



# **CROP DIVERSIFICATION 2017**

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## RR Soybean Adaptation Trials

**Project duration** – On Going

**Objectives** - Evaluate soybean variety performance & adaptation to the Carberry and Portage la Prairie regions of the Central plains.

**Collaborators** - Manitoba Pulse & Soybean Growers (MPSG)  
Manitoba Crop Variety Evaluation Team (MCVET)

### Results 2017

In 2017 among the Western Canada trials Carberry had above average grain yield (table 1) of 4066 kg/ha, ranging between 3339-4961kg/ha. In contrast to 2016 where short season varieties in general performed better than mid-season varieties, in general the longer season varieties were able to compete with the shorter season lines.

As new varieties are added each year assuming they are superior to previous lines is not always valid; especially if the said lines have not been tested intensively within the region of interest. Furthermore, even if a variety has been previously tested at the location of interest that testing will always be limited to the environmental (growing conditions) parameters of that period, which can be much different from the future testing period. Therefore, the best estimate of future performance is the examination of performance over as many years of data as possible (or even adjacent locations). This permits an understanding of sustained performance. Varieties that are consistently among the top performers across multiple years will most likely remain top performers in the near future, with the duration depending on the actual annual yield increase due to genetic improvement. For example, two varieties that appear to be stable performers from the short season category in Carberry include PS 0035 NR2 & 23-60RY with Lono R2 demonstrating consistent performance for the mid-season varieties.

For more custom comparisons of soybeans and other crops in Manitoba visit [www.seedinteractive.ca](http://www.seedinteractive.ca).

Zone	name	2017	rk	2017-2016	rk	2017-2015	rank	2017-2014	rk
VSZ	P002A63R	4130	22						
VSZ	NocomaR2	3969	29						
VSZ	S0009-M2	3938	32	3411	21				
VSZ	NSC LEROY RR2Y	3533	46	3151	24				
VSZ	P000A87R	3339	50						
SZ	PS 0035 NR2	4958	2	4045	6	3665	4	3918	6
SZ	TH 87003 R2X	4815	3						
SZ	23-60RY	4600	4	4047	5	3756	1	4015	2
SZ	Akras R2	4571	6	4084	3	3471	7	3940	5
SZ	S003-L3	4513	7	3898	9				
SZ	LS002R24N	4444	8	4058	4	3743	2	3994	4
SZ	MARDUK R2X	4275	13						
SZ	MANI R2X	4200	16						
SZ	MCLEOD R2	4191	17	3980	7	3709	3	3996	3
SZ	NSC StarCity RR2X	4179	18						
SZ	Mahony R2	4157	19	3748	15	3236	10	3739	9
SZ	22-60RY	4088	23	3599	20	3136	12	3595	11
SZ	Torro R2	4059	26						
SZ	NSC AUSTIN RR2Y	4044	27	3707	16				
SZ	S001-B1	4001	28	3695	17				
SZ	NSC RESTON RR2Y	3950	30	3778	13	3497	6	3783	8
SZ	DKB003-29	3940	31						
SZ	DKB0008-39	3921	33						
SZ	DYLANO R2X	3909	34						
SZ	PS 00095 R2	3859	36	3274	23				
SZ	NSC Watson RR2Y	3835	37	3402	22	3231	11		
SZ	PV 11S001 RR2	3779	39						
SZ	S007-Y4	3758	40	3763	14	3452	8	3852	7
SZ	PS 0044 XRN	3724	41						
SZ	Barron R2X	3669	43						
SZ	S0009-D6	3616	44						
SZ	LS TRI92RY	3535	45						
SZ	LS TRI7XT	3532	47						
SZ	TH 87000 R2X	3497	48						
SZ	DARIO R2X	3480	49						
MZ	PV 10S005 RR2	4581	5						
MZ	Lono R2	4423	9	4124	2	3615	5	4042	1
MZ	P006T46R	4385	10	3862	10				
MZ	LS SOLAIRE	4381	11	3783	12				
MZ	TH 33003R2Y	4274	14	3692	19	3389	9	3727	10
MZ	Foote R2	4229	15						
MZ	PS 0055 R2	4142	21	3694	18				
MZ	TH 88005R2XN	4084	24						
MZ	S006-W5	3859	35	3953	8				
MZ	Kosmo R2	3793	38						
MZ	NSC Newton RR2X	3684	42						
LZ	TAMULA R2	4961	1	4416	1				
LZ	EXP TH 37004R2Y	4276	12	3812	11				
LZ	LS MISTRAL	4146	20						

LZ	DS0067Z1	4065	25			
	Highest	4961		4416	3756	4042
	Average	4066		3791	3492	3873
	Lowest	3339		3151	3136	3595
	LSD	474		356	302	254
	C.V.	7.2		8.1	8.8	8.5

## Background

Variety trials for all of Manitoba's major crops are conducted across the crop growing regions of Manitoba every year by the Manitoba Crop Variety Evaluation Team (MCVET). This performance data, along with variety characteristic information, is summarized in "SEED MANITOBA" and online at [www.seedinteractive.ca](http://www.seedinteractive.ca). Both formats provide long term yield data as well as annual yield comparisons at various locations.

## Materials & Methods

Experimental Design: Randomized complete block design with 3 replicates  
Seeding Date: May 15, 2017  
Harvest Date: September 28, 2017  
Fertility: 40lbs Side Banded actual Phos/acre (11-52-0-0); Granular Inoculum placed with seed.  
In Crop Weed Control: Roundup applied on May 31<sup>st</sup>, 2017  
Fungicide: No Fungicide was applied

## Convention Soybean Adaptation Evaluation

**Project duration** – On Going

**Objectives** - Evaluate newly registered Conventional Soybean varieties for adaptation and yield performance in the Central Plains region of Manitoba.

**Collaborators** - Manitoba Pulse & Soybean Growers (MPSG)  
Manitoba Crop Variety Evaluation Team (MCVET)

### Results

Entries and yield results for Carberry are in table 1. CDC Prudence is the check variety. Overall yield for conventional soybeans was above average in 2017, both relative to other locations and historically speaking. There were no statistical differences among varieties at Carberry in 2017 with the exception of FJORD, which yielded significantly less than other entries. For more custom comparisons of soybean varieties and other crops in Manitoba visit [www.seedinteractive.ca](http://www.seedinteractive.ca).

Table 1: Conventional soybean varieties and yield performance at Carberry in 2017.

Name	kgha	bu/ac	% OAC Prudence
AAC Halli	3752.1	<b>59.7</b>	97
OT 16-01	3956.0	<b>62.9</b>	103
OT 16-02	4001.1	<b>63.6</b>	104
AAC Edward	3866.2	<b>61.5</b>	100
<b>OAC Prudence</b>	<b>3852.6</b>	<b>61.3</b>	100
Answer	4065.9	<b>64.7</b>	106
FJORD	3089.3	<b>49.1</b>	80
Kebeck	4009.2	<b>63.8</b>	104
<b>CV</b>		<b>9.8</b>	
<b>LSD</b>		<b>10.5</b>	
<b>GRAND MEAN</b>		<b>60.8</b>	
<b>Entry Significant</b>		YES	

### Background

Variety trials for all of Manitoba's major crops are conducted across the crop growing regions of Manitoba every year by the Manitoba Crop Variety Evaluation Team (MCVET). This performance data, along with variety characteristic information, is summarized in "SEED MANITOBA" and online at [www.seedinteractive.ca](http://www.seedinteractive.ca). Both formats provide long term yield data as well as annual yield comparisons at various locations.

### Materials & Methods

Experimental Design: Randomized complete block design with 3 replicates  
Seeding Date: May 15, 2017

Harvest Date:	September 28, 2017
Fertility:	40lbs Side Banded actual Phos/acre (11-52-0-0); Granular Inoculum placed with seed.
In Crop Weed Control:	Poast Ultra applied June 8, 2017 Basagran Forte applied June 19, 2017
Fungicide:	No Fungicide was applied

# Effect of Soil Temperature at Different Planting Dates, and of Residue Management on Soybean

**Project duration** - 2014 – 2018

**Objectives** - A better understanding of the impact of management practices, including planting date and residue management practices, and of early-season soil temperatures, on soybean growth, yield and quality in Manitoba may help to refine management practices in order to reduce risks associated with cold temperatures and thereby to optimize soybean production. The objectives of this study were:

1. Experiment 1: to determine the effect of soil temperature at different planting dates on soybean growth, yield and quality
2. Experiment 2: to determine the effect of residue management on soybean growth, yield and quality

**Collaborators** - Manitoba Pulse & Soybean Growers  
Ramona Mohr – Research Scientist, AAFC  
Craig Linde – Diversification Specialist, Manitoba Agriculture  
James Frey – Diversification Specialist, Manitoba Agriculture

## Results/Conclusions

Results of the current study suggest that delaying planting beyond the currently recommended planting window of May 15th to 25th has the potential to result in significant yield penalties and may present a significant production risk. Under the conditions of this study, delayed planting resulted in marked yield declines in most site-years at Brandon, Carberry and Portage (Figure 2). Delaying planting in this study, typically by 9 to 15 days (from the 3rd to 4th week of May into June), resulted in 40 to 80% the yield of the May planting dates depending upon the site-year. Further, at one of three years at Roblin, significant frost damage occurred with the later planting date resulting in negligible yields.

A strong and clear relationship between soil temperature at planting and soybean performance was not evident under the conditions of the current study. In Study 1, soil coverings installed in the field in early spring often produced a range of soil temperatures at planting, and for varying lengths of time thereafter, but differences in soil temperature at planting were not consistently associated with differences in soybean yield (Figure 2). This was the case although soil temperatures at planting were often below the 18 to 22°C suggested as ideal based on current provincial recommendations, and occasionally <10°C. Of five cases where yields were higher in “warm” treatments that had been covered by black plastic than in “cold” treatments covered by Styrofoam, warmer temperatures at planting were evident in the “warm” treatments in only three cases.

Similar general trends were evident in Study 2, which assessed the effect of residue management practices preceding soybean on soil temperature and its relationship to soybean performance. Although residue management frequently influenced early-season soil temperature and/or moisture, and occasionally affected the days to crop emergence, effects on soybean yield were limited (2 of 12 site-years) (Figure 3). In part, because soybeans had been planted within the recommended planting dates for Manitoba and when soil temperatures



exceeded the critical 10°C, the effects of residue management on growth and yield may have been less than under more marginal conditions.

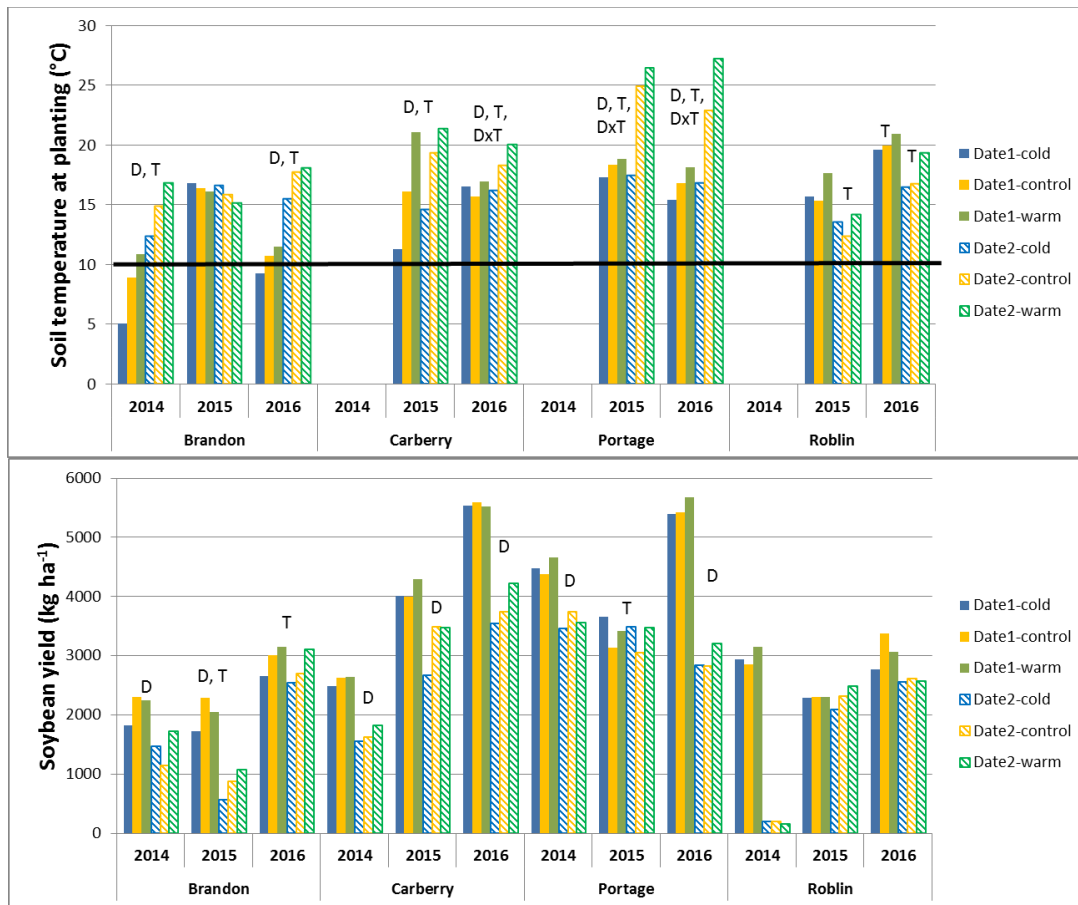


Figure 2. Effect of planting date and soil temperature treatment on soil temperature measured at time of planting and on soybean yield at Brandon, Carberry, Portage and Roblin (2014-16). (D, T and DxT indicate significant ( $P \leq 0.05$ ) effects of planting date (D), temperature treatment (T), and DxT interactions based on analysis of variance.)

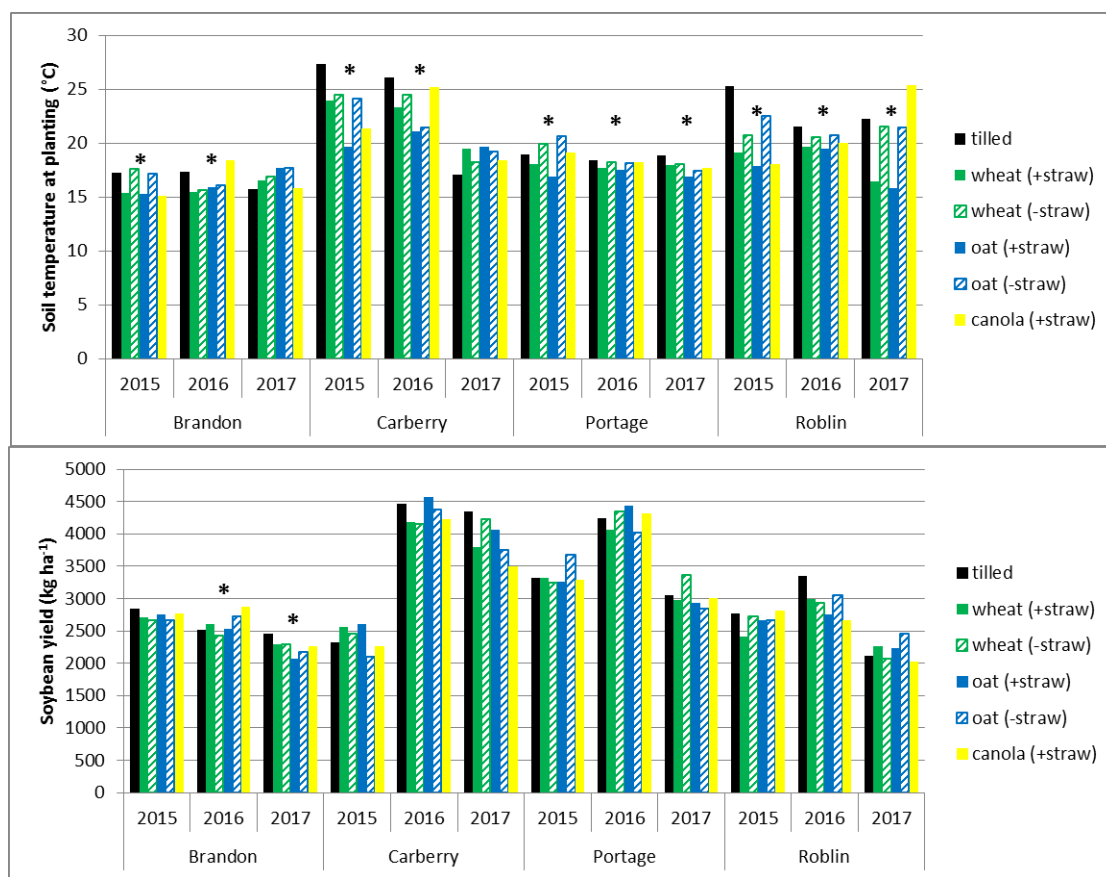


Figure 3. Effect of residue management practices on soil temperature measured at time of planting and on soybean yield at Brandon, Carberry, Portage and Roblin (2015-17). (\* indicates a significant ( $P \leq 0.05$ ) effect of residue management treatment based on analysis of variance by site-year.)

In conclusion, managing the risk of cold temperature damage in soybean crops grown in short-season areas can be most effectively addressed with an integrated approach. Selection of a well-adapted cultivar suited to local growing conditions is key, as are appropriate planting dates and soil temperature conditions. Current provincial recommendations suggest that soybean be planted from May 15th to May 25th, or when the average soil temperature has reached 10°C, with 18 to 22°C considered ideal (Manitoba Agriculture 2013). These research findings suggest that delaying planting beyond the recommended window may result in a significant yield penalty and may expose the crop to fall frost damage. The relationship between soil temperature at planting and soybean growth and yield appears to be more complex, however. The potentially damaging effects of chilling injury, which occurs when soybean seed imbibes water of <10°C particularly during the first 24 hours after planting, is well-recognized, and underlies the recommendation to delay seeding until the average soil temperature has reached 10°C. However, the current study did not identify a clear relationship between soil temperature at planting and soybean establishment or yield when soil temperatures were >10°C. While the current research findings suggest that warmer temperatures at planting may occasionally enhance emergence and increase seed yield when soil temperatures at planting are >10°C, warmer soil temperatures at planting did not consistently enhance crop emergence or translate into higher yields. When soybeans were planted within or near the recommended planting date window and soil temperatures at planting were above the critical 10°C, residue management practices like tillage and straw removal that often increased soil temperature to varying degrees

(<1 to 5°C) rarely increased seed yield. In order to better understand the effects of residue management practices on soybean growth and yield under a broader range of conditions, a field study was initiated in fall 2017 which will look at the effect of a range of residue management practices including burning, tillage, stubble height and straw removal on soybean planted before and during the recommended planting date window

## **Background**

The Canadian prairies represent the northern fringe of soybean production in North America. Growing soybean in this region was long considered unlikely because few areas had more than 120 consecutive frost-free days, and temperatures during the frost-free period were too cold for adequate crop development (Burnett et al. 1985).

With the introduction of early-maturing cultivars adapted to Manitoba conditions, the soybean industry in this province has grown rapidly over the past decade. Production has expanded from traditional areas in the Red River Valley to other regions, leading to a record soybean acreage of 2.3 million acres in 2017 (Statistics Canada 2017).

Despite ongoing improvements to soybean cultivars, the short growing season and climate in Manitoba can be a significant production risk for this long-season crop. Frost and near-freezing conditions in spring and fall can damage soybean. Early planting in cool and wet conditions can increase seedling disease and reduce plant stand (NDSU Extension Service 2010). Soil temperature at seeding, together with soil moisture conditions, may impact establishment (Helms et al. 1996a; Helms et al. 1996b; Wuebker et al. 2001).

Potential may exist to reduce the risks associated with cool temperatures, frost and/or near-freezing conditions through management. Selection of well-adapted cultivars suited to short-season areas is critical. However, proper choice of planting date, and management of preceding crop residue, may influence early-season temperatures and therefore crop growth. A better understanding of the impact of these factors on soybean growth, yield and quality in various regions within Manitoba may help to refine management practices in order to reduce production risk and optimize soybean production.

**Planting date:** Manitoba recommendations indicate that soybean should be planted from May 15th to May 25th, or when the average soil temperature has reached 10°C, with 18 to 22°C considered ideal (Manitoba Agriculture 2013). North Dakota recommendations suggest that soybeans not be planted earlier than five days before the average date for the last killing frost in order to reduce the risk of spring frost damage (NDSU Extension Service 2010).

Manitoba production data indicates that soybean yield generally decreases with delayed seeding (Manitoba Agricultural Services Corporation 2013), although research suggests this effect may vary among regions in Manitoba. In seeding date trials in the Morden/Carman area conducted from 2006 through 2008, yield was similar for May planting dates but declined with mid-June planting dates (Manitoba Agriculture 2011). At Arborg, yield declined when planting was delayed until late May and declined further when planting was delayed until mid-June. Soil temperature at planting may have influenced the results obtained. As well, because a killing frost did not occur until late September in these studies, yield differences among planting dates were likely smaller than if an early fall frost had occurred.

In studies conducted in North Dakota, early planting of late-maturing cultivars (Maturity Group I and II) did not increase yield, but early planting of early-maturing cultivars (Maturity Group 0) that were adapted to the region increased yield when an early fall frost occurred (Halvorson et al. 1995). Although early planting increased the risk of spring frost damage, this approach allowed the option of re-planting.

**Effect of residue management:** Soybean may be grown under a range of cultural practices, from conventional to reduced tillage systems (NDSU Extension Service 2010). Residue

management practices may influence the micro-environment the crop is exposed to, both above and below the soil surface. In field studies near Brandon, MB, the effect of wheat residue management (short stubble, tall stubble, cultivated) on canola, pea and wheat was assessed from 2000-02 (Volkmar and Irvine 2003). In this study, stubble delayed day-time soil warming and night-time cooling at the soil surface and at a depth of 7.5 cm, and generally increased day-time and decreased night-time air temperature compared to the cultivated treatment. Stubble treatments also typically had higher soil moisture levels than the cultivated soil. Although these micro-environment effects contributed to increased emergence and vegetative growth, especially for tall stubble, there was minimal effect on crop yield. Little information is available regarding the effect of stubble management on soybean in Manitoba.

Another aspect of residue management that could potentially affect crop growth relates to the type of residue. Anecdotal information suggest that, in the case of canola, direct seeding into oat stubble may sometimes slow emergence and increase the risk of frost damage compared to other cereal stubble types. This effect has been attributed to the “brightness” of the oat straw relative to other cereals, which may reflect more incident light and result in cooler soil and air temperatures near the soil surface. This effect has not been documented in Manitoba however.

## **Materials & Methods**

A series of field studies were conducted at each of Brandon, Carberry, Portage and Roblin during the period 2014 through 2017 as outlined below. Two experiments were conducted at each site over three field seasons: Experiment 1: Effect of soil temperature at different planting dates on soybean growth, yield and quality (2014-16) and Experiment 2: Effect of residue management on soybean growth, yield and quality (2015-17).

### Experimental design and management

Experiment 1. Effect of soil temperature at different planting dates on soybean growth, yield and quality

Small plot field experiments were conducted at four Manitoba sites (Brandon, Carberry, Portage, Roblin) in each of 2014 through 2016. Details regarding the experimental sites are summarized in Table 1. A randomized complete block design (RCBD) with four replicates was established, with treatments arranged in a split plot design consisting of two planting dates (main plots) and three soil temperature treatments (subplots). At Roblin only, main plots were not randomized due to logistical factors; therefore early and late planting dates were considered as two separate studies for the purpose of analysis.

Planting dates consisted of an earlier and later planting date, with the earlier planting date typically occurring from mid- to late May, and the later planting date typically 9 to 15 days later (Table 1). Three soil temperature treatments, designated as “cold”, “control” and “warm” depending upon the soil coverings applied, were established as subplots. To produce soil temperature treatments, plots were covered in early spring with: 1) styrofoam and/or reflective material to insulate the soil (“cold”); 2) black plastic to warm the soil (“warm”); and 3) white+clear plastic to reflect the sun (“control”) (Figure 1).

Soil coverings were typically removed shortly before seeding to allow some drying of the soil surface prior to seeding, while maintaining soil temperature differences. Soybean (RR2, Maturity grouping 00.1, short-season zone) commercially treated with seed treatment and Rhizobium was solid-seeded directly into untilled soil at a rate of 50 pure live seeds per m<sup>2</sup>. The germination rate of the seedlots used ranged among years from 97 to 100%. Soybeans

were grown using generally-accepted agronomic practices with respect to seeding, fertilizer, weed, and harvest management (Table 1).

#### Experiment 2: Effect of residue management on soybean growth, yield and quality

Small plot field studies were initiated at four Manitoba sites (Brandon, Carberry, Portage, Roblin) in 2014. Residue management treatments were imposed at each site in 2014, 2015 and 2016, with soybean established into these treatments in each of 2015, 2016 and 2017. Details regarding experimental sites are summarized in Table 2. A randomized complete block design (RCBD) with four replicates was established, comprised of six residue management treatments: control (wheat residue, fall tilled), wheat with straw chopped and retained (standing stubble), wheat with straw removed (standing stubble), oat with straw chopped and retained (standing stubble), oat with straw removed (standing stubble), and canola with straw chopped and retained (standing stubble).

During the year of stubble establishment, hard red spring wheat, oat, and hybrid canola were established at each site using the same seedlot, with seeding rates adjusted to achieve 250, 300 and 120 plant m<sup>-2</sup>, respectively. Generally-accepted agronomic practices with respect to seeding, fertilizer, weed, and harvest management were applied. In most site-years, residue management treatments were imposed in the fall prior to soybean as per treatment (Table 2). Exceptions were Roblin where tillage treatments were conducted in the spring prior to soybean establishment, and Brandon in 2014 where the fall tillage treatment was delayed until spring.

Soybean (RR2, Maturity grouping 00.1, short-season zone) commercially treated with seed treatment and Rhizobium was solid-seeded at a rate adjusted to achieve 40 plants per m<sup>2</sup>. The same cultivar and seedlots were used in Experiments 1 and 2. Soybeans were grown using generally-accepted agronomic practices with respect to seeding, fertilizer, weed, and harvest management.

#### Data collection and analysis (Experiments 1 and 2)

Similar datasets were collected from Experiments 1 and 2. Soil temperatures were recorded hourly using self-logging sensors (Model DS1922L, iButton Temperature Logger, Maxim Integrated) installed at a 5 cm depth in each plot following planting at two sites in 2014 (Brandon and Carberry) and all four sites in 2015 and 2016 for Experiment 1. In Experiment 2, two iButton loggers were installed in each plot at a 5 cm depth. One logger was installed at the front and back of each plot, approximately 1 m from the plot edge.

In both experiments, soil temperature and moisture were also measured at seeding depth at time of planting using a manual digital thermometer (Key-Chain Thermometer, Fisher Scientific) and soil moisture probe (ML3 ThetaProbe, Delta-T Devices). Plant counts were conducted periodically for several weeks after planting, from the first evidence of crop emergence until no further change in plant stand was detected. At crop maturity, plots were harvested by plot combine and cleaned yields determined. Test weight, % oil and % protein of seed was determined using an Infratec™ 1241 Grain Analyzer (Foss North America Inc., Eden Prairie, MN), and thousand seed weight determined using a mechanized seed counter. Date of emergence and crop growth stage were determined based on periodic visual assessment of the field experiments.

Both early-season biomass and Greenseeker measurements were collected in an effort to quantify early-season growth, in addition to the repeated plant counts conducted. Early-season biomass was determined by hand-harvesting 2-1 m lengths of row several weeks after planting and determining dry weight. Preliminary analysis of the early-season biomass data demonstrated a high degree of variability in most site-years which limited the value of this measurement for identifying treatment effects; therefore, these data have not been included in the current report. Greenseeker measurements were collected using a handheld Greenseeker

device periodically during the early part of the growing season; however, the presence of volunteers and/or weeds in some site-years influenced the readings obtained and therefore these data have not been included in the current report.

For the purpose of this report, data from each experiment were analyzed by site-year. For Experiment 1, data were analyzed as a split plot using Proc Mixed in SAS, with treatments considered fixed effects and replicates considered random effects. Data collected at Roblin were analyzed as a randomized complete block design separately for each planting date because planting date treatments had not randomized at this site for logistical reasons. For Experiment 2, data were analyzed as a randomized complete block design using Proc Mixed in SAS, with treatments and replicates considered fixed and random effects, respectively. A combination of Tukey's test and contrast analysis were used to identify treatment effects of interest. A P-value  $\leq 0.05$  was considered significant.

Sub-daily soil temperature (TSOIL) treatment means were calculated from the self-logging sensor data based on the 3-hour average values for each plot (i.e.  $n = 8$  for TSOIL for every plot each day). Only those site-years where the sensors were installed the same day as planting and where data was retrievable from at least 3 out of 4 treatment replications were retained for further analyses from each experiment. Cumulative soil degree hours less than  $10^{\circ}\text{C}$  ( $\sum\text{SDH} < 10^{\circ}\text{C}$ ) were calculated as the summation of negative values of  $\text{TSOIL} - 10^{\circ}\text{C}$ , and cumulative soil degree hours greater than  $10^{\circ}\text{C}$  ( $\sum\text{SDH} > 10^{\circ}\text{C}$ ) were calculated as the summation of positive values of  $\text{TSOIL} - 10^{\circ}\text{C}$ . Preliminary statistical analyses of the TSOIL data indicated several interactions between year and site (Experiment 1 and Experiment 2), as well as site and planting dates within years (Experiment 1), so analyses focused in on each planting date separately for individual site-years to evaluate the significance of the temperature (Experiment 1) and residue (Experiment 2) treatments imposed for the studies. Sub-daily TSOIL data were analyzed for Experiment 1 for each site-year planting date with a univariate repeated-measures analysis of variance (ANOVA) model where plot (i.e. replicate) was considered a random effect, and treatment, days after planting (DAP) and the interaction term (treatment x DAP) were considered fixed effects using JMP software (version 13, SAS Institute, Inc.). The significance of the temperature (Experiment 1) and residue (Experiment 2) treatments imposed on  $\sum\text{SDH} < 10^{\circ}\text{C}$  for 20 DAP and  $\sum\text{SDH} > 10^{\circ}\text{C}$  for 30 DAP were tested using one-way ANOVA in SigmaPlot (version 13, Systat Software, Inc.). Where data did not meet the assumptions for parametric ANOVA (i.e. distribution not normal and/or unequal variances), the equivalent non-parametric statistical test was used (i.e. Kruskal-Wallis one-way ANOVA on ranks).

## Pea Adaptation Evaluation

**Project duration** – On Going

**Objectives** - Evaluate newly registered pea varieties for adaptation and yield performance in the Central Plains region of Manitoba.

**Collaborators** - Manitoba Crop Variety Evaluation Team (MCVET)

### Results

Entries and yield results for Carberry and table 1 & 2. CDC Meadow is the check variety. The greatest yielding varieties at Carberry in 2017 included AAC Carver, BELMONDO, CDC Inca and P0520-116. Table 3 displays long term mean estimates of pea performance within Manitoba, showing that overall 2017 was an above average year with regard to grain yield for Carberry. For more custom comparisons of Pea varieties and other crops in Manitoba visit [www.seedinteractive.ca](http://www.seedinteractive.ca).

Table 1: Pea varieties and yield performance at Carberry in 2017.

<b>Name</b>	<b>kgha</b>	<b>Bu/Ac</b>	<b>% CDC Meadow</b>
AAC Ardill	6204.0	92	97
AAC Carver	7492.0	111	117
AAC Comfort	6386.5	95	100
AAC Lacombe	6542.4	97	103
AAC Liscard	6014.1	89	94
AAC Radius	5702.9	85	89
AAC Royce	6535.8	97	102
Agassiz	6196.4	92	97
ANGELUS	6444.9	96	101
BELMONDO	7147.4	106	112
CDC Amarillo	7339.3	109	115
CDC Golden	5685.7	84	89
CDC Greenwater	6392.8	95	100
CDC Inca	6984.9	104	110
CDC Limerick	6487.8	96	102
<b>CDC Meadow</b>	<b>6378.0</b>	<b>95</b>	<b>100</b>
CDC Patrick	6429.5	95	101
CDC Saffron	6154.9	91	97
CDC Striker	5463.6	81	86
EQUIP	6846.3	102	107
P0520-116	7257.9	108	114
SPOT	6358.4	94	100
<b>CV</b>	<b>5.9</b>	<b>5.9</b>	

<b>LSD</b>	631.7	9
<b>Prob. Entry</b>	0.0000	YES
<b>GRAND MEAN</b>	6474.8	96

Table 2: Long Term yield (BLUP) mean estimates of Pea varieties grown in Manitoba.

Variety	kgha	bu/ac	N*	% CDC_Meadow	Testing Period
AAC Ardill	4913	73	16	100	2014 - 2017
AAC Carver	5419	80	10	110	2016 - 2017
AAC Comfort	4572	68	5	93	2017 - 2017
AAC Lacombe	5109	76	14	104	2015 - 2017
AAC Liscard	4537	67	5	92	2017 - 2017
AAC Radius	4246	63	15	86	2014 - 2017
AAC Royce	4758	71	13	97	2015 - 2017
Agassiz	4957	74	53	101	2007 - 2017
ANGELUS	4884	73	6	99	2017 - 2017
BELMONDO	4923	73	6	100	2017 - 2017
CDC Amarillo	5069	75	16	103	2014 - 2017
CDC Golden	4567	68	58	93	2003 - 2017
CDC Greenwater	4847	72	15	99	2014 - 2017
CDC Inca	5246	78	14	107	2015 - 2017
CDC Limerick	4872	72	15	99	2014 - 2017
CDC Meadow	4922	73	66	100	2004 - 2017
CDC Patrick	4554	68	51	93	2007 - 2017
CDC Saffron	4947	73	30	101	2010 - 2017
CDC Striker	4412	65	70	90	2003 - 2017
EQUIP	4731	70	6	96	2017 - 2017
P0520-116	5357	80	6	109	2017 - 2017
SPOT	4554	68	6	93	2017 - 2017
<b>LSD</b>	<b>297</b>	<b>4</b>		<b>6</b>	

\*N – number of total sites included in estimate during testing period.

## Background

Variety trials for all of Manitoba's major crops are conducted across the crop growing regions of Manitoba every year by the Manitoba Crop Variety Evaluation Team (MCVET). This performance data, along with variety characteristic information, is summarized in "SEED MANITOBA" and online at [www.seedinteractive.ca](http://www.seedinteractive.ca). Both formats provide long term yield data as well as annual yield comparisons at various locations.

## Materials & Methods

Experimental Design: Randomized complete block design with 3 replicates  
Seeding Date: May 13, 2017  
Harvest Date: August 28, 2017



Fertility:	130lbs 20-0-0-24 Side Banded at seeding plus inoculation with seed.
In Crop Weed Control:	Poast Ultra applied June 8, 2017 Basagran Forte applied June 19, 2017
Fungicide:	No Fungicide was applied

## Sunflower Adaptation Evaluation

**Project duration** – On Going

**Objectives** - Evaluate newly registered oil and confection type sunflower varieties for adaptation and yield performance in the Central Plains region of Manitoba.

**Collaborators** - National Sunflower Association of Canada (NSAC)  
Manitoba Crop Variety Evaluation Team (MCVET)

### Results

Entries and yield results for Carberry and table 1 & 2. P63ME70 is the check variety. The greatest yielding varieties at Carberry in 2017 included N4HM354 DMR and Cobalt II. Tables 3 & 4 display long term mean estimates of Sunflower performance within Manitoba, showing that overall 2017 was an average year with regard to grain yield for Carberry. For more custom comparisons of Pea varieties and other crops in Manitoba visit [www.seedinteractive.ca](http://www.seedinteractive.ca).

Table 1: Oil Sunflower varieties and yield performance at Carberry in 2017.

name	Kg/ha	% P63ME70
Honeycomb NS	3143.8	83.4
P63ME70	3771.3	100.0
P63ME80	3603.1	95.5
Talon	3398.4	90.1
P63HE60	3758.5	99.7
8H288CLDM	3271.9	86.8
MY8H131CL	3472.1	92.1
MY8H270CL	3384.2	89.7
Cobalt II	3919.8	103.9
N4HM354 DMR	4138.6	109.7
CV	4.3	
LSD	266.7	
GRAND MEAN	3586.2	
Entry Significant	YES	

Table 2: Confection Sunflower varieties and yield performance at Carberry in 2017.

name	kgha	% 6946 DMR
6946 DMR	3750	100
NSKM53777	3521	94
Panther DMR	2947	79
57007	1746	47
57009	1708	46
57085	3607	96

CV	10.3
LSD	537
GRAND MEAN	2880
Entry	
Significant	Yes

Table 3: Long Term yield performance for Oil Sunflowers in Manitoba.

Type	Variety	kgha	%P63ME70	n
High Oleic	8H288CLDM	3384	94	6
High Oleic	Cobalt II	3704	102	9
High Oleic	N4HM354 DMR	4011	111	6
High Oleic	P63HE60	3574	99	6
Mid Oleic	3495 NS/CL/DM	4125	112	3
Mid Oleic	63N82	3231	91	4
Mid Oleic	Defender Plus	3074	92	5
Mid Oleic	Falcon EX	3137	94	5
Mid Oleic	P63ME70	3482	100	11
Mid Oleic	P63ME80	3509	101	11
Mid Oleic	Talon	3731	104	6
Oil	8N270CLDM	3648	98	3
Oil	E84131CLDN	3493	97	6
Oil	Honeycomb NS	3069	85	6

Table 4: Long Term yield performance for Confection Sunflowers in Manitoba.

Type	Variety	kgha	%6946 DMR	n
Non-Oil	57007	3182	88	4
Non-Oil	57009	2901	80	4
Non-Oil	57085	3956	110	4
Non-Oil	6946 DMR	3406	100	15
Non-Oil	EX 64508	3342	83	2
Non-Oil	Jaguar CL	3010	95	9
Non-Oil	Jaguar DMR	4069	97	3
Non-Oil	NSKM5377	3513	97	4
Non-Oil	Panther DMR	3449	92	6
Non-Oil	RH400 CL	2987	94	9
Non-Oil	X9180	3795	95	4

## **Background**

Variety trials for all of Manitoba's major crops are conducted across the crop growing regions of Manitoba every year by the Manitoba Crop Variety Evaluation Team (MCVET). This performance data, along with variety characteristic information, is summarized in "SEED MANITOBA" and online at [www.seedinteractive.ca](http://www.seedinteractive.ca). Both formats provide long term yield data as well as annual yield comparisons at various locations.

## **Materials & Methods**

Experimental Design:	Randomized complete block design with 3 replicates
Seeding Date:	May 11, 2017
Harvest Date:	Lines were hand cut based on individual maturity (October)
Fertility:	40lbs Side Banded actual Phos/acre (11-52-0-0); Granular Inoculum placed with seed.
Weed Control:	Authority applied May 13, 2017 Post & Assert applied June 6, 2017

# Quinoa Adaptation Evaluation

**Project duration** – On Going

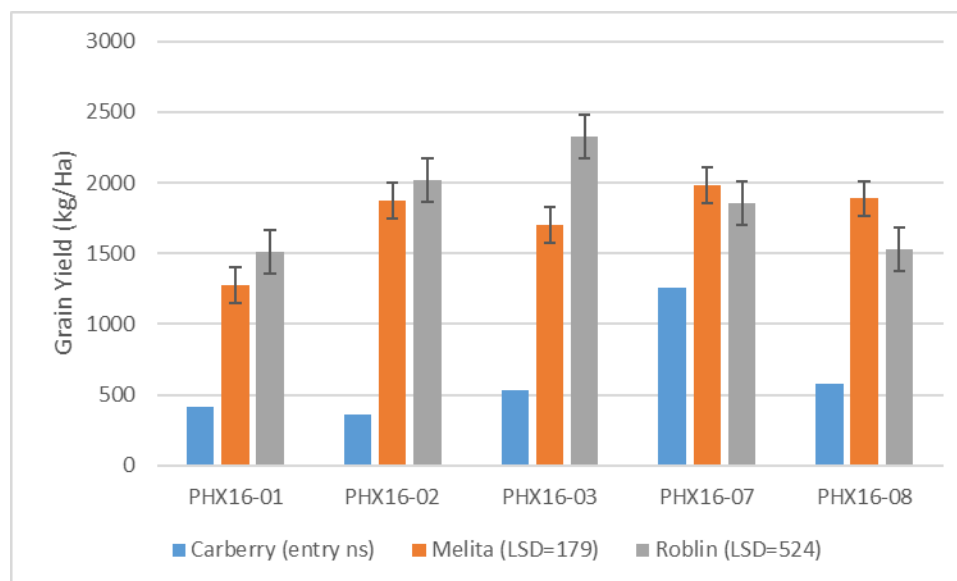
**Objectives** - Evaluate quinoa lines/varieties for adaptation and yield performance in the Central Plains region of Manitoba.

**Collaborators** - Phillex Inc.

## Results

Entries and yield results for Carberry and the other Diversification Centres in Manitoba that participated are in Figure 1. Due to stand establishment problems at Carberry plot variability was high and no differences could be detected. Yield within Manitoba otherwise were very good in 2017 with many plots falling above 1500 kg/ha. More work is needed regarding pest control, optimal planting densities and seeding date; however, the yield potential of new lines being introduced to Manitoba are showing promise.

Figure 1: Quinoa lines and yield performance at Manitoba DC locations in 2017.



## Background

Quinoa is a broadleaf annual plant that produces small, round seeds with excellent nutritional qualities [1,2]. The crop can be grown in all agricultural regions of Manitoba. Phillex Ltd, based in Portage la Prairie, participated with all four Manitoba Diversification Centres to conduct the quinoa variety trial.

## Materials & Methods Carberry

Experimental Design: Randomized complete block design with 3 replicates

Seeding/Harvest Dates: May, 2017

Location	Seeding Date	Harvest Date
Carberry	May 13, 2017	

Harvest Dates: September 28, 2017

Fertility: Added (available) lbs/acre of actual

Location	Nitrogen	Phosphorus	Potassium	Sulfur
Carberry	Seeding: 27 (33) 20-0-0-24  Flowering 60 (46-0-0)	0 (64)	0 (673ppm)	Seeding 33 (20) 20-0-0-24

In Crop Weed Control: None Registered

Fungicide: None Registered

## Fall Cereal Adaptation Evaluation

**Project duration** – On Going

**Objectives** - Evaluate newly registered winter wheat and fall rye varieties for adaptation and yield performance in the Central Plains region of Manitoba.

**Collaborators** - Manitoba Crop Variety Evaluation Team (MCVET)

### Results

Entries and yield results for Carberry and table 1 & 2. CDC Falcon is the check variety and yielded the lowest. The greatest yield came from Emerson which significantly out yield all other entries. Table 3 displays long term mean estimates of performance over seven years of variety evaluation, showing that overall 2017 was an above average year with regard to grain yield for all but Emerson, which yielded above average. For more custom comparisons of winter wheat, fall rye and other crops in Manitoba visit [www.seedinteractive.ca](http://www.seedinteractive.ca).

Table 1: Winter Wheat varieties and yield performance at Carberry in 2017.

name	kg/ha	Bu/Ac	% Falcon
<b>CDC Falcon</b>	<b>5738.0</b>	85.2	100
AAC Gateway	5336.2	79.2	93
AAC Elevate	5694.4	84.5	99
CDC Chase	6089.5	90.4	106
2AFC-19C	6837.1	101.5	119
AAC Wildfire	6469.2	96.0	113
AAC Goldrush	5734.9	85.1	100
AAC Icefield	6715.2	99.7	117
<b>CV</b>	<b>7.7</b>	<b>7.7</b>	
<b>LSD</b>	839.1	12.5	
<b>Prob. Entry</b>	0.02	Yes	
<b>GRAND MEAN</b>	6076.8	90.2	

Table 2: Long Term BLUP mean estimates of Winter Wheat varieties grown at Carberry

Name	kgha	rank	Bu/Ac	% Falcon
AAC Elevate	5413	6	80.4	101
AAC Gateway	5534	5	82.2	104
AAC Goldrush	5347	7	79.4	100
AAC Icefield	5940	3	88.2	111
AAC Wildfire	5960	2	88.5	112
CDC Chase	5783	4	85.8	108
<b>CDC Falcon</b>	<b>5336</b>	<b>8</b>	79.2	<b>100</b>
W520	6144	1	91.2	115
LSD	258		3.8	

Table 1: Fall Rye varieties and yield performance at Carberry in 2017.

Name	kg/ha	Bu/Ac	% Hazlet
<b>Hazlet</b>	<b>8400.3</b>	125	100
Danko	8687.4	129	103
Guttino	10890.0	162	130
Brasetto	10598.6	157	126
Bono	10633.3	158	127
<b>CV</b>	2.8		
<b>LSD</b>	525.8	8	
<b>Prob. Entry</b>	0.0000		
<b>GRAND MEAN</b>	9841.9	146	

Table 2: Long Term BLUP mean estimates of Fall Rye varieties grown at Carberry

Name	2017	Bu/Ac	% Hazlet
Bono	7968	118	121
Brasetto	7965	118	121
Danko	6378	95	97
Guttino	8121	121	123
Hazlet	6596	98	100
Prima	6023	89	91
LSD	252	4	

## Background

Variety trials for all of Manitoba's major crops are conducted across the crop growing regions of Manitoba every year by the Manitoba Crop Variety Evaluation Team (MCVET). This performance data, along with variety characteristic information, is summarized in "SEED MANITOBA" and online at [www.seedinteractive.ca](http://www.seedinteractive.ca). Both formats provide long term yield data as well as annual yield comparisons at various locations.

## Materials & Methods

Experimental Design:	Randomized complete block design with 3 replicates
Seeding Date:	September 20, 2016
Harvest Date:	August 11, 2017
Fertility:	Nitrogen Side Banded at seeding; Phosphorus banded with seed.
In Crop Weed Control:	Tundra was applied June 5, 2017
Fungicide:	No Fungicide was applied



# Effects and interactions of variety use, plant growth regulators, and fertility in high yielding winter wheat production in Manitoba

Cooperators: Ducks Unlimited Canada – Ken Gross

Manitoba Diversification Centres Field Trial Locations: Arborg, Carberry, Melita, Roblin

## **Trial Objectives:**

- Assess BMPs for winter wheat production in terms of harvest management, yield, and protein quality.
- Integrate BMPs such as variety use, timing nitrogen application and rate, plant growth regulators (PGRs), and fungicides to achieve high yield winter wheat.
- Understand the interaction between variety use, nitrogen application, and PGRs on yield, harvest management and protein quality parameters in high yielding winter wheat.

## **Introduction**

Winter wheat can be a high yielding crop on the prairies. With high yield potential and producers aiming for better protein values in winter wheat, come risks such as lodging. Lodging is the inability of a plant to sustain its own weight causing the plant to fall over. Factors that influence lodging include variety use (genetic) and environmental conditions such as heavy rain, wind, hail, disease issues, and often elevated soil fertility. Farmers often aim for high yield and high protein by utilizing high nitrogen fertilizer rates but often realize a difficult to harvest crop that has lodged. Choice of variety, use of fungicides, and potentially plant growth regulators (PGRs) can reduce risk of lodging.

Palisade EC (Trinexapac-ethyl) is a plant growth regulator that has several highlights ([syngenta.com](http://syngenta.com)) such as:

- Shortens internodes to reduce crop height and lower center of gravity, which improves crop standability and mitigates risk from adverse weather
- Increases stem thickness and diameter to help strengthen the stem and decrease lodging, which avoids harvest delays, yield loss and reduced grain quality
- Has very good crop tolerance when applied between Feekes Growth Stages 4 to 7 and under favorable environmental conditions

The Manitoba Diversification Centre in collaboration with Duck Unlimited Canada aimed to determine the effects of nitrogen rate, use of a plant growth regulator (Palisade EC) and variety on winter wheat performance in terms of yield potential, crop height, and lodging. A small plot trial was designed to test these factors over one year in four locations across Manitoba.

**Treatments and Design:** Split-Split Plot Design, 3 replicates

Factor 1: Fertility (main plot)

1. 70% in Fall recommended Rate N ( this is what the traditional farmer will do)
2. 100% Fall (Blend) all down at once.
3. 70% Fall (Blend) + 30% spring applied (use either UAN or granular Urea with Agrotain ASAP in spring @ breaking of dormancy)
4. 70% Fall (Blend) + 30% spring applied (use either UAN or granular Urea at Boot; Zadock 32)

Factor 2: Variety (sub plot)

1. AAC Gateway, Gateway has “very good” lodging resistance. High Yielding, CWRW wheat class
2. AAC Wildfire. Wildfire has “good” lodging resistance. High Yielding, CWRW wheat class

Factor 3: PGR (sub-sub plot)

1. Control (without)
2. Palisade – applied at first node detectible (feeks 4-7 or Zadock 31-33)

**All sites had to abide by the following agronomic practice at each site:**

Seeding Rate is 33 plants/ft<sup>2</sup>. Seed Treated with Raxil Pro. A single pedigreed seed source was used for all sites.

Weed control:

- a. Pre-seed burn off
- b. Winter annual in fall if required
- c. Spring broadleaf if required

Fertilizer Program:

- Fertilizing for 250 lbs/ac N as 100% rate ([soil test N x 1.4] plus applied N) to achieve 120 bu/ac wheat yield
- Fall treatments use 50/50 blend of ESN and straight urea (46-0-0 granular)
- P, K are applied for removal rates plus 10%. Phosphorous is 0.56 lbs/bu plus 10% (73 lbs/ac P), K is 0.37lbs/bu plus 10% (49 lbs/ac K)
- Sulfur is normal recommendation in soil tests say 10-20 lb/ac or 0.16 lb/bu
- Side band all base fertilizer in the fall (NPKS)
- Broadcast spring nitrogen (with Agrotain) at dormancy or boot stages

Trials were located in Arborg, Roblin, Carberry and Melita across the province of Manitoba. Carberry will be omitted from the report data set since this location used a different PGR and may have had a environmental influence during application of PGRs with a north wind, thus skewing treatment effects. Specific agronomic information is located in the table below for each location.

#### Specific Site Agronomy:

Location	Melita	Carberry	Roblin	Arborg
Soil Series	Waskada Loam	Wellwood Loam	Erickson Loamy Clay	Peguis Clay
Pre-Seed Soil Test (0-24")				
N - lbs/ac	71	63	42	66
P- ppm	3	10	26	38
K - ppm	218	327	302	400
S - lbs/ac	114	48	46	234
Burnoff Date	15-Sep-16	15-Sep-16	17-Sep-16	1-Sep-16
Product	Roundup	Roundup	Roundup	Roundup
Seed Date	15-Sep-16	20-Sep-16	16-Sep-16	2-Sep-16
Seed Depth	0.5"	1"	0.5"	0.75"
Fall Base Fertilizer (Less ESN/Urea Blend per treatment)				
N – lbs/ac	33	9	33	11
P – lbs/ac	73	40	73	50
K – lbs/ac	48	0	48	50
S – lbs/ac	21	0	21	
Spring Top Up Fertilizer Dates	Apr 20 (dorm) 29-May (boot)	24-Apr Late May	24-Apr late May	mid Apr 30-May
In-crop Herbicides Date	11-May-17	5-Jun-17	None	None
Herbicide Product	Achieve, Mextrol 450	Tundra	None	None
PGR Date	26-May-17	16-May-17	5-Jun-17	5-Jun-17
Fungicide Date	16-Jun-17	June 19, July 5	10-Jul-17	26-Jun-17
Fungicide product/rate	Prosaro	Prosaro	Prosaro	Prosaro
Harvest Date	28-Jul-17	11-Aug-17	30-Aug-17	15-Aug-17

Lodging ratings at maturity, crop height at maturity, grain yield, grain moisture, test weights, protein content were all measurements taken. Data was combined and analyzed with an analysis of variance for each site (with interaction) and a REML analysis for all sites combined data using Agrobases Gen II statistical software. Probabilities of each factor were determined in addition to coefficient of variation, and least significant difference (LSD).

#### Results

There were significant differences in overall crop height and yield with variety use and PGRs. Individual sites response was variable with use of variety or PGRs but not fertility. There were no significant interactions at Arbrog or Roblin. There were some interactions between factors in Melita or Roblin which suggests a combination use of type of variety, use of PGRs or changes in fertility can play a role in crop height or yield response. In Melita, this interaction with fertility with PGRs or variety use may have

been exacerbated by local salinity effects on crop height. Overall and by individual location there were no differences in yield, crop height, or lodging among the use of fertility treatments. This may have to do with low precipitation values for each site over the growing season, reducing the chance for lodging. Percent of normal summer rainfall (Apr 15 - Aug 31) amounts where: Melita 78%, Roblin 63%, Arborg – 87%. Reference: Manitoba Ag Weather Program.

Lodging was significant in Arborg with the use of variety or PGRs. Fertility treatments did not have an effect on lodging.

Table 1: Probability of response to factors (variety, PGR, fertility) on crop height, lodging, and yield at locations Arborg, Melita and Roblin and overall. Significant values in bold. Lodging scale (1 = upright, 5 = flat)

Factor	Crop Height (cm)				Yield (kg/ha)				Lodge (1-5)
	Arborg	Melita	Roblin	All Sites	Arborg	Melita	Roblin	All Sites	Arborg
Variety	<b>0.001</b>	0.941	<b>0.002</b>	<b>0.016</b>	<b>&lt;0.001</b>	<b>&lt;0.001</b>	<b>0.006</b>	<b>&lt;0.001</b>	<b>&lt;0.001</b>
PGR	0.163	<b>0.002</b>	<b>0.001</b>	<b>&lt;0.001</b>	<b>0.002</b>	0.166	<b>0.017</b>	<b>&lt;0.001</b>	<b>0.048</b>
Fertility	0.694	0.704	0.865	0.787	0.575	0.985	0.462	0.416	0.157
Variety x PGR	0.847	0.149	0.494	0.226	0.117	0.494	0.352	0.751	0.489
Variety x Fertility	0.991	<b>0.014</b>	0.094	0.543	0.420	0.425	<b>0.017</b>	0.356	0.108
PGR x Fertility	0.822	<b>0.021</b>	0.677	0.614	0.555	0.975	0.906	0.899	0.493
Variety x PGR x Fertility	0.763	<b>0.004</b>	0.458	0.252	0.541	0.586	0.152	0.604	0.493
Coefficient of Variation	19.1	7.6	9.1	-	7.1	7.8	5.6	-	7.1
Variety									
LSD	<b>1.8</b>	4.0	<b>3.5</b>	3.441	<b>211</b>	<b>267</b>	<b>372</b>	176.4	<b>0.17</b>
PGR	9.9	<b>3.5</b>	<b>4.0</b>	3.441	<b>312</b>	297	<b>208</b>	176.4	<b>0.25</b>
Fertility	4.9	13.3	9.3	NS	NS	NS	NS	NS	NS
Variety x PGR	13.9	5.0	5.7	NS	NS	NS	NS	NS	NS
PGR x Fertility	19.7	<b>7.1</b>	8.1	NS	NS	NS	NS	NS	NS
Fertility x Variety	19.7	<b>7.1</b>	8.1	NS	NS	NS	<b>416</b>	NS	NS

NS – not significant

Both Roblin and Arborg observed greater crop height with the use of Wildfire compared to Gateway. All sites observed greater yield with Wildfire as well and Roblin experiencing slight greater lodging with Wildfire compared to Gateway. With all data combined, both height and crop yield were significantly greater for Wildfire compared to Gateway.

Overall sites, use of PGRs resulted in a shorter crop on average by 8 cm. However, with use of a PGR also resulted in a 5% yield decrease when site data was combined. However, the Melita location did not experience a yield loss despite having responded in crop height.

Table 2: Mean crop height, lodging, and yield responses to variety use, PGR application and nitrogen fertility in locations Arborg, Melita, and Roblin, and all sites combined overall. Significant values in bold

Treatment			Crop Height (cm)			Yield (kg/ha)			Lodge (1-5)	Combined Sites Means and LSD			
Variety	PGR	Fertility	Arborg	Melita	Roblin	Arborg	Melita	Roblin	Arborg	Height	REML LSD	Yield	REML LSD
Gateway			<b>83</b>	76	<b>69</b>	<b>6781</b>	<b>5746</b>	<b>5823</b>	<b>1.08</b>	<b>76</b>	3.4	<b>6121</b>	176
Wildfire			<b>87</b>	76	<b>77</b>	<b>7703</b>	<b>6785</b>	<b>6460</b>	<b>1.75</b>	<b>80</b>		<b>6979</b>	
Control			88	<b>79</b>	<b>77</b>	<b>7520</b>	6368	<b>6272</b>	<b>1.54</b>	<b>82</b>	3.4	<b>6726</b>	176
PGR			82	<b>72</b>	<b>69</b>	<b>6964</b>	6164	<b>6011</b>	<b>1.29</b>	<b>74</b>		<b>6374</b>	
70-30_Boot			85	78	71	7356	6309	6344	1.33	78	NS	6674	NS
70_Fall			86	77	75	7091	6200	6250	1.25	79		6513	
100_Fall			84	77	74	7286	6298	6014	1.58	78		6532	
70-30_Dorm			85	71	73	7233	6310	5959	1.50	77		6481	

NS – not significant

Tables 3: Mean interaction effects of variety use, PGRs and fertility on crop height and yield by specific location. Significant values in bold

Height by Site Means Table

Site	Gateway		Wildfire	
	PGR Control	PGR Applied	PGR Control	PGR Applied
Melita	76		76	
	78	76	81	70
Arborg	83		87	
	86	80	91	83
Roblin	69		77	
	73	66	82	73

Yield by Site Means Table Variety x PGR

Site	Gateway		Wildfire	
	PGR Control	PGR Applied	PGR Control	PGR Applied
Melita	5746		6785	
	5799	5694	6936	6634
Arborg	6781		7703	
	7181	6380	7859	7547
Roblin	5823		6460	
	5907	5740	6638	6282

Height by Site Means Fertility x PGR

Site	PGR Control				PGR Applied			
	70-30_Boot	70_Fall	100_Fall	70-30_Dorm	70-30_Boot	70_Fall	100_Fall	70-30_Dorm
Melita	84	81	76	76	71	74	<b>79</b>	66
Arborg	86	90	90	87	85	81	77	83
Roblin	76	79	76	78	67	70	72	69

Significant values in bold

Yield Site Means Fertility x PGR

Site	PGR Control				PGR Applied			
	70-30_Boot	70_Fall	100_Fall	70-30_Dorm	70-30_Boot	70_Fall	100_Fall	70-30_Dorm
Melita	6403	6319	6439	6309	6216	6080	6158	6201
Arborg	7544	7334	7505	7698	7169	6848	7067	6770
Roblin	6487	6326	6192	6084	6201	6174	5836	5834

Height by Site Means Variety x Fertility

Site	Gateway				Wildfire			
	70-30_Boot	70_Fall	100_Fall	70-30_Dorm	70-30_Boot	70_Fall	100_Fall	70-30_Dorm
Melita	78	79	81	<b>68</b>	78	75	73	76
Arborg	83	83	81	84	88	89	86	86
Roblin	67	74	66	70	76	75	81	76

Yield Mean Variety x Fertility

Site	Gateway				Wildfire			
	70-30_Boot	70_Fall	100_Fall	70-30_Dorm	70-30_Boot	70_Fall	100_Fall	70-30_Dorm
Melita	5730	5567	5982	5706	6889	6832	6615	6804
Arborg	6971	6414	6934	6805	7742	7768	7638	7663
Roblin	5893	5944	5526	5930	6795	6556	6502	<b>5988</b>

Conclusions:

- Application of Palisade reduced crop height by 8 cm on average over all sites
- Application of Palisade also reduced crop yield by 5% overall. Yield was reduced in two out of three sites by use of Palisade.
- In Arborg, the use of Palisade PGR reduced lodging effect by 16% for Gateway and Wildfire combined.
- Wildfire compared to Gateway is more at risk of lodging due to height and yield capability.

# Determining Optimum Target Plant Stands for Spring Cereal Crops in Manitoba

**Project duration** – 2017-2018

**Objectives** - To determine optimum plant populations for spring wheat, oat, and barley, and will determine if optimum plant population differs for individual cultivars.

**Collaborators** - Anastasia Kubinec – Manager, Crop Industry Development, Manitoba Agriculture  
Anne Kirk – Crop Industry Development, Manitoba Agriculture

## Results

### ***Mortality***

- Seedling mortality averaged 21% across all crop types, locations, and seeding rates, but ranged from 0-51% (data not shown). In general, mortality was higher at higher seeding rates. Figure 2 shows actual plant stand for each crop and location.
- When calculating seeding rates for spring cereals 10-20% stand loss should be taken into account.

### ***Tillering***

- Cereals typically compensate for lower plant populations by increasing tillering. Varieties have differing abilities to tiller, but in this study no differences between the wheat and oat varieties were found at any location, only at the Melita site did the barley varieties differ in heads/plant (data not shown).

While the general trend was for heads/plant to decrease as plant population increased (Table 1), statistically significant differences in heads/plant across plant populations were only seen in wheat at the Melita site and in oat at the Arborg site.

**Table 1.** Heads/plant for spring wheat, oat, and barley at five target plant populations averaged across locations.

Target Plant Population (plants/ft <sup>2</sup> )	Heads/Plant		
	Wheat	Oat	Barley
15	2.8	2.0	3.3
21	2.4	1.8	3.0
27	2.2	1.5	2.3
33	2.2	1.8	2.2
39	2.1	1.5	2.3

## ***Yield***

- Both cultivars of each crop responded similarly to increasing plant stands; therefore, yield results are averaged over cultivars.



- Plant stand did not have a significant effect on barley yield at the Carberry and Melita locations, but at Arborg the trend was for yield to increase with higher plant stands (Figure 1A).
- Plant stand did not have a significant effect on oat yield at either location (Figure. 1B).
- For wheat, plant stand did not effect yield at the Carberry location but yield did significantly increase with increasing plant stands at Melita (Figure 1C).

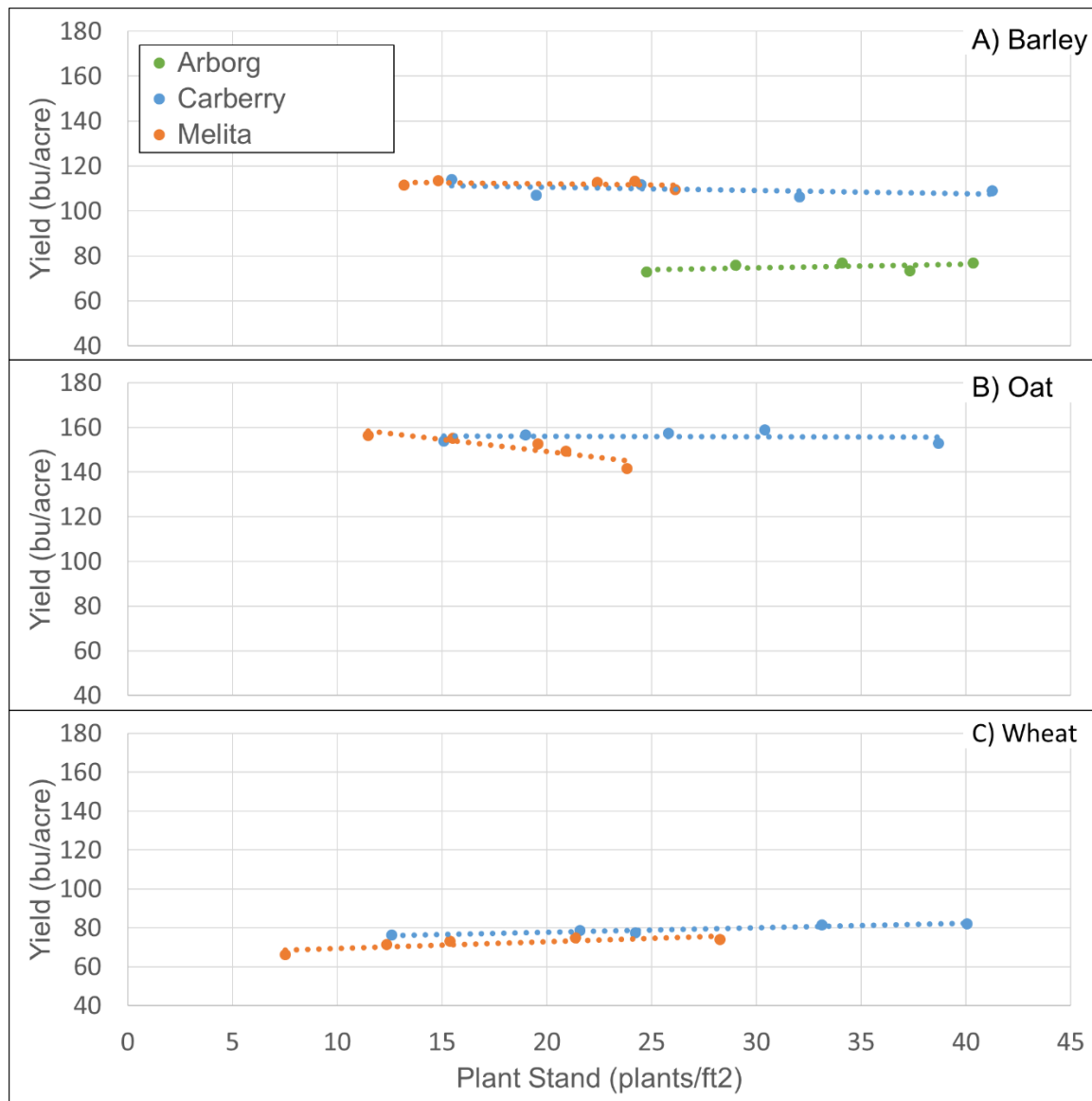


Figure 1. Yield (bu/acre) at five plant stands (plants/ft<sup>2</sup>) for barley (A), oat (B), and wheat (C), at Arborg (green, barley only), Carberry (blue), and Melita (orange). Yields are represented by circles, linear trend lines are dashed lines. Treatments within the same location with the same letter are not significantly different ( $P < 0.05$ ).

## Project findings

Mortality, tillering, and yield are highly influenced by environment, more data is needed to make recommendations about optimal plant stand

## Background

Yield of spring cereals is impacted by many agronomic practices, but starts with variety selection, seeding date, target plant stand, and the seeding rate needed to achieve those plant stands. Optimum plant population is determined by factors including crop management practices and growing conditions. Previous research has shown that optimum plant stand can also differ by crop type and for individual cultivars. Manitoba Agriculture currently recommends target plant stands of 23-28 plants/ft<sup>2</sup> for spring wheat, 18-23 plants/ft<sup>2</sup> for oat, and 22-25 plants/ft<sup>2</sup> for barley. With the introduction of semi-dwarf and higher yielding cultivars, target plant stands may need to be adjusted to maximize profitability.

## Materials & Methods

Two cultivars of spring wheat (AAC Brandon and Prosper), oat (CS Camden and Summit), and barley (AAC Synergy and CDC Austenson) were grown at the crop diversification centres in Arborg, Carberry, Melita and Roblin, at five seeding rates. Target plant stands were 15, 21, 27, 33, and 39 plants/ft<sup>2</sup>. Data collected includes plant stand, mortality, heads/plant, and yield. Data from the Roblin location is not included in the results since a range of plant stands was not achieved. A late season hail storm damaged oat and wheat plots in Arborg, yield data from those trials is not included in the results. This project will take place over two growing seasons, data presented is preliminary and from 2017 only.



**Figure 2.** AAC Synergy barley planted at target plant stands of 15, 27, and 39 plants/ft<sup>2</sup> (left to right).

## Effect of fertility, seeding date, and seeding rate on the agronomic performance of flax in Manitoba.

**Project duration** – 2017

**Objectives** - Provide data on the validity and priority of select BMPs and to illustrate these BMPs to growers. Demonstrate and quantify yield differences from varying fertilizer management practices.

**Collaborators** - Flax Council of Canada

### Results

Overall flax grain yields were very good reaching the the ideal plot target yield of 2814 kg/ha or 45bu/ac. There was no significant effect of fertility practice on flax at Carberry in 2017 (figure 1) although the no fertilizer treatment was the lowest yielding treatment. Establishment was not a problem and as a result seed treatment or the lack thereof had no effect on yield. Fall soil analysis showed ample phosphorus (64lbs/ac) so there was also no effect removing start-up fertilizer. Broadcast fertilizer was less efficient but once again not significantly different than the ideal plot.

Seeding date and seeding depth had the largest effect on yield in Carberry in 2017. A dry spring meant that seeding into moisture and close to timely rains had an effect on flax performance. Seeding date 2 (May 19<sup>th</sup>) which falls right with in the recommended seeding date for flax overall yielded better than any other dates (May 12, May 25 & June 5). The dry conditions presented some challenges when setting seeding depth and as a result the 3" depth (which was actually the deepest setting on our drill) resulted in the greatest yield. Seeding shallower and earlier reduced final yield which was most likely the result of more variable seed bed/moisture rather than pure depth. It is not recommended to seed flax at 3 inches. The forth seeding date coincided with largest precipitation event of the spring which, along with warmer temperatures reduced the emergence time by 2 days to 9 days. All other treatments took approximately 11 days to emerge.

Figure 1: Grain yield of flax under different fertility management practices at Carberry in 2017. Entry was Not Significant ( $p=0.11$ ).

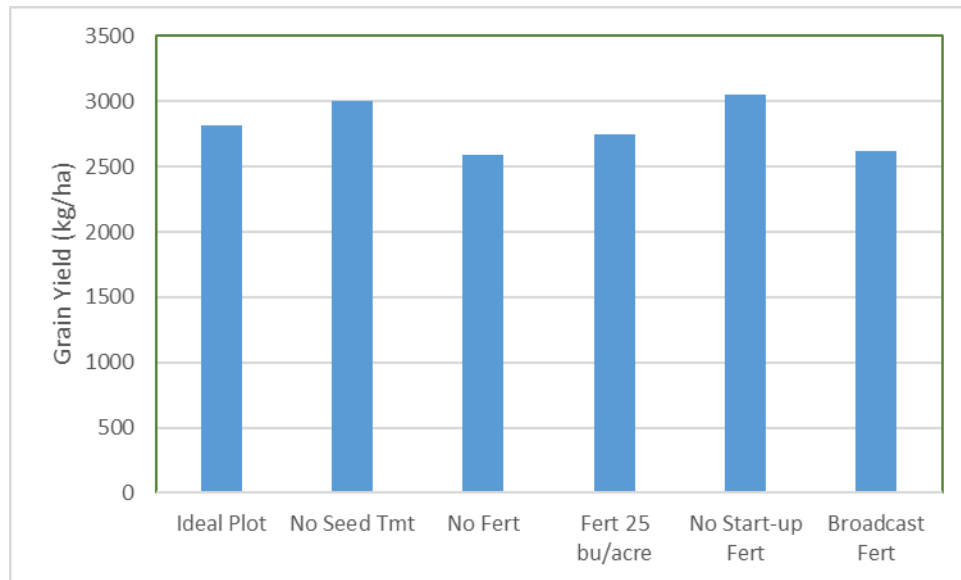


Figure 2: Grain yield (kg/ha) as affected by seeding date, seeding depth and seeding rate at Carberry, 2017. LSD=668kg/ha.

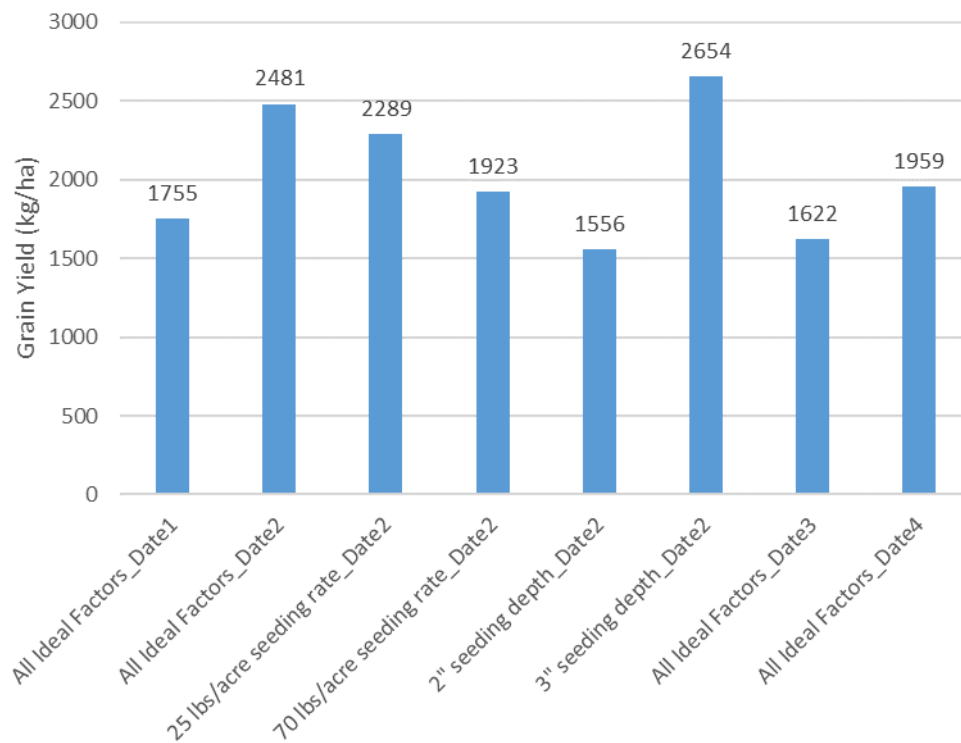
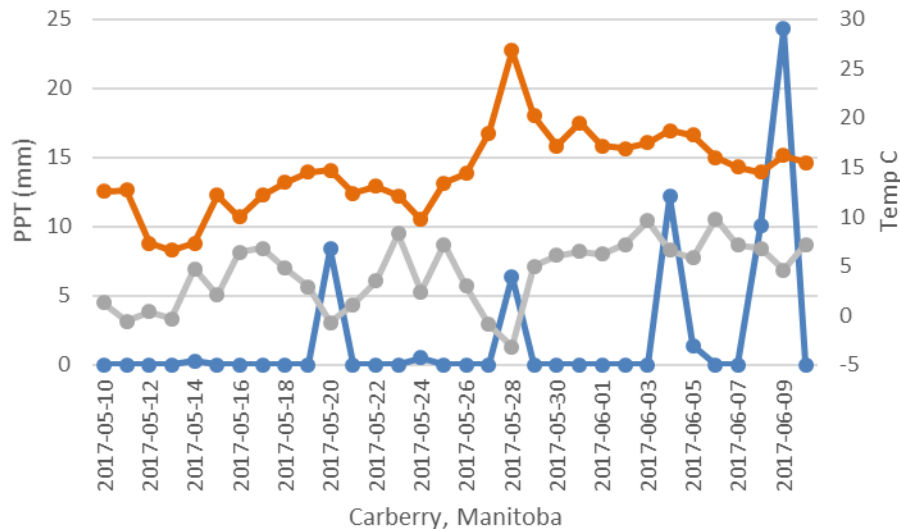


Figure 3: Precipitation, mean and minimum temperatures at Carberry from May 10<sup>th</sup> to June 10<sup>th</sup>, 2017.



## 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. 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 nutrient levels, 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 (N) is the ideal placement for flax due to seedling sensitivity. Many producers still prefer to broadcast N which takes less time than banding. Seed-placed phosphorus (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, 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.

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. Seeding rate has previous been established at 300 to 400 plants per square meter, however changes in equipment, management, seed treatments and cultivars warrants reassessment periodically. 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.

## Materials & Methods

The BMP program has been broken down into four projects:

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

Due to space and rotational limitations only projects A and C were conducted completed at the Carberry location.

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 15th
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®

Table 4. Fertility rates (lbs/acre) by treatment at Carberry for Demo A Seeded May 18, 2017				
	Nitrogen (N)	Phosphorus (P <sub>2</sub> O <sub>5</sub> )	Potassium (K)	Sulphur (S)
<i>Ideal Plot</i>	97	0	0	0

<i>No Seed Treatment</i>	97	0	0	0
<i>No Fertilizer</i>	0	0	0	0
<i>Fertilize 25 bu/acre</i>	42	0	0	0
<i>No Start-up P</i>	97	0	0	0
<i>Broadcast Application</i>	97	0	0	0

Table 5: Trial C treatment List	
Treatment	Carberry
Ideal Plot	19-May-17 45lbs/ac seeding rate 1" seeding depth 12" row spacing
1wk earlier than normal	12-May-17 45lbs/ac seeding rate 1" seeding depth 12" row spacing
1wk later than normal	23-May-17 45lbs/ac seeding rate 1" seeding depth 12" row spacing
Low seeding rate	19-May-17 25lbs/ac seeding rate 1" seeding depth 12" row spacing
High seeding rate	19-May-17 45lbs/ac seeding rate 1" seeding depth 12" row spacing
2" seeding depth	19-May-17 45lbs/ac seeding rate 2" seeding depth 12" row spacing
3" seeding depth	19-May-17 45lbs/ac seeding rate 3" seeding depth 12" row spacing

## Industrial Hemp Variety Trial

**Project duration** - May 2017 – October 2017

**Objectives** - To estimate varietal differences in grain and fibre yield for industrial hemp in Manitoba.

**Collaborators** - Craig Linde – Diversification Specialist, Manitoba Agriculture  
James Frey – Diversification Specialist, Manitoba Agriculture

### Results

The average grain and fibre yields by variety are provided in Figures 1 and 2, respectively. Least significant differences for grain yield were 290lbs/ac and 190lbs/ac for Carberry and Melita, respectively. Least significant differences for fibre yield were 0.5, 0.6 & 0.3 tons/ac for Arborg, Carberry and Melita, respectively. Percent cannabidiol results are provided in Table 1. Due to high coefficients of variability, some results for Arborg are not included, and no results for Roblin are included.

*Figure 1: Hemp grain yield (lbs/ac) 2017*

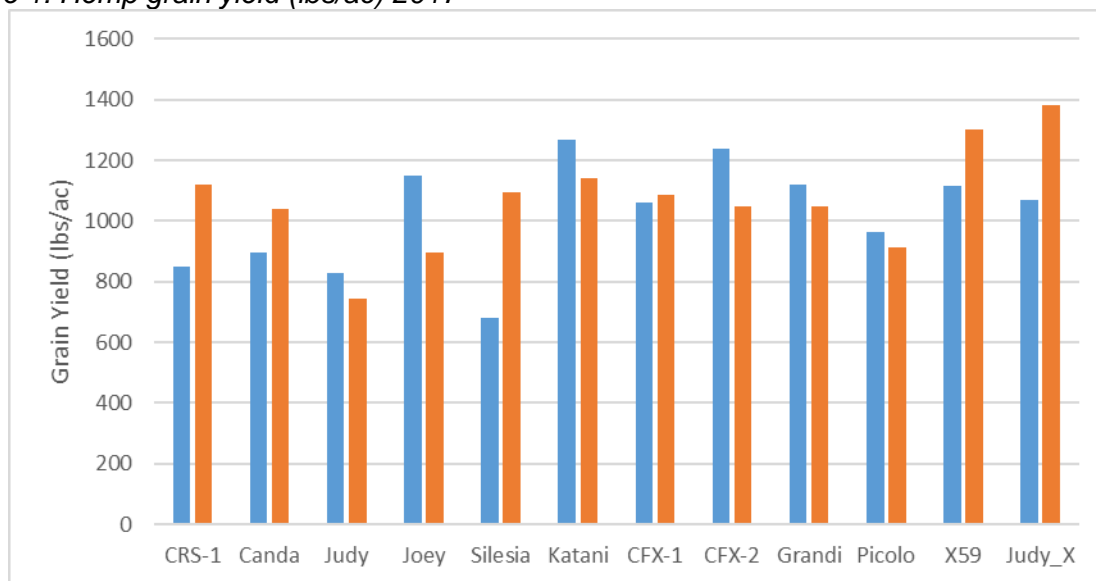




Figure 2: Hemp fibre yield (ton/ac) 2017

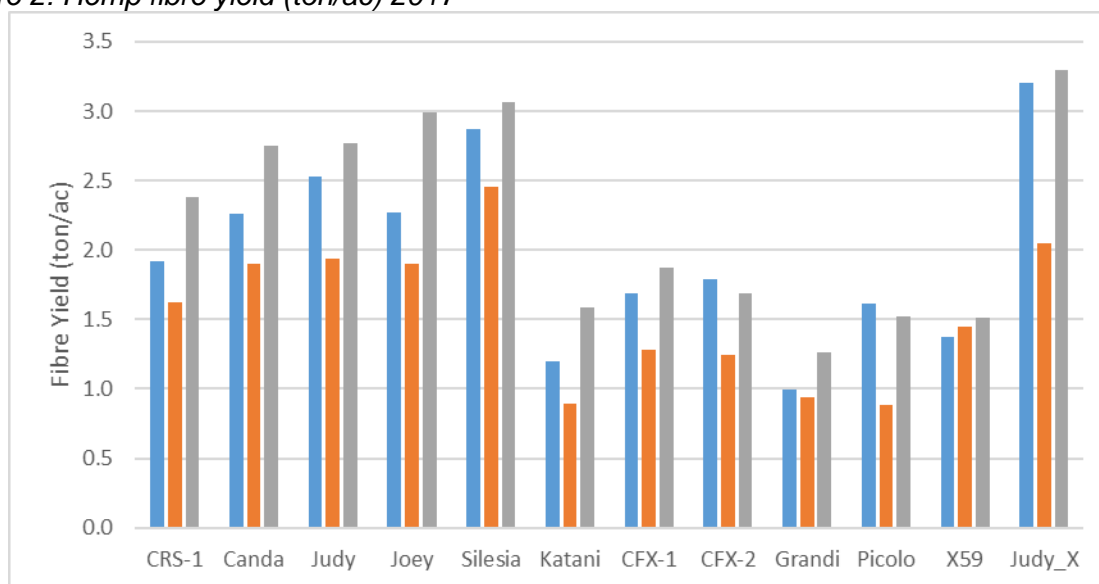


Table 1: Total cannabidiol (CBD) content (%) of upper stem leaf material removed at grain harvest (chaff)

Average of Total CBD	Location			
Variety Name	Arborg	Carberry	Melita	Average
Canda	0.39	0.48	0.70	0.52
CFX-1	1.89	0.94	1.81	1.55
CFX-2	1.07	0.72	1.70	1.16
CRS-1	0.98	0.85	1.78	1.20
Grandi	0.67	0.78	1.48	0.90
Joey	1.84	0.63	1.25	1.24
Judy	1.23	0.82	1.46	1.17
Judy X	1.14	0.34	1.35	1.04
Katani	0.96	0.89	1.53	1.13
Picolo	0.99	0.62	1.53	1.17
Silesia	0.25	0.30	0.66	0.40
X59	0.87	0.58	1.65	1.03
<b>Average</b>	<b>1.00</b>	<b>0.66</b>	<b>1.41</b>	<b>1.04</b>

## Project findings

Grain yield results are available through the SEED Manitoba guide (2017).

## Background

The Manitoba Diversification Centres participated in a hemp variety trial, in partnership with private industry and the Canadian Hemp Trade Alliance.

## Materials & Methods

Experimental Design: Randomized complete block design  
 Entries: 12 varieties

**Table 2: Varieties included in variety trial, 2017**

Canda	CRS-1	Judy	Piccolo
CFX-1	Grandi	Judy X	Silesia
CFX-2	Joey	Katani	X59

**Table 2: Agronomic info for all sites**

ITEM	Melita	Carberry	Roblin	Arborg
Legal Location	NE 27-3-27W1	SW 8-11-14W	NE 20-25-28 W1	RL 37-22-2 E
Soil Series	Waskada Loam	Wellwood Loam	Erikson Clay Loam	Heavy Clay
Soil Test (0-24")				
N - lbs/ac	7.2	33	60	138
P- ppm	11	12	11	15
K - ppm	260.8	250	194	300
S - lbs/ac	219.8	22	64	1634
Burnoff Date	May 23		June 3	
Product	Glyphosate/Liberty		RoundUp Transorb	
Seed Date	May 23	May 15	June 2	May 23
Seed Depth	0.75"	1"	0.75"	0.75"
Spring Fertilizer Application - lbs/ac				
N	120	110	75	25
P	35	0	10	25
K	25	0	0	0
S	10	0	0	0
Spring Fertilizer Date	SB at seeding	Side-banded at seeding	Side-banded at seeding	Side-banded at seeding
In-crop Herbicides Date	June 16	N/A	N/A	June 19
Product	Koril/Arrow	N/A	N/A	Brotex 240 @0.5L/ac
Fibre Harvest Date	August 11	Aug 17	Aug 18	Aug 10
Grain Harvest Date	September 6	Aug 25	Sept 11	Sep 14

# The Effect of Split Nitrogen Application Rate on Three Varieties of Industrial Hemp in Manitoba

**Project duration** - May 2017 – September 2017

**Objectives** - To understand the effect of split versus banding nitrogen fertilizer to optimize industrial hemp grain yields.

**Collaborators** - Hemp Genetics, Parkland Industrial Hemp Growers, Manitoba Harvest

## Results

- Overall, despite the split nitrogen application averaging 13% greater grain yield, overall there was no statistically significant difference in grain yield when applying nitrogen in one application at seeding versus 70% at seeding and 30% at stem elongation.
- At Melita there was a significant effect on grain yield when nitrogen was divided into split applications. At Carberry, although split application resulted in greater yield it was not statistically different due to overall higher variability in the trial.
- There was no significant difference in height between a split application or single application of nitrogen.
- Further study is required to better understand and confirm any positive effect of split versus banding all nitrogen at time of seeding on grain yield.

Figure 1: Effect of Split Nitrogen Application on Industrial Hemp Grain Yield (kg/ha) Combined over two Manitoba locations in 2017

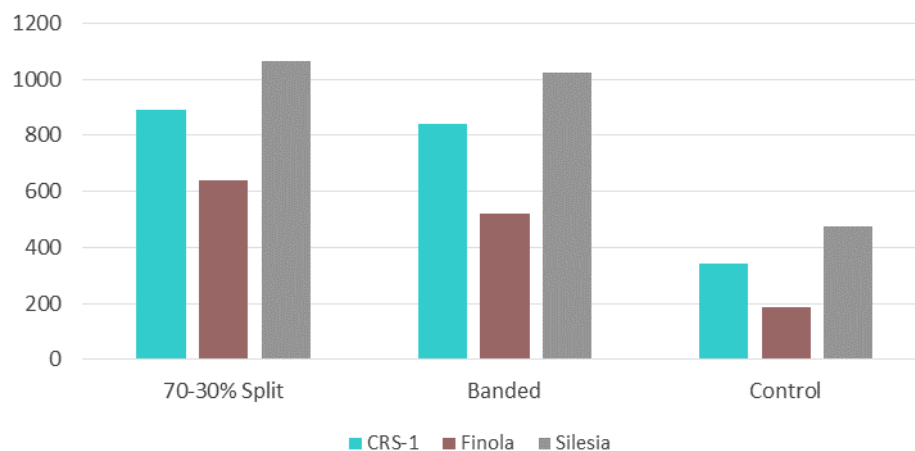


Figure 2: Effect of Split Nitrogen Application on Industrial Hemp Grain Yield (kg/ha) at Carberry, Manitoba 2017.  
LSD=169

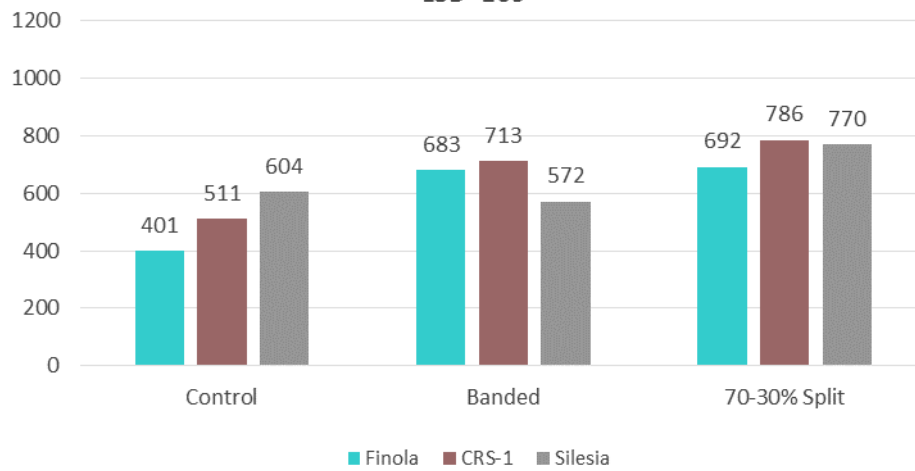
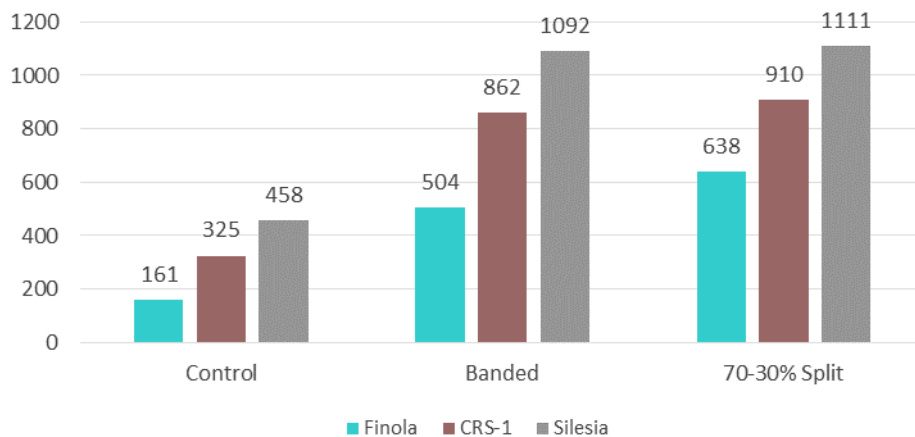


Figure 3: Effect of Split Nitrogen Application on Industrial Hemp Grain Yield (kg/ha) at Melita, Manitoba 2017. LSD=132



### Project findings

- Applying nitrogen at both sites resulted in a significant increase in grain yield.
- Applying nitrogen in a split format versus applying all at seeding increased grain yield at both sites; however, the increase was only significant at the Melita location.
- Lower yields at the Carberry site was most likely a result of below average rainfall, not allowing plants to fully utilize available nutrients.
- Further study is required to understand the potential benefit of split nitrogen application in industrial hemp.

## Background

Current nitrogen recommendations for nitrogen are 80-120 lb/ac, with some suggesting higher rates, depending on variety and growing conditions. However, the economic risk of applying all nitrogen at planting can be high, especially if prolonged stress restricts the plants' utilization of the added nutrients. Additionally, in many cases it is not logistically possible to apply all the nutrient requirements at seeding. Split nitrogen applications have the potential to increase seeding efficiencies and allow growers to adjust rates of application according to growing conditions.

<http://www.hemptrade.ca/eguide/production/nutrient-use>

## Materials & Methods

Locations:	Carberry, Melita (Roblin results not included due to high %CV)
Experimental Design:	Split plot design with four replications
Main plot:	Silesia (tall, fibre-type) CRS-1 (medium, dual purpose-type) Finola (short, grain-type)
Split plot:	Control – no nitrogen added Banded – nitrogen side-banded at seeding Split application – 70% nitrogen side-banded at seeding, 30% broadcast at canopy closure
Data collected:	Seeding date Emergence date Plants/m <sup>2</sup> Mortality Vigor (1 low, 9 high) Height (cm) % Moisture Yield (kg/ha)

**Table 2: Agronomic info for all sites**

ITEM	Melita	Carberry	Roblin
Legal Location	NE 27-3-27W1		NE 20-25-28 W1
Soil Series	Waskada Loam	Wellwood Loam	Erikson Clay Loam
Soil Test (0-24")			
N - lbs/ac	7.2	33	86
P- ppm	11	64	10
K - ppm	260.8	673	183
S - lbs/ac	219.8	22	184
Burnoff Date	May 23	n/a	May 25
Product	Glyphosate/Liberty	n/a	RoundUp Transorb
Seed Date	May 24	May 19	May 24
Seed Depth	0.5"	1"	0.75"
Spring Fertilizer Application - lbs/ac	Variable N + Blend	46-0-0	
N	120/84+36	100/70+30	49
P	35	0	10
K	25	0	0
S	10	0	0
Spring Fertilizer Date	SB at Seeding + broadcast	SB at Seeding + broadcast	SB at Seeding + broadcast
In-crop Herbicides Date	June 16	N/A	N/A
Product	Koril/Arrow	N/A	N/A
Fibre Harvest Date	N/A	N/A	Aug 28
Grain Harvest Date	September 7		Sept 26

# The Effect of Seeding Date on Three Varieties of Industrial Hemp in Manitoba

**Project duration** - May 2017 – September 2017

**Objectives** - To understand the effect of seeding date by variety on industrial hemp grain yields.

**Collaborators** - Hemp Genetics, Parkland Industrial Hemp Growers, Manitoba Harvest

## Results

- The greatest mortality was observed for Seeding Date 3 which followed a series of large rain events, affecting all varieties (Figure 1). Overall, variety was significant for seedling mortality with CRS-1 having the greatest mortality at 73%, followed by CanMa at 60% and Finola at 47%.
- Overall average grain yield for the trial was 871 kg/ha and ranged from 313-1427 kg/ha (Figure 2)
- The earliest seeding date in Melita resulted in the greatest grain yield.
- Seeding between May 31 and June 16 did not significantly increase grain yield.
- Seeding at June 23 significantly reduced grain yield.
- Overall height was negatively impacted by seeding date with the exception of Date 3.
- There was a significant interaction between test weight and variety with longer season varieties showing a negative relationship between seeding date and test weight (figure ). Test weight Finola (early season) was not affected by seeding date while both CRS1 (mid season) and CanMa (late season) were affected.

Figure 1: Mortality levels associated to seeding date and total precipitation events (within 5d period of seeding date)

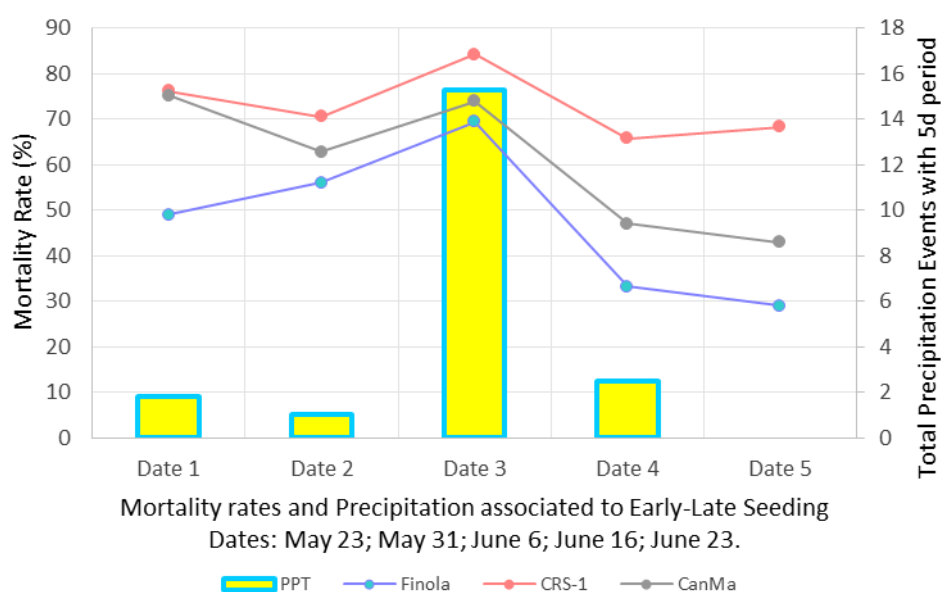


Figure 2: Effect of seeding date by variety on grain yield (kg/ha) for hemp planted at Melita Manitoba, 2017.

