IHARF
INDIAN HEAD AGRICULTURAL RESEARCH FOUNDATION

2017 Annual Report

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Contents

Introduction

The Indian Head Agricultural Research Foundation (IHARF) is a non-profit, producer directed applied research organization which works closely with various levels of government, commodity groups, private industry and producers.

Founded in 1993, the mission of IHARF is to promote profitable and sustainable agriculture by facilitating research and technology transfer activities for the benefit of its members and the agricultural community at large.

IHARF Mandate

- Identify new research priorities required to meet the needs of agriculture now and in the future,
- Support public good research - research that has value to the public but is not tied to studying or promoting a specific product or service,
- Maintain strategic alliances with the agricultural community in order to strengthen the provincial research base,
- Play an active role in the technology transfer process and be involved in public education and awareness activities,
- Maintain a scientific research base at the Indian Head Research Farm.

IHARF Board of Directors

IHARF is led by a nine member Board of Directors consisting of producers and industry stakeholders who volunteer their time and provide guidance to the organization. Residing all across south eastern Saskatchewan, IHARF Directors are dedicated to the betterment of the agricultural community as a whole. The 2017 IHARF Directors included:

- Chris Brown - President *(Indian Head)*
- Travis Wiens - Vice President *(Milestone)*
- Janel Delage - Secretary / Treasurer *(Indian Head)*
- Fred Stilborn *(Balcarres)*
- Rick Procyk *(Fillmore)*
- Kyle Heggie *(Leross)*
- Cameron Gibson *(Kendal)*
- Ivan Ottenbreit *(Grayson)*
- Doug Hannah *(Foam Lake)*

Ex-Officio

IHARF receives additional guidance from an experienced team of Agriculture and Agri-Food Canada (AAFC) personnel at the Indian Head Research Farm, they include:

- Henry de Gooijer - Coordinating Biologist
- Bill May - Research Scientist
- Chris Omoth - Research Assistant

IHARF Staff

The 2017 team of IHARF staff included:

- Danny Petty - Executive Manager
- Chris Holzapfel - Research Manager
- Christiane Catellier - Research Associate
- Jared Solomon - Farm Technician
- Andrea De Roo - Agronomy Research Intern
- Dan Walker - Seasonal Technician
- Shaelyn Stadnyk - Summer Research Assistant
- Karter Kattler - Summer Research Assistant
- Dr. Ron Palmer - Electronic Systems Engineer

Dr. Guy Lafond Memorial Award

Guy had a passion for agricultural research and was dedicated to the advancement of the industry. He was instrumental in establishing the Indian Head Agricultural Research Foundation, and believed in IHARF's Mission, Mandate and the training of young agronomists.

The recipient of the Dr. Guy Lafond Memorial Award in 2017 was Gursahib Singh. Gursahib is completing his Masters in Plant Sciences at the University of Saskatchewan, studying fusarium head blight management strategies in wheat.

Extension Events

Indian Head Crop Management Field Day

On July 18, 2017, IHARF and AAFC hosted the annual Indian Head Crop Management Field Day. 186 producers and agronomists from across the Prairies came for tours led by IHARF, AAFC, University of Saskatchewan and industry specialists. Tours and presentations were provided by:

- Chris Holzapfel (IHARF)
- Bill May (AAFC Indian Head)
- Gursahib Singh (University of Saskatchewan)
- Rachel Evans (Flax Council of Canada)
- Stu Brandt (Northeast Agriculture Research Foundation)
- Dr. Raju Soolanayakanahally (AAFC Saskatoon)

AgriARM Research Update

On January 11, 2018, IHARF, along with Agriculture Applied Research Management (AgriARM) organizations from across the province, jointly hosted the AgriARM Research Update as part of Crop Production Week in Saskatoon, SK. The event highlighted components of each organizations applied research and demonstration programs. Presenters for the day included:

- Chris Holzapfel (IHARF)
- Mike Hall (East Central Research Foundation)

- Jessica Weber (Western Applied Research Corporation)
- Joel Peru (Irrigation Crop Diversification Corporation)
- Gary Kruger (Irrigation Crop Diversification Corporation)
- Jessica Pratchler (Northeast Agriculture Research Foundation)
- Garry Hnatowich (Irrigation Crop Diversification Corporation)
- Bryan Nybo (Wheatland Conservation Area)
- Lana Shaw (South East Research Farm)

Presentations from each speaker are available for download at www.agriarm.ca.

IHARF Soil and Crop Management Seminar

On February 7, 2018, IHARF hosted its annual winter seminar in Balgonie, SK, highlighting results of the 2017 season and current industry issues. 179 guests took in presentations delivered by:

- Chris Holzapfel (IHARF)
- Bill May (AAFC Indian Head)
- Dustin Gabor (GrainShark.com)
- Dr. Bruce Gossen (AAFC Saskatoon)
- Dr. Diane Knight (University of Saskatchewan)
- Dr. Kelly Turkington (AAFC Lacombe)

Presentations from each speaker are available for download at www.iharf.ca.

2017 IHARF Partners

Every year, IHARF works with many organizations dedicated to advancing agriculture into the future. IHARF would like to thank all of our partners for their outstanding support of our efforts in 2017:

Platinum

- Agriculture & Agri-Food Canada - Indian Head Research Farm
- Agriculture & Agri-Food Canada - AgriInnovation Program
- Agriculture Development Fund
- Bayer CropScience
- Canada/Saskatchewan ADOPT Program
- Saskatchewan Ministry of Agriculture
- Saskatchewan Oat Development Commission
- Saskatchewan Pulse Growers
- Western Grains Research Foundation

Gold

- Agriculture & Agri-Food Canada - Green Jobs Initiative
- BASF
- Compass Minerals
- DSW Enterprises
- Emerald BioAG
- Koch Agronomic Services
- NorthStar Genetics
- Saskatchewan Canola Development Commission

- Saskatchewan Wheat Development Commission
- Syngenta

Silver

- Agrisoma Biosciences
- Anuvia Plant Nutrition
- Ceapro
- Crop Production Services
- Dow AgroSciences
- Ducks Unlimited Canada
- Engage Agro
- Manitoba Canola Growers
- Markusson New Holland
- Mosaic
- Pioneer Hi-Bred
- Saskatchewan Flax Development Commission
- University of Saskatchewan
- Yara

Bronze

- Dekalb
- FendX
- GrainShark.com
- HCI Ventures
- IntraGrain Technologies
- Lutzer-Latrace Seed Farm
- Manitoba Pulse & Soybean Growers
- Monsanto BioAg
- TD Canada Trust
- Thunder Seeds
- Town of Indian Head

AgriARM

The Saskatchewan AgriARM (Agriculture Applied Research Management) program connects eight regional, applied research and demonstration organizations into a province wide network. Each location is structured as a non-profit organization, and is led by volunteer Boards of Directors, generally comprised of producers in their respective areas.

Each organization receives base-funding from the Saskatchewan Ministry of Agriculture to assist with operating and infrastructure costs; with project-based funding sought after through various government funding programs, producer / commodity groups and industry stakeholders. AgriARM provides a forum where government, producers, researchers and industry can partner on provincial and regional projects.

The eight AgriARM organizations found throughout Saskatchewan include:

- Conservation Learning Centre (CLC), Prince Albert
- East Central Research Foundation (ECRF), Yorkton
- Indian Head Agricultural Research Foundation (IHARF), Indian Head
- Irrigation Crop Diversification Corporation (ICDC), Outlook
- Northeast Agriculture Research Foundation (NARF), Melfort
- South East Research Farm (SERF), Redvers
- Western Applied Research Corporation (WARC), Scott
- Wheatland Conservation Area (WCA), Swift Current

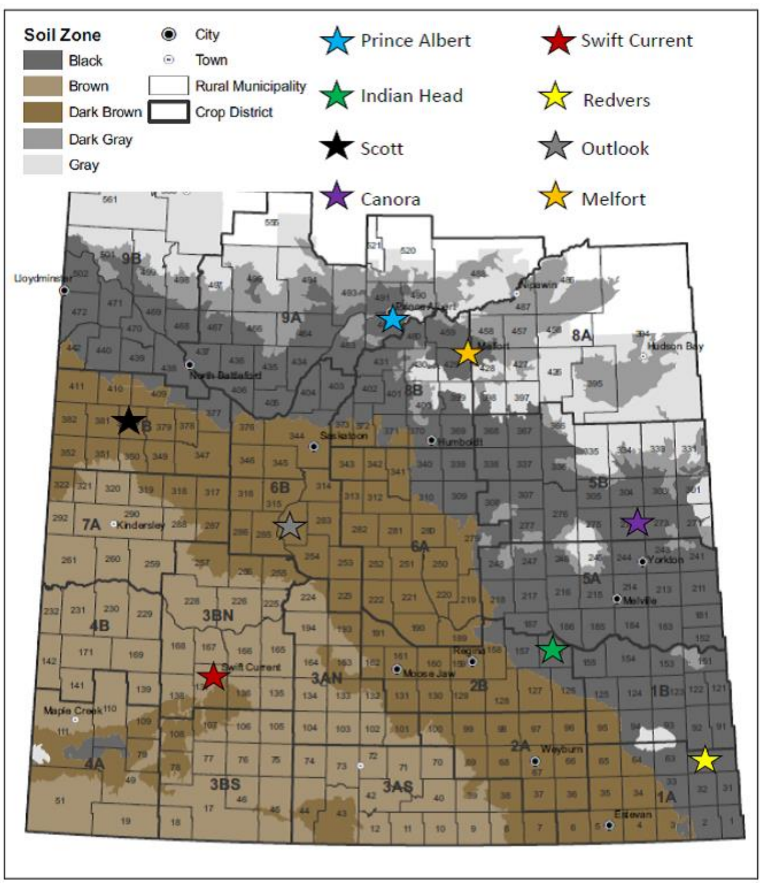

Figure 1. Locations of organizations comprising the Saskatchewan AgriARM Network.

Environmental Data

Weather data for Indian Head, Melfort, Scott, and Swift Current, Saskatchewan, are provided, as many of the studies were conducted at these locations and the data were combined for analyses. Data were obtained from an Environment Canada weather station found at each site, and accessed online [http://climate.weather.gc.ca/historical_data/search_historic_data_e.html].

The 2017 growing season produced above average yields amongst the crops grown at Indian Head. The spring began with adequate soil moisture levels with timely rains received and favorable growing conditions throughout the season. Though harvest was wrapped up relatively close to the long term average, as harvest went on, more rain events did delay field operations and the harvest of longer season crops. Some plots were damaged by hail during storm events in June and July, delaying maturity slightly, while yield and quality appