2016	16.1	0.0	8.1	0.0	137.5
May 15 2016	21.4	0.0	10.7	0.0	143.2
May 16 2016	19.6	2.2	10.9	0.0	149.1
May 17 2016	22.7	1.9	12.3	0.0	156.4
May 18 2016	25.2	7.4	16.3	0.0	167.7
May 19 2016	27.3	11.6	19.5	0.0	182.2
May 20 2016	24.9	13.3	19.1	0.0	196.3
May 21 2016	26.7	10.3	18.5	0.0	209.8
May 22 2016	25.7	13.1	19.4	1.1	224.2
May 23 2016	24.6	9.2	16.9	0.0	236.1
May 24 2016	22.3	6.3	14.3	0.0	245.4
May 25 2016	14.8	7.0	10.9	9.1	251.3
May 26 2016	16.4	11.5	14.0	8.7	260.3
May 27 2016	18.9	11.5	15.2	17.6	270.5
May 28 2016	17.3	11.0	14.2	0.2	279.7
May 29 2016	24.0	10.1	17.1	0.0	291.8
May 30 2016	24.9	8.4	16.7	2.4	303.5
May 31 2016	13.8	8.5	11.2	53.1	309.7
Jun 1 2016	18.3	7.8	13.1	0.2	317.8
Jun 2 2016	24.5	6.1	15.3	0.0	328.1
Jun 3 2016	23.4	13.4	18.4	0.0	341.5
Jun 4 2016	26.1	11.9	19.0	0.0	355.5
Jun 5 2016	25.6	11.7	18.7	0.2	369.2

Jun 6 2016	20.6	9.2	14.9	0.0	379.1
Jun 7 2016	23.9	7.3	15.6	0.0	389.7
Jun 8 2016	28.0	13.2	20.6	0.0	405.3
Jun 9 2016	32.0	16.2	24.1	12.9	424.4
Jun 10 2016	28.1	14.8	21.5	0.2	440.9
Jun 11 2016	20.6	10.7	15.7	0.3	451.6
Jun 12 2016	22.8	12.6	17.7	6.5	464.3
Jun 13 2016	26.3	9.2	17.8	0.0	477.1
Jun 14 2016	21.9	11.5	16.7	3.1	488.8
Jun 15 2016	26.1	11.1	18.6	0.0	502.4
Jun 16 2016	28.2	15.7	22.0	0.5	519.4
Jun 17 2016	25.0	13.3	19.2	0.0	533.6
Jun 18 2016	26.9	12.8	19.9	0.0	548.5
Jun 19 2016	24.5	13.0	18.8	5.7	562.3
Jun 20 2016	24.0	9.7	16.9	0.0	574.2
Jun 21 2016	24.9	7.6	16.3	4.0	585.5
Jun 22 2016	20.2	10.8	15.5	22.6	596.0
Jun 23 2016	23.9	9.3	16.6	0.0	607.6
Jun 24 2016	27.5	13.2	20.4	9.0	623.0
Jun 25 2016	21.4	14.3	17.9	3.1	635.9
Jun 26 2016	20.2	12.9	16.6	0.0	647.5
Jun 27 2016	20.4	11.7	16.1	3.9	658.6
Jun 28 2016	25.5	9.2	17.4	0.2	671.0
Jun 29 2016	27.8	11.2	19.5	0.0	685.5
Jun 30 2016	20.2	7.6	13.9	0.2	694.4
Jul 1 2016	22.0	7.7	14.9	0.0	704.3
Jul 2 2016	25.3	13.3	19.3	0.0	718.6
Jul 3 2016	24.0	16.3	20.2	14.4	733.8
Jul 4 2016	27.8	13.6	20.7	0.3	749.5
Jul 5 2016	25.0	12.1	18.6	0.0	763.1
Jul 6 2016	25.3	9.1	17.2	0.0	775.3
Jul 7 2016	20.7	11.3	16.0	44.2	786.3
Jul 8 2016	24.0	9.2	16.6	0.2	797.9
Jul 9 2016	24.7	15.1	19.9	1.4	812.8
Jul 10 2016	28.4	15.6	22.0	0.0	829.8
Jul 11 2016	26.7	14.4	20.6	0.0	845.4
Jul 12 2016	22.8	14.3	18.6	0.0	859.0
Jul 13 2016	19.9	13.9	16.9	1.4	870.9
Jul 14 2016	22.8	13.5	18.2	0.0	884.1
Jul 15 2016	23.7	11.7	17.7	0.0	896.8
Jul 16 2016	22.1	10.2	16.2	6.7	908.0
Jul 17 2016	25.7	11.9	18.8	0.0	921.8

Jul 18 2016	27.1	10.9	19.0	0.0	935.8
Jul 19 2016	30.5	17.1	23.8	0.0	954.6
Jul 20 2016	32.3	17.9	25.1	8.4	974.7
Jul 21 2016	30.3	16.0	23.2	0.0	992.9
Jul 22 2016	28.5	12.9	20.7	0.0	1008.6
Jul 23 2016	26.7	16.8	21.8	1.0	1025.4
Jul 24 2016	25.5	14.1	19.8	0.0	1040.2
Jul 25 2016	29.7	11.1	20.4	0.0	1055.6
Jul 26 2016	26.3	15.3	20.8	0.0	1071.4
Jul 27 2016	24.2	13.0	18.6	0.0	1085.0
Jul 28 2016	24.4	7.2	15.8	0.0	1095.8
Jul 29 2016	25.7	10.1	17.9	0.0	1108.7
Jul 30 2016	28.9	14.5	21.7	0.0	1125.4
Jul 31 2016	31.8	16.0	23.9	0.0	1144.3
Aug 1 2016	26.9	16.1	21.5	1.3	1160.8
Aug 2 2016	28.4	12.9	20.7	0.0	1176.5
Aug 3 2016	32.1	12.8	22.5	0.0	1194.0
Aug 4 2016	23.5	12.2	17.9	0.0	1206.9
Aug 5 2016	26.0	9.3	17.7	0.0	1219.6
Aug 6 2016	26.7	7.9	17.3	0.0	1231.9
Aug 7 2016	27.0	16.2	21.6	0.0	1248.5
Aug 8 2016	30.3	16.5	23.4	24.4	1266.9
Aug 9 2016	22.9	14.5	18.7	0.0	1280.6
Aug 10 2016	25.4	13.7	19.6	0.0	1295.2
Aug 11 2016	26.5	13.5	20.0	0.0	1310.2
Aug 12 2016	24.0	12.6	18.3	0.0	1323.5
Aug 13 2016	25.7	11.9	18.8	0.0	1337.3
Aug 14 2016	29.2	10.0	19.6	0.0	1351.9
Aug 15 2016	29.9	14.6	22.3	0.0	1369.2
Aug 16 2016	29.4	11.6	20.5	0.0	1384.7
Aug 17 2016	32.6	12.8	22.7	0.0	1402.4
Aug 18 2016	25.2	12.7	19.0	2.8	1416.4
Aug 19 2016	21.3	11.6	16.5	1.6	1427.9
Aug 20 2016	20.9	7.6	14.3	0.0	1437.2
Aug 21 2016	28.5	9.0	18.8	0.0	1451.0
Aug 22 2016	33.7	14.2	24.0	0.0	1470.0
Aug 23 2016	27.3	13.0	20.2	0.0	1485.2
Aug 24 2016	21.0	11.1	16.1	1.9	1496.3
Aug 25 2016	23.3	8.8	16.1	0.0	1507.4
Aug 26 2016	24.6	8.6	16.6	0.0	1519.0
Aug 27 2016	24.2	9.4	16.8	0.0	1530.8
Aug 28 2016	32.2	12.1	22.2	0.0	1548.0

Aug 29 2016	24.3	8.1	16.2	0.0	1559.2
Aug 30 2016	27.2	6.3	16.8	0.0	1571.0
Aug 31 2016	24.9	10.0	17.5	0.0	1583.5
Sep 1 2016	30.9	12.7	21.8	0.0	1600.3
Sep 2 2016	27.0	18.0	22.5	0.0	1617.8
Sep 3 2016	21.8	11.4	16.6	2.6	1629.4
Sep 4 2016	18.1	9.8	14.0	0.0	1638.4
Sep 5 2016	16.0	8.8	12.4	2.3	1645.8
Sep 6 2016	18.9	6.8	12.9	0.0	1653.7
Sep 7 2016	17.5	7.7	12.6	16.6	1661.3
Sep 8 2016	17.6	7.1	12.4	0.5	1668.7
Sep 9 2016	20.7	9.3	15.0	2.6	1678.7
Sep 10 2016	21.6	4.5	13.1	0.0	1686.8
Sep 11 2016	24.7	8.3	16.5	0.0	1698.3
Sep 12 2016	12.8	6.7	9.8	0.0	1703.1
Sep 13 2016	13.7	2.6	8.2	0.0	1706.3
Sep 14 2016	20.4	1.0	10.7	0.0	1712.0
Sep 15 2016	19.1	9.8	14.5	8.4	1721.5
Sep 16 2016	19.2	3.8	11.5	3.1	1728.0
Sep 17 2016	25.6	0.9	13.3	0.0	1736.3
Sep 18 2016	25.6	11.1	18.4	0.0	1749.7
Sep 19 2016	21.9	7.0	14.5	0.0	1759.2
Sep 20 2016	22.0	1.6	11.8	0.0	1766.0
Sep 21 2016	14.0	9.7	11.9	0.2	1772.9
Sep 22 2016	18.4	3.5	11.0	0.0	1778.9
Sep 23 2016	13.6	9.4	11.5	24.6	1785.4
Sep 24 2016	24.2	11.9	18.1	10.9	1798.5
Sep 25 2016	17.0	6.4	11.7	7.8	1805.2
Sep 26 2016	18.6	3.0	10.8	0.0	1811.0
Sep 27 2016	20.6	1.4	11.0	0.0	1817.0
Sep 28 2016	20.1	1.5	10.8	0.0	1822.8
Sep 29 2016	21.4	5.9	13.7	0.0	1831.5
Sep 30 2016	17.2	10.7	14.0	0.2	1840.5
Total				359	

## *Appendix B - Background information*

### *Equipment*

#### John Deere 6140R

- Front end loader
- 3pt hitch
- Row crop capabilities
- Trimble RTK guidance
- Typically runs Wintersteiger planter, strip tiller, and sprayer

#### John Deere 5075M

- Front end loader with pallet forks
- 3pt hitch
- Greenstar guidance
- Typically runs plot seeder, sprayer, and mower

#### Wintersteiger Classic plot combine

- Straight header
- Gerringhoff 2 row corn/sunflower header
- Harvest Master/Mirus software
- Capable of individual bagging or bulk grain storage

#### Hege 140

- Straight header
- Sunflower Pans
- Capable of individual bagging or bulk grain storage

#### R-Tech plot Swather

#### Hege (Hemp combine)

#### Wintersteiger planter

- 4 Row 15-40" spacing.
- Capable of bulk seeding and individual plot
- Variable rate granular fertilizer capability
- Paired with JD6140R tractor with Trimble RTK guidance

#### SeedHawk seeder

- 9.5 inch spacing
- Dual knife opener single side band seed knife
  - Capable of placing fertilizer 1.5 inches to the side and 1.5 inches below the seed in one pass
- Set up for liquid nitrogen and dry granular blends
- Belt cone spinner

- Alloys used to quickly and accurately seed plots with even seed disbursement
- Capable of bulk seeding

#### R-Tech 24ft Sprayer

- 3pt hitch
- Offset to spray full plot without tramping
- Two 15 gal mix tanks and One 70 gal fresh water tank

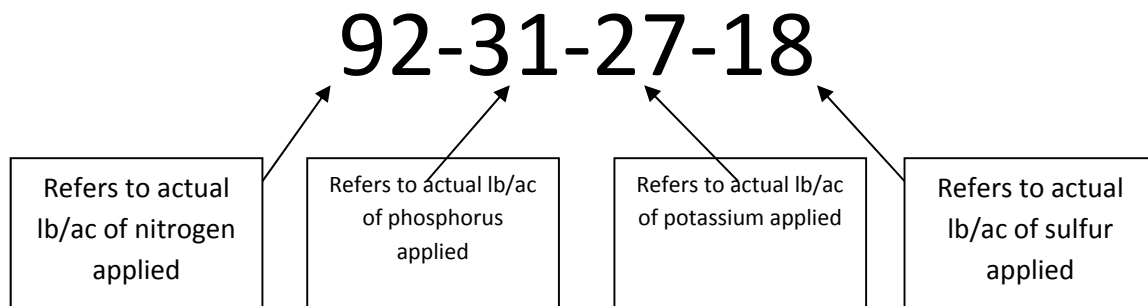
#### Elmers Strip tiller

- 4 rows – 30" spacing

### Fertilizer

#### Fertilizer used

- Nitrogen is applied in the form of liquid 28-0-0 side banded
- Phosphorus is applied in a blend with potash and sulfur unless otherwise stated. Monoammonium Phosphate (11-52-0) is the product we use. This year we put down 31lbs actual on most plots which would also give us approximately 6.5lbs of nitrogen
- Potassium is applied in a blend with phosphate and sulfur. Potash (0-0-60) is the product we use. This year most plots received 27lbs actual.
- Sulfur is applied in a blend with phosphate and potash. Ammonium sulfate (21-0-0-24) is the product we use. This year most plots got 18lbs actual which would also give us approximately 15.75lbs of nitrogen.



### Plot dimensions

Our plots are normally 9m in length by 1.44m wide. We seed pass these lengths and then trimmed them down using a 3 point hitch mower and a GPS enabled tractor.

### Spraying

Our sprayer is offset which allows us to spray half of the plot from one side, then spray the other half from the other side without having to drive through the plot. Unless otherwise stated, our standard water volume we spray at is 10 gal/ac. We have a quad sprayer which we mainly use to spray ahead of the seeder. Most trials get an application of 1REL Glyphosate, .5l/ac trifluralin, and/or 15 ml/ac carfentrazone as a pre-seed burndown. These of course depend of re-cropping restrictions. We also have a CO<sub>2</sub> pressured backpack sprayer which allows us to be able to do individual plots inside a trial.



### ***Data Processing***

We have the ability to be able to take total weight, moisture content, bushel weight, thousand kernel weight, green count and new for the coming year a protein tester. We have 2 small air screens for cleaning samples if need be.



**WADO**

Westman Agricultural  
Diversification Organization Inc.

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