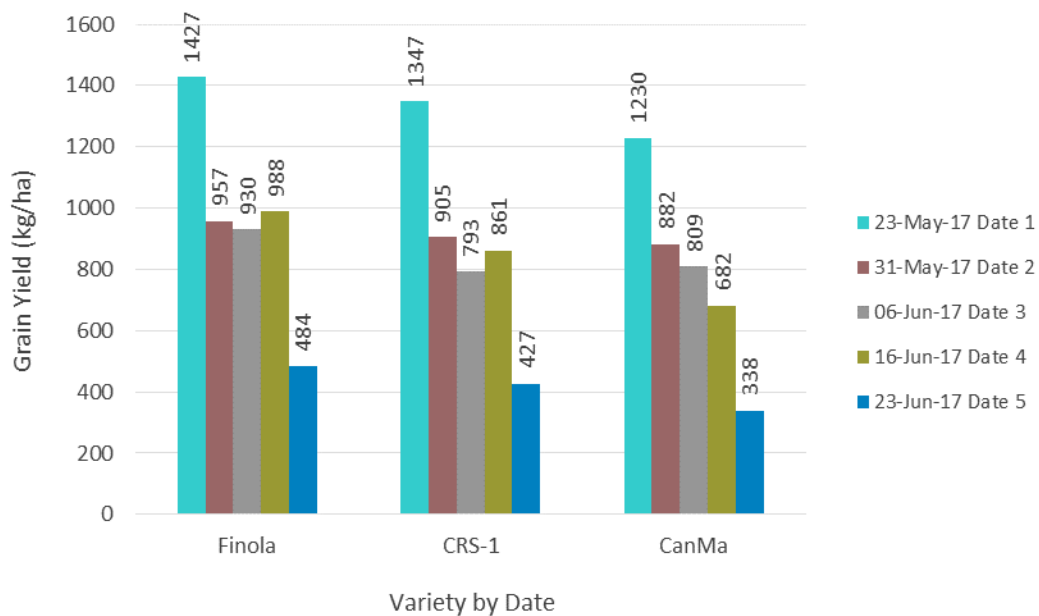


Figure 3: Effect of seeding date by variety on plant height (cm) for hemp planted at Melita Manitoba, 2017.

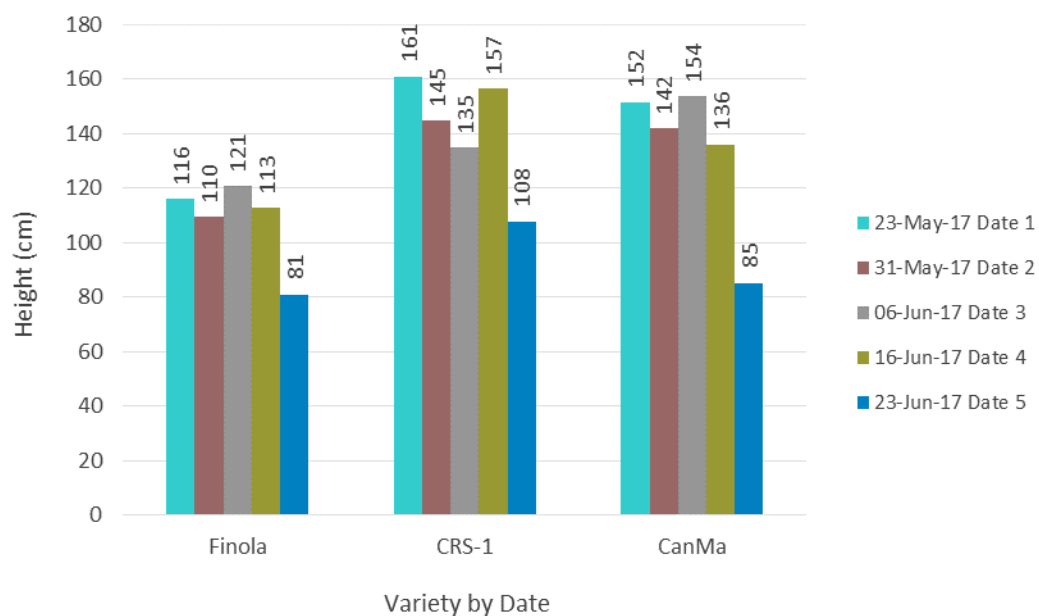
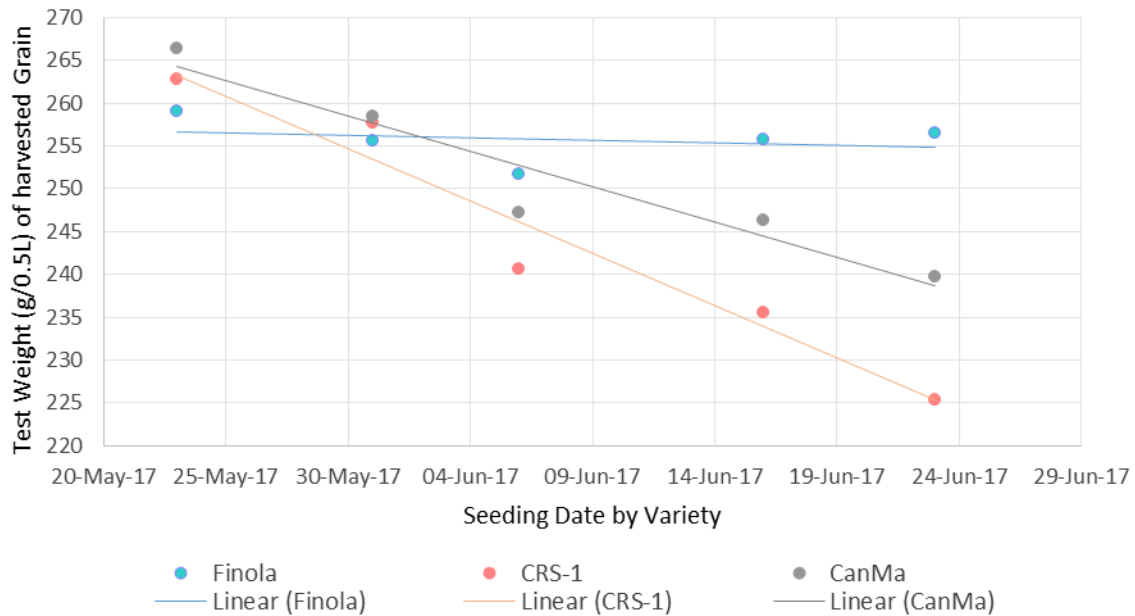


Figure 4: Effect of seeding date by variety on test weight (g/0.5L) for hemp planted at Melita Manitoba, 2017.





## Project findings

- There was not a significant effect of seeding date on seedling mortality although there was a general trend of greater mortality for the earlier seeding dates. Despite the mortality levels seed densities were still sufficient, with Finola and CanMa averaging 79 and 59 plants/m<sup>2</sup>, respectively. The exception may have been CRS-1 which averaged 41 plants/m<sup>2</sup>. Previous work done by the Diversification Centres (2011-2012) demonstrated that grain yield is typically not affected until densities drop below 40 plants/m<sup>2</sup>. CRS-1 therefore would have had densities right around the threshold where yield may have been impacted.
- The effect of seeding date appears to be variety dependent. All varieties showed a general reduction in both height and grain yield with no interaction between variety and seeding date. However, there was no statistical advantage or penalty detected for seeding until mid June. These results suggest that early seeding, if establishment risk factors (cold, wet soil conditions) are perceived low and the added height at harvest is not an issue can result in greater yield.
- Quality may also be of concern when choosing to seed late, especially for mid and long season varieties such as CRS-1 and CanMa. In this study both varieties expressed decreasing test weights as seeding date was delayed with CanMa being affected the most. Although there was a decrease in yield for Finola when seeded at the end of June, test weight was not effected by seeding date. CRS-1, and especially CanMa had both lower yield and decreasing test weights as seeding was delayed.

## Background

Earlier seeding dates (before May 15) for industrial hemp may result in high plant mortality rates, as well as taller, thicker stems [1]. Limited research is available on the effect of seeding date in Western Canada.

## Materials & Methods

Locations: Melita (Roblin results not included due to high %CV)  
 Experimental Design: 3 varieties with 5 seeding dates  
 Main plot: CanMa (tall, dual purpose-type)  
 CRS-1 (medium, dual purpose-type)  
 Finola (short, grain-type)  
 Data collected: Seeding date  
 Emergence date  
 Plants/m<sup>2</sup>  
 Mortality  
 Vigor (1 low, 9 high)  
 Height (cm)  
 % Moisture  
 Yield (kg/ha)

**Table 1: Agronomic info for all sites**

ITEM	Melita	Roblin
Legal Location	NE 27-3-27W1	NE 20-25-28 W1
Soil Series	Waskada Loam	Erikson Clay Loam
Soil Test (0-24")		
N - lbs/ac	7.2	86
P- ppm	11	10
K - ppm	260.8	183
S - lbs/ac	219.8	184
Burnoff Date	May 23	May 25
Product	Glyphosate/Liberty	RoundUp Transorb
Seed Date	Date 1-May 23 Date 2- May 31 Date 3- June 6 Date 4-June 16 Date 5- June 23	Date 1 – May 24 Date 2 – June 2 Date 3 – June 9 Date 4 – June 28 Date 5 – June 28
Seed Depth	0.75"	0.75"
Spring Fertilizer Application - lbs/ac		
N	120	49
P	35	10
K	25	0

S	10	0
Spring Fertilizer Dates	SB at Seeding	Side-banded at seeding
In-crop Herbicides Date	July 11 for Seed Date 2 - 5	N/A
Product	Koril/Arrow	N/A
Fibre Harvest Date	N/A	Aug 28
Grain Harvest Date	September 7	Sept 27

## References

Canadian Hemp Trade Alliance: Production, Seeding Date.

<http://www.hemptrade.ca/eguide/production/seeding>

# The Effect of Seeding Rate on Industrial Hemp Fibre Yield and Mortality in Manitoba

**Project duration** - May 2017 – October 2017

**Objectives** - To understand the effect of seeding rate on plant/seed mortality and final fibre yield of industrial hemp.

**Collaborators** - Parkland Industrial Hemp Growers

## Results

- Seedling mortality was constant at both the Melita and Carberry locations (Figure 1).
- At the Roblin site mortality increased with seeding rate.
- Increasing seeding rate resulted in a decrease in height.
- There was no significant difference in total fibre yield at Carberry or Roblin, only at Melita.
- In general, fibre yield reached a maximum at a target rate of 250 plants/m<sup>2</sup>, however the recommended target rate of 150 plants was not significantly different from higher rates at all sites.

Figure 1: Seedling mortality rates relative to target planting populations at Melita, Carberry & Roblin, 2017.

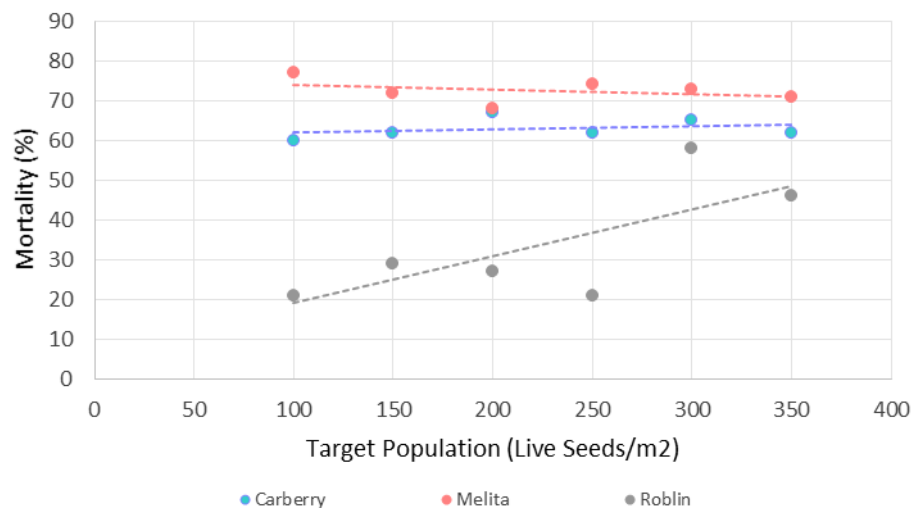


Figure 2: Effect of target population density on plant height in hemp at Melita and Roblin, Manitoba, 2017.

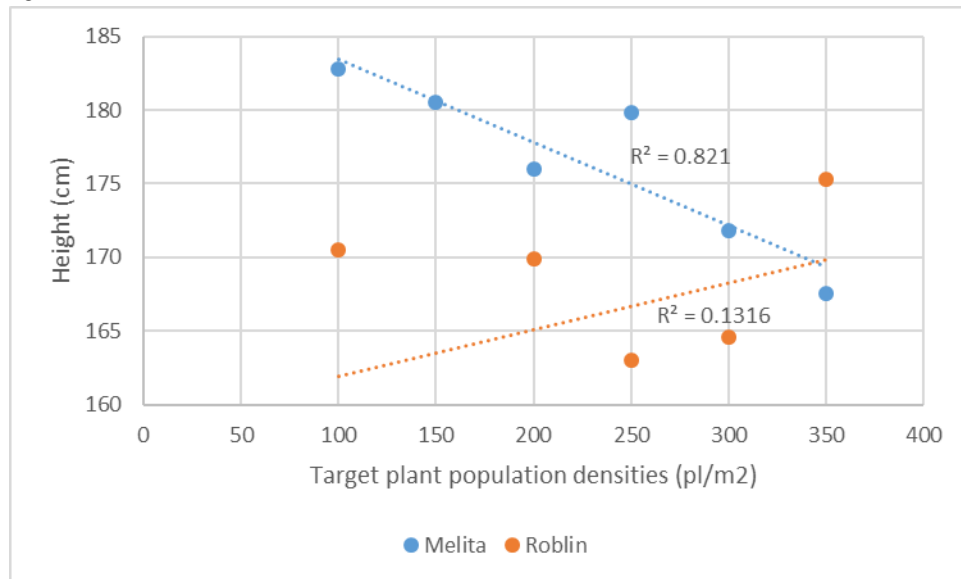
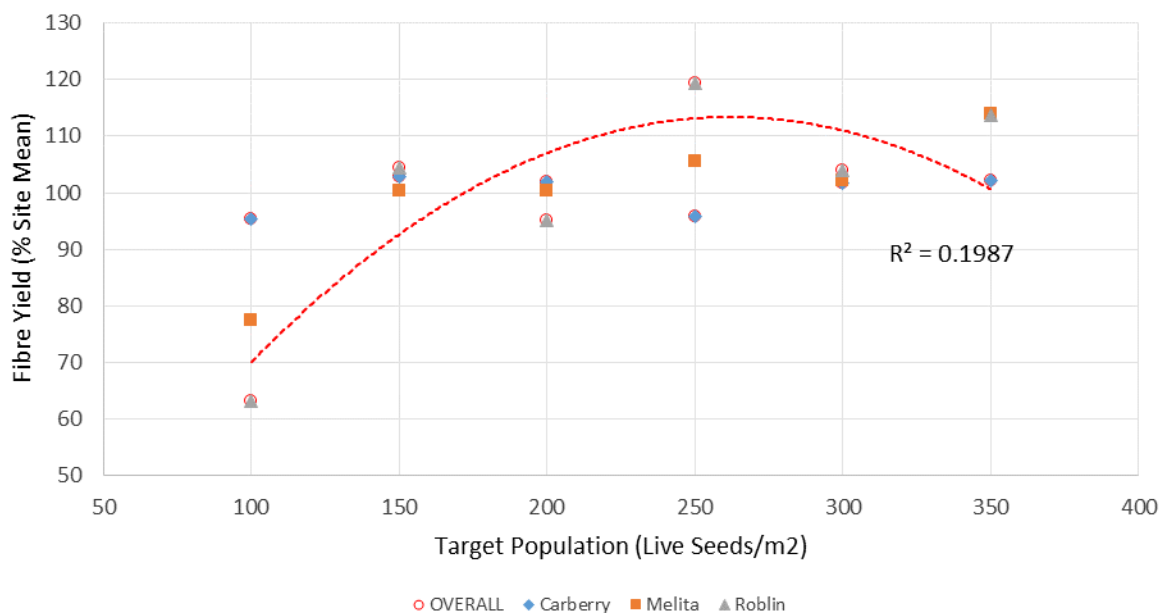


Figure 3: Effect of target population on hemp fibre yield at Carberry, Melita, and Robin Manitoba, 2017.

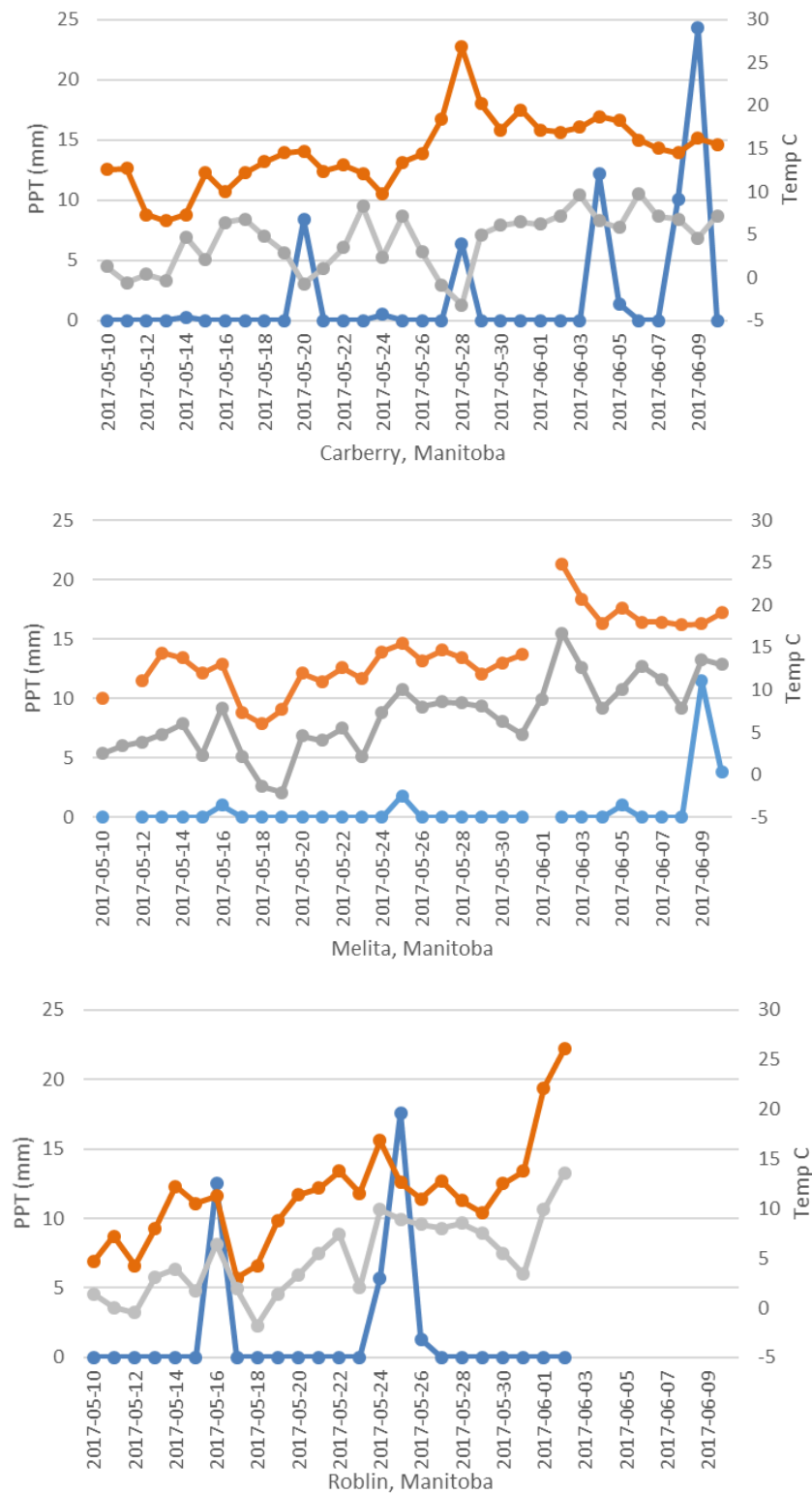


## Project findings

This work supports previous work by the Diversification Centres focusing more specifically on grain varieties where mortality rates were constant and within a similar range regardless of the target plant population.

Roblin in 2017 was a bit of an anomaly with regard to mortality rates changing with increased population targets. This needs to be investigated further to better understand the mechanisms behind the different mortality rates.

Unfortunately weather data is missing for the Roblin site between June 2 and June 16 however, comparisons between sites from May 10<sup>th</sup> to June 10 (Figure 4).



Overall, all sites had a moisture deficit relative to historical averages with Carberry, Melita and Roblin receiving 43%, 8% and 84% of 10yr average rainfall in May and the April prior was only at 63%, 80%, & 37% of normal, respectively. Moisture conditions at seeding for all sites was rated satisfactory. Both Melita and Carberry were similar with small rain events occurring around seeding but otherwise relatively fair to dry conditions with moderate temperatures. The Roblin site however, had a large rain event following seeding and cool temperatures. Given these differences however it would be expected that Roblin should have seen the largest levels of mortality and equal mortality across all plant populations which did not occur.

Future Work must focus more on environmental conditions during early stages of establishment, specifically soil conditions and the rate of emergence and seedling recruitment/death. The reasons why low stress weather conditions at both Carberry and Melita resulted in similar with mortality across all population levels verses the excess moisture and cooler temperatures at the Roblin site that resulted in different mortality rates across target populations needs to be explored in more detail.

## Background

Mortality rates for industrial hemp can vary from 10-70% [1]. Nevertheless, the crop demonstrates the ability to adapt to different plant densities by altering its architecture (e.g. tall and thin vs. shorter and branched). Consequently, plant density has an impact on stem length and thickness. Higher seeding rates are used when targeting a hemp fibre crop. Varieties suited to fibre production typically have long, “pencil-thin” stems, sometimes exceeding two metres in height. Stem thickness affects the ratio of bast (long, outer fibres) and hurd (short, inner fibres), with thicker stems producing more hurd. This in turn affects the industrial application of the fibres.

<http://www.hemptrade.ca/equide/production/seeding>

<http://www.hemptrade.ca/equide/fibre-production/selecting-hemp-varieties-for-fibre-only-applications>

## Materials & Methods

Experimental Design: Randomized complete block design  
Entries: 5 (1 variety, 5 seeding rates)

**Table 2: Treatments included in hemp fibre seeding rate trial, 2017**

Variety	Seeding Rate (pl/m <sup>2</sup> )
Canda	100
	200
	250
	300
	350

**Table 2: Agronomic info for all sites**

ITEM	Melita	Carberry	Roblin
Legal Location	NE 27-3-27W1		NE 20-25-28 W1
Soil Series	Waskada Loam	Wellwood Loam	Erikson Clay Loam
Soil Test (0-24")			
N - lbs/ac	7.2	33	86
P- ppm	11	32	10
K - ppm	260.8	673	183
S - lbs/ac	219.8	22	184
Burnoff Date	May 23	N/A	May 25
Product	Glyphosate/Liberty	N/A	RoundUp Transorb
Seed Date	May 24	May 18	May 24
Seed Depth	0.5"	1"	0.75"
Spring Fertilizer Application - lbs/ac			
N	120	100	49
P	35	0	10
K	25	0	0
S	10	0	0
Spring Fertilizer Date	SB at Seeding	SB at Seeding	Side-banded at seeding
In-crop Herbicides Date	June 16	N/A	N/A
Product	Koril/Arrow	N/A	N/A
Fibre Harvest Date	August 10		Aug 18
Grain Harvest Date	August 31	N/A	Sept 4

**References**

Canadian Hemp Trade Alliance: Production, Seeding Rate.  
<http://www.hemptrade.ca/eguide/production/seeding>



## Edible Bean Variety Evaluation

Unfortunately, due to stand establishment problems caused by damaged seeds and seeder malfunction no data was collected for the Edible Bean variety evaluation trial in Carberry for 2017. See Seed Manitoba for other site evaluations and performance summary data.

## Corn Yield Trial Evaluation

In collaboration with the Manitoba Corn Growers Association and AAFC, Ottawa, 90 lines were evaluated. Data from this trial provides adaptation and test cross information for parental performance.

## Corn Parent Evaluation Nurseries

Three corn nurseries were established in Carberry in 2017. These nurseries were a collaboration with the Manitoba Corn Growers Association, AAFC, Ottawa, and the University of Manitoba. The largest was a parental evaluation nursery of 400 Double Haploid lines, the second a replicated cold tolerance nursery that was seeded in early May and the third was a disease nursery evaluating the genetic resistance of 90 lines to Goss's Wilt. All nurseries contributed data to the AAFC led/MCGA directed corn development program.

# Potato *Verticillium dahliae* and Potato Early Dying Control Project

**Project duration** – 2014-2017

**Objectives** - Quantify impact of soil levels and remediation techniques on a native soil population of *Verticillium dahliae*

**Collaborators** - Darin Gibson, Gaia Consulting - Winnipeg  
Alison Nelson, AAFC – Carberry  
Manitoba Potato Research Committee  
Mario Tenuta, University of Manitoba - Winnipeg

## Results

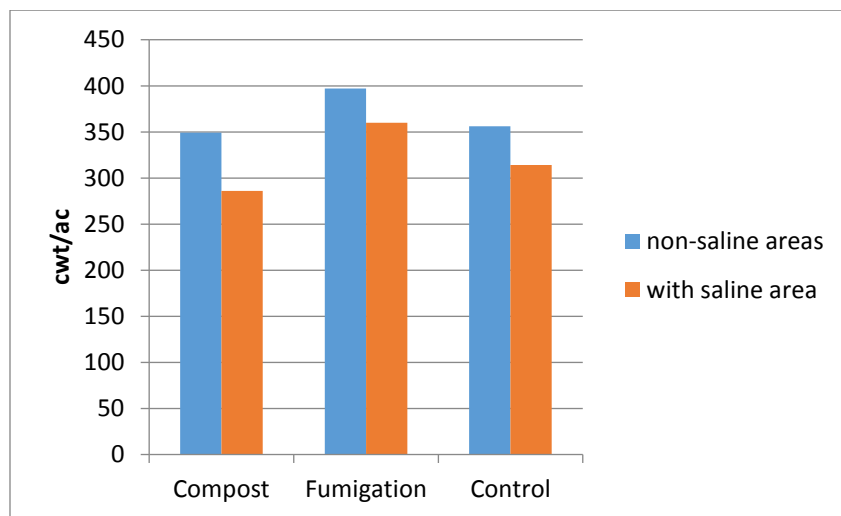
Fumigation and compost treatments were compared with a (no treatment) control of Potato Early Dying and *Verticillium dahliae*.

In this non-replicated demonstration, the average potato yield from the fumigation strip was higher than the compost or control treatments, but was not statistically significant.

Soil *V. dahliae* quantification is underway, and results will be shared when data analysis is complete.

Average fumigation yields in the demonstration area were higher than the compost and control treatments, but t-tests comparing the fumigation yields to the control and compost did not indicate that differences were statistically significant. Tuber size profiles, defects and fry quality were similar across the various treatments.

The laboratory results of the soil *V. dahliae* levels will be compared following completion of the analysis. Soil levels from 2014 will be compared with soil levels in 2017 under fumigation, compost and control treatments.



**Figure 1.** Average tuber yields by treatment. Blue bars do not include yields collected in saline area. Red bars are average yields, including saline area yields.

## **Background**

This project, carried out at Winkler was designed to help quantify the impact of two separate remediation techniques (compost and fumigation) on a native soil population of *V. dahliae*, the incidence of Potato Early Dying and tuber yield.

In 2014, an approximate 1-acre plot of potatoes was grown to establish the baseline levels of *V. dahliae* in the soil and observe the expression of potato early dying in the plot. The research plot area was selected to encroach into a saline zone, so observations could be made on the interaction of salinity and *V. dahlia* levels. In 2015 and 2016, rotational crops of canola and wheat (respectively) were grown, with fall compost and fumigation treatments applied. The study area was split into three, non-replicated demonstration strips:

- One strip received two fall applications of compost (one application in 2015 and a second application in 2016)
- One strip received a 2016 fall fumigation application of Metam Sodium
- One strip remained untreated

In 2017, the study area was planted to potatoes to test the impact of mitigation practices. Soil samples collected in spring and fall to measure *V. dahliae* levels. Yield samples were collected, and yield and quality was compared across treatments. As the demonstration plots were not replicated, results should be interpreted with caution.

## Seed Physiological Age of Russet Burbank Potatoes

**Project duration** – 2016-2018

**Objectives** - Determine the impact of seeding date, harvest date and soil moisture regime of a potato seed crop, and seed storage regime on physiological seed age and subsequent field performance of a Russet Burbank processing crop. Establish base seed performance values and physiological measures for future seed physiological age studies in Manitoba

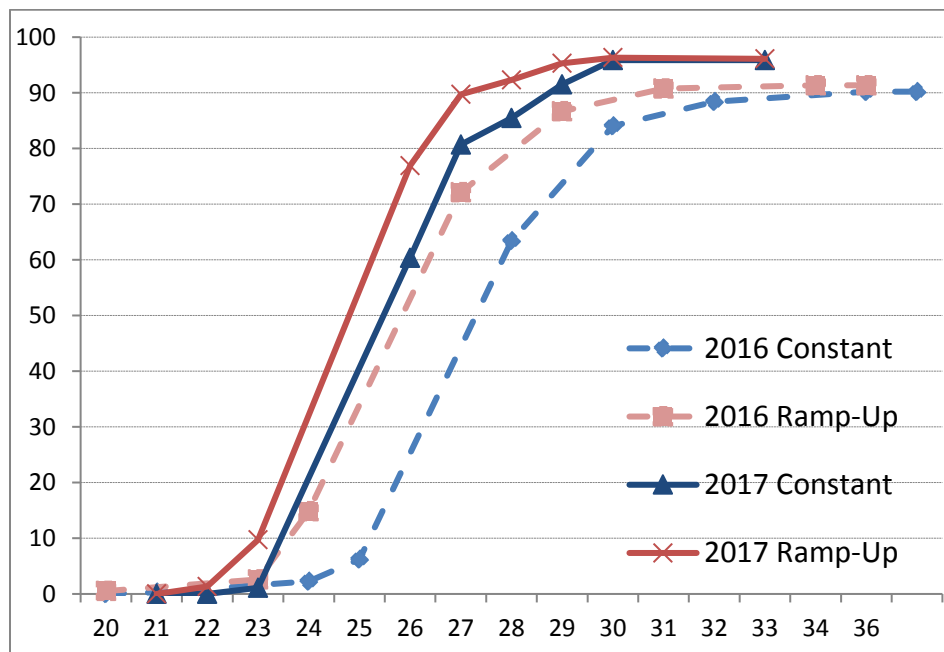
**Collaborators** - Alison Nelson, AAFC  
Manitoba Potato Research Committee

### Results

Warming seed for a number of weeks prior to planting did not impact crop yield, but did affect the tuber size profile. The warmed seed produced more tubers sized less than 6 oz. The constant storage temperature had more tubers in the 10-12 and >12 oz categories.

#### Year 2 Test Plot Results and Discussion

The 2016 and 2017 test plots were statistically similar, allowing the data from both years to be combined. Early seed crop planting and warming the seed before planting in year 2 increased the speed of emergence (Figure 1). There was also slightly lower total emergence (approximately 4% difference) from dryland seed compared to irrigated seed. Some trends and significant interaction effects were also observed, but these were not consistently strong sources of variation.



**Figure 1.** Effect of storage temperature on timing and percentage of emergence.

Early planting increased the number of tubers and stems per plant and decreased the percentage of oversized tubers (Table 3). Irrigated plots had a higher gross yield and a greater percentage of total defects (Table 3). Storage regime had the strongest impact on processing crop growth, and the characteristics of the tuber yield. The ramp up treatment had more tubers per acre and more stems per plant compared to the constant treatment (Table 3).

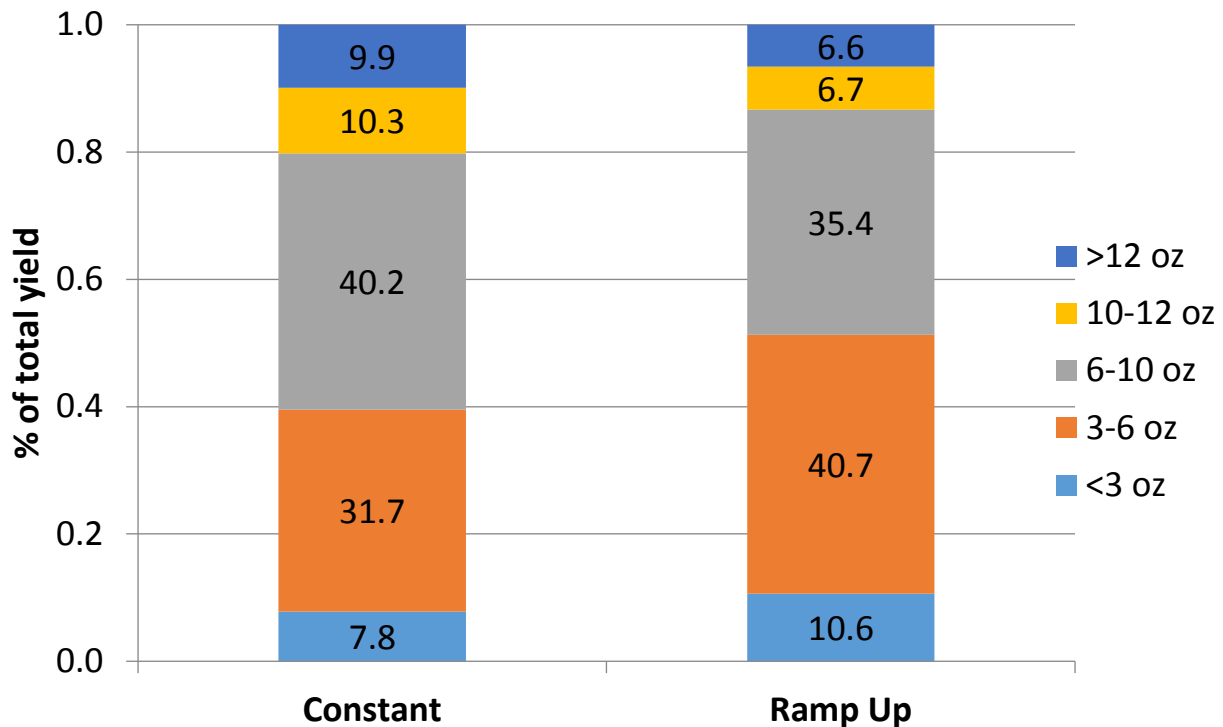
While storage regime did not have a significant impact on gross or marketable yield, it did have a significant impact on the tuber size profile (Table 1, Figure 2). All categories of size profile were impacted by the spring storage regime. The seed held at a constant temperature until a week before planting had more large tubers. The constant storage seed had more yield in the 6-10 oz, 10-12 oz and greater than 12 oz size categories, compared to the ramp-up storage seed. The seed that was ramped up and held at 10°C for a number of weeks before planting had more small tubers. The ramp up treatment had just over 10% more yield in tubers sized less than six oz (Table 1, Figure 2).

In 2018, the final Year 1 seed pieces will be planted at our Offsite location to provide a total of three years of data.

**Table 1.** Main factor effects on tuber number, stems per plant, defects and yields. Study years 2016 and 2017 are combined in this table.

	Tuber Number	Stems/Plant	Gross Yield (no dirt)	Total Defects	<3 oz	3-6 oz	6-10 oz	10-12 oz	>12 oz
	(#000/ac)		(cwt/ac)	(%)	(%)				
<b>Planting</b>	*	**							**
Early	173	4.2							7
Late	168	4.0							9
<b>Harvest</b>									
Early									
Late									
<b>Moisture</b>			*	**					
Dryland			578	4					
Irrigated			588	6					
<b>Storage</b>	***	***			***	***	***	***	***
Constant	159	3.9			7.8	31.7	40.2	10.3	9.9
Ramp up	182	4.3			10.6	40.7	35.4	6.7	6.6

\*, \*\*, \*\*\* indicate a significant effect of the main factor at  $P < 0.1$ ,  $P < 0.05$ ,  $P < 0.01$ , respectively. Increasing number of stars indicate greater level of statistical significance of the effect. Blank squares indicate that the mean values are not significantly different from one another.



**Figure 2.** Processing crop (year 2) tuber size profile from the two seed crop storage regimes over 2 years of data collection.

## Background

Growing and storage conditions of a potato seed crop are known to affect the seed physiological age, and the performance of the seed in the following production crop. The purpose of this study is to assess the effects and interactions of various potato seed crop management practices on the physiological age and subsequent performance of a processing potato crop.

## Materials & Methods

Treatments are applied to non-replicated seed plots in year 1. The impact of the seed treatments are observed in the randomized, replicated test plots in year 2.

In 2015, 2016 and 2017, non-replicated plots of E3 Russet Burbank seed were planted at CMCDC-Carberry Onsite to obtain all combinations of:

- Early and late planting dates (2-3 weeks apart)

- Early and late termination and harvest dates (2 weeks apart)

- Irrigated and dryland seed production

- Constant and ramp-up storage temperature regimes

A total of 16 seed crop treatments were obtained (Table 2) – the treatments are all applied to the seed crop plots (year 1). The seed crop treatment impacts on subsequent (year 2) crop performance were tested in a randomized complete block design trial, at CMCDC-Carberry Offsite in 2016 and 2017. The test plots in year 2 are all treated the same to determine the impact of seed crop management on processing crop stand, emergence, yield and quality. A third season of seed crop treatments were also grown in 2017, with the test plots slated for 2018.

**Table 2.** Treatment listing for the potato seed physiological age trial. All treatments are applied in the seed crop year (year 1), with the test plots (year 2) being treated equally across all plots.

<b>Treatment</b>	<b>Seed Crop Planting</b>	<b>Seed Crop Harvest</b>	<b>Seed Crop Moisture</b>	<b>Seed Storage Temperature</b>
<b>1</b>	Early	Early	Irrigated	Constant
<b>2</b>	Early	Late	Irrigated	Constant
<b>3</b>	Early	Early	Dryland	Constant
<b>4</b>	Early	Late	Dryland	Constant
<b>5</b>	Early	Early	Irrigated	Ramp up
<b>6</b>	Early	Late	Irrigated	Ramp up
<b>7</b>	Early	Early	Dryland	Ramp up
<b>8</b>	Early	Late	Dryland	Ramp up
<b>9</b>	Late	Early	Irrigated	Constant
<b>10</b>	Late	Late	Irrigated	Constant
<b>11</b>	Late	Early	Dryland	Constant
<b>12</b>	Late	Late	Dryland	Constant
<b>13</b>	Late	Early	Irrigated	Ramp up
<b>14</b>	Late	Late	Irrigated	Ramp up
<b>15</b>	Late	Early	Dryland	Ramp up
<b>16</b>	Late	Late	Dryland	Ramp up

## Seed Crop Treatments

The year 1 seed plot treatment details are outlined in Table 3. Planting and harvest dates differed by approximately two weeks. The tubers were dug approximately two weeks after vine kill, when field conditions were suitable for harvest. Tubers sized 3-8 oz. were stored for year 2 testing.

**Table 3.** Details of differences in year 1 seed crop treatment details.

Main Treatment	Treatment Details	
Planting Date	Early – before May 1	Late – mid-May
Harvest Date	Early - Terminated mid-Aug	Late - Terminated late Aug
Seed Crop Moisture	Irrigated – 4-5" added water	Rainfed – no added water
Seed Storage	Ramp up – in late March, start warming seed 0.5°C/day. Hold at 10°C until planting.	Constant – seed warmed by 0.5°C/day for approximately 1 week before planting

The length of the sprouts on the Ramp Up treatments required all seed pieces to be de-sprouted during handling, cutting and seed treatments (Figure 1). All seed pieces (3-8oz when put into storage) had a single cut made by hand, to make relatively uniform seed pieces with the same cut profile.



**Figure 1.** Sprouting on Ramp Up tubers (right) compared to Constant tubers (left)

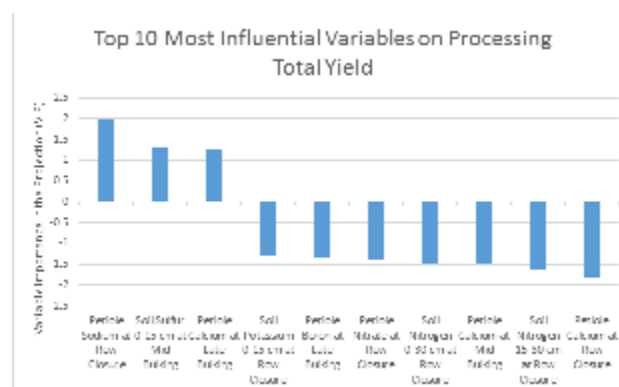




## Executive Summary of Understanding Potato Yield Variability: Increasing the Competitiveness of Manitoba's Potato Industry

Manitoba potato growers must generate an increased yield of a high-quality crop grown in a sustainable, cost effective manner to improve market competitiveness because of an upcoming expansion in processing potential within Manitoba. Competitive factors outside our influence include Manitoba's distance to markets, global supply and demand of processed potato products, and volatility in the exchange rate between Canada and the United States. Yield increases must be achieved through regional research, development, and evaluation of crop management strategies because the long-distance importation of research results from other areas risks overlooking regionally significant yield-limiting factors. The overall goal of the research program "Increasing the Competitiveness of Manitoba's Potato Industry" is to foster sustainable, competitive growth of the Manitoba potato industry through a research program within Manitoba. The current objective of this research program was to identify areas of variable potato yield and to characterize the variables responsible for variable yield. The future objective is to compile the most important variables responsible for variable yield and evaluate strategies to remediate each factor in-field.

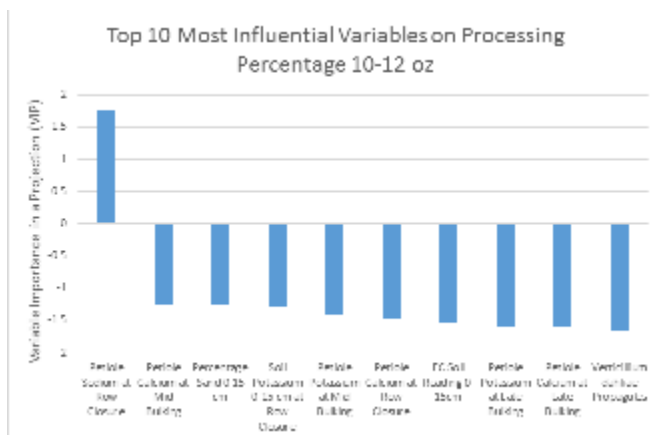
The variables associated with variability in the value (in dollars), specific gravity, and tuber size profiles of <3 oz, 3-6 oz, 6-10 oz, 10-12 oz, and > 12 oz of processing tubers are covered in detail in the full report. In the case of each dependant variables, such as total yield, a model was created which listed the major contributing variables and denotes if the association was positive or negative. In this summary, the results for total yield are included:



Listed above are the top ten most influential positive and negative variables on total yield of processing fields evaluated 2015-2017. The X axis (bottom) identifies the variable recorded, whether it was from the soil or petioles, and the time of year it was collected. Nutrients were generally recorded as lbs available to the plant in soil and PPM in petioles, as determined by Agvise testing. The Y axis identifies the Variable of Importance in Projection (VIP) in the creation of the model predicting total yield. Greater positive VIP (above zero) indicates that variable has a bigger, positive association with yield. In other words, a bigger VIP indicates that greater total yield from sampling points

was associated with the increasing amount of this nutrient in the soil or petiole. Lower, negative VIPs (below zero) indicates that variable has a bigger negative association with yield. As the VIP drops, the increasing amount of that nutrient is associated with the lowest yielding sampling points. The exact relationship between a negative VIP and too much or too little of nutrient must be determined by a resource such as Agvise recommendations or the Manitoba Soil Fertility guide (<https://www.gov.mb.ca/agriculture/crops/soil-fertility/soil-fertility-guide/>). It is important to note that 45-55 variables were associated with yield for all tuber size categories and total yield, but only the top ten were reported here for simplicity.

The same type of models were created for each of the tuber size categories as total yield. It is important to note that not all variables are consistent across total yield and each size category, meaning that some variables are important for specific size categories. These variables can be the target of remediation efforts if interest lies in improving the yield of that specific size category. Variables that show up across some or all size categories are consistently associated with greater or lesser potato yield, and the consistency is an important observation for remediation efforts to improve yield regardless of size category. The figure below lists the top ten most influential variables on 10-12 oz tubers to compare and contrast with total yield.



The most important variables contributing positively to both 10-12 oz tubers and total yield was petiole sodium at row closure. Over the course of the experiment, the percentage sodium recorded in the petiole by Agvise varied from 0.01% to 0.07%, indicating the percentage range of positive benefit was small. However, the analysis indicated that the higher percentages were associated with higher yielding sampling points. It is also important to note that the petiole sodium content became a negative yield association from mid bulking and late bulking, albeit not one of the top ten.

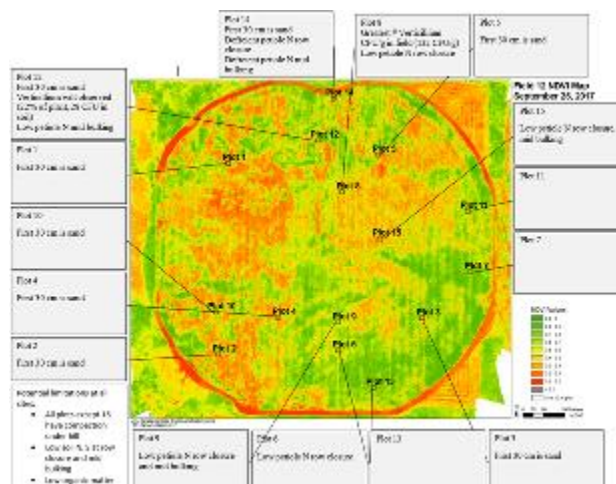
There were also two variables that were negatively associated with yield for both total yield and 10-12 oz yield. In these cases, too much or too little of either nutrient was associated with lower yielding sampling points. A soil test and reference are necessary to determine whether it was too much or too little – the model will not inform this result. Soil potassium at row closure from 0-15 cm was one such example, and 91 to 1150 PPM recorded as lowest to very high. The other consistent variables were petiole calcium at row closure and mid bulking. The percentage of petiole calcium at row

closure ranged from 0.87-2.48%, which appeared to range from high to very high. It is possible that excessive calcium was part of the negative yield association. Field experimentation to address the relationship between calcium or potassium on negative yield associations is absolutely necessary to verify this claim, especially before major management decisions are implemented.

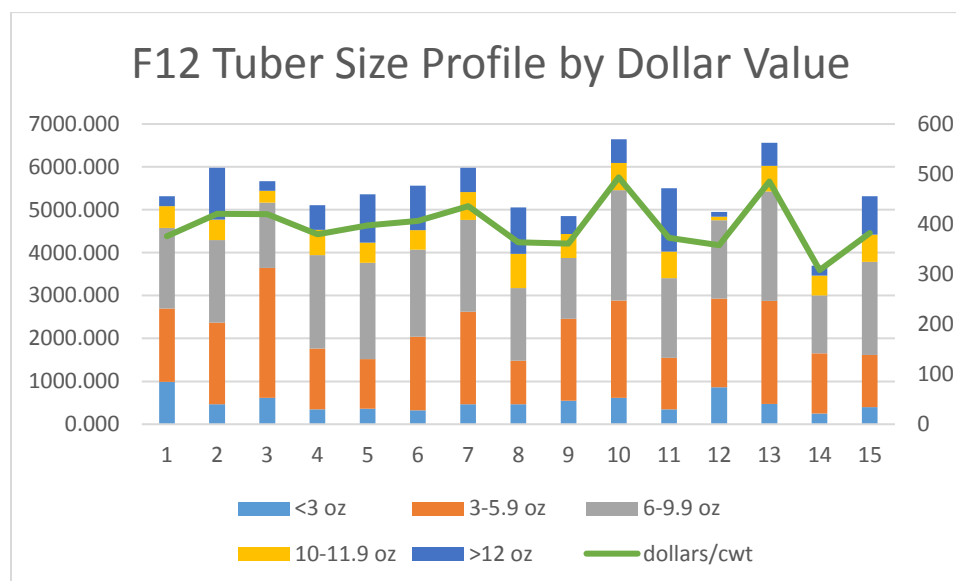
There are also many variables that appear on the top ten for total yield, but not 10-12 oz yield. For example, sampling points with greater petiole nitrate at row closure are associated with total yield negatively (i.e. greater petiole nitrate at row closure is associated with the lowest yielding sampling points). The PPM of nitrate in the petiole ranged from 3,892 to 24,852. Ten of the sixty sampling points were deficient at this time, and fifteen of the sixty were low. No sampling point had high petiole nitrate at this time. It is likely that the negative yield association for total yield was observed with low to deficient petiole nitrate sampling points. As with soil potassium and petiole calcium, field experimentation is necessary to demonstrate this relationship and evaluate remediation approaches.

Increasing numbers of *Verticillium* propagules were the largest negative contribution to 10-12 oz yield. *Verticillium* infection is likely preventing the tubers from sizing in the 10-12 oz category more so than the smaller categories. The fact that these variables appear in only one tuber size category is an important consideration for specific remediation strategies aimed at improving yield to just this size of tuber.

In addition to evaluating the impact of variables on yield of all the processing fields combined, individual fields from 2017 were rated for nutrient, soil, disease, and plant health status. Drone imagery was used in conjunction with scouting, nutrient status as determined by Agvise recommendations, and yield to visualize variability at each sampling point and what trends were apparent in the overall yield. The point of this individual analysis is to demonstrate the usefulness of the PLS analysis from all processing fields in identifying one or a few major yield-limiting factors from a larger list of potential problems listed for a specific site. This information begins the conversation with a local consultant and grower about priorities in remediating yield variability, and ultimately ideal practices to remediate the situation. The results are covered in detail in the following report. In summary, the results for one 2017 processing field are included:



Green on above drone image indicates the living potato plants from a drone flight on September 25<sup>th</sup>, while varying degrees of yellow indicate areas of plant die-down. Red indicates bare earth. Each of the 15 sampling points is geo-referenced and were selected to represent the full variation in soil nutrient content, organic matter, texture, and topography. Possible factors for yield variability, as indicated by the Manitoba Soil Fertility guide, are highlighted for each point and on a field-wide basis.

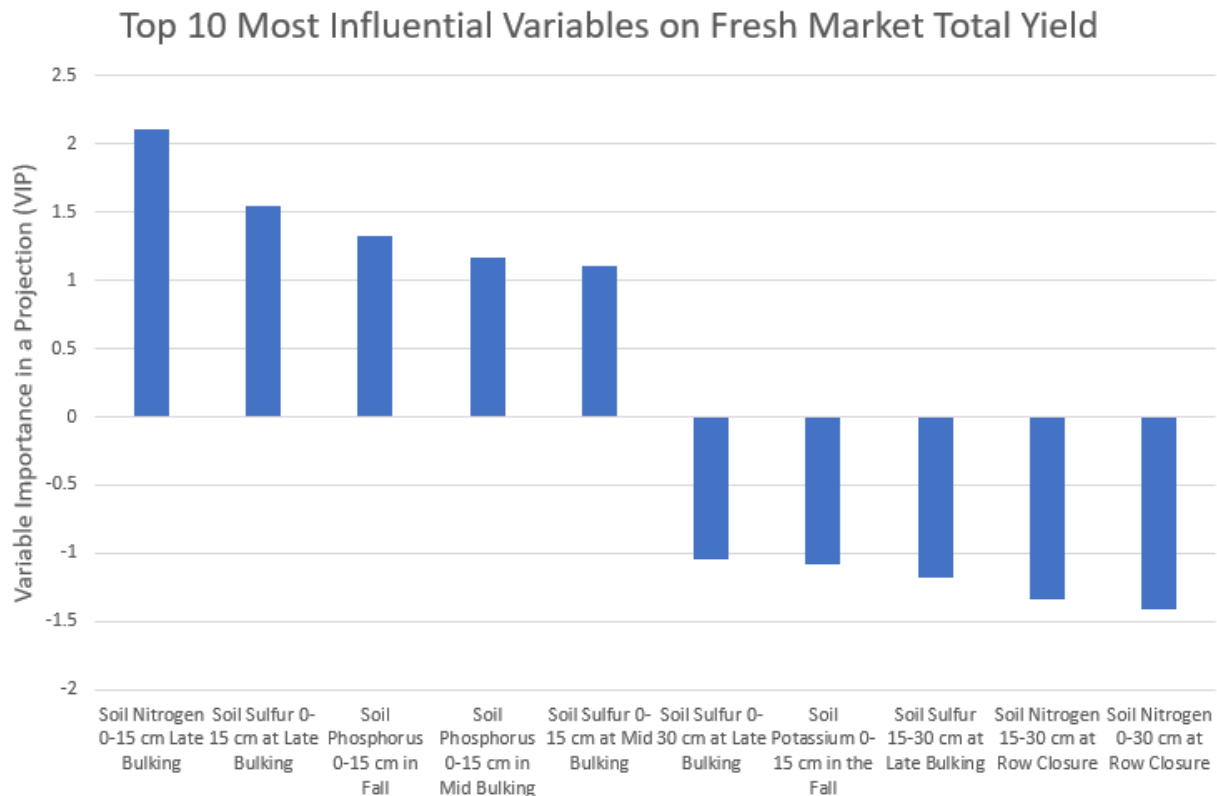


The yield of the same field (#12), split by tuber size profile, is listed about by each sampling point. Each point (1-15) on the above image corresponds to the plot numbers in the previous image. Each color represents a specific tuber size profile. For example, yellow bars near the top indicate the 10-11.9 oz tuber size. The yield is measured in hundredweight per acre (Cwt/A) on the right side, and the harvest date was the first week in September. The green line connecting the bars is the estimated dollar value of the sampling point. The scale for the dollar value is on the left side.

In comparing the drone image of field 12 to the tuber size profile, some trends become apparent. The lowest yielding sampling point number 14 was observed to have compaction under 30 cm, low soil nitrogen and sulfur at row closure and mid bulking, low organic matter, high sand composition, and deficient petiole nitrogen at row closure and mid bulking. It is possible that the combination of some or all of these factors contributed to the yield limitation. This situation is where the partial least squares regression (PLS) analysis from earlier can provide some clarity. The sulfur concentration in the soil at mid bulking was an important, positive yield association for total yield. The low soil sulfur at mid bulking could possibly be a large contributor to this yield reduction. In addition, the noted low soil nitrogen availability is also an important variable identified in the PLS regression analysis for all processing fields. Further trends are apparent as the potential problems of an individual sampling point are cross-referenced with the PLS regression analysis for each tuber size profile further into this report. The full set of conclusions complete objective of this research program was to identify areas of variable potato yield and to characterize the factors responsible for variable yield. These conclusions are expected to influence the choices in meaningful

yield variability remediation strategies and products are evaluated moving forward in the future of this project.

Fields destined for processing were not the only market consideration throughout the course of this project. Two fresh market fields were analyzed separately from processing fields in 2017. The variables associated with variability in the misshapen tubers, knobs, growth cracks, enlarged lenticels, russeting, and tuber size profiles of <2 in, 2-2.25 in, 2.25-3 in, 3-3.5 in, and > 3.5 in of fresh market tubers is also covered in detail in the full report. In summary, only the results for total yield are included:



Listed above are the top ten most influential positive and negative variables on total yield of fresh market fields evaluated in 2017. As before, a bigger VIP indicates that greater total yield from sampling points was associated with the increasing amount of this nutrient in the soil or petiole. As the VIP drops, the increasing or decreasing amount of that nutrient is associated with the lowest yielding sampling points.

Sampling points with greater soil nitrogen concentration at late bulking are associated with total yield positively (i.e. greater soil nitrogen at late bulking is associated with the highest yielding sampling points). Conversely, greater soil nitrogen concentration (0-30 cm) at row closure was negative associated with yield – more soil nitrogen at row closure was associated with lower yielding points. Greater soil sulfur in the upper (0-15 cm) soil layer were associated with the highest yielding sampling points at mid and late bulking. The most pronounced benefit of soil sulfur was more strongly associated with late bulking than mid bulking. In contradiction, soil sulfur from the deeper (15-30 cm) soil layer was negatively associated with fresh market yield at late bulking.

The objective of this research program was to identify areas of variable potato yield and to characterize the factors responsible for variable yield. Lists of the top ten most important variables associated with variable yield for fresh market and processing tubers sizes have been established. Moving forward, the objective will be to revisit fields coming back into the potato rotation at the beginning of the study to observe if these same yield-limiting variables can be observed repeatedly. In addition, yield-limiting variables identified and mapped in the first objective will be used to develop and evaluate remediation strategies in-field. Improving yield of desirable tuber sizes in less-than-ideal patches of fields in the project will add to the value of the crop, thereby improving the competitiveness of the Manitoba potato farmer in the market. This is important as processing expansions in Manitoba come into effect in the near future. Once cooperators are satisfied by remediation strategies to variable yield, other Manitoba growers can judge the fit of the practice to their operation. Remediation strategies that are adopted on a larger scale provincially will amplify the desired goal to reach and improve the competitiveness of all Manitoba potato growers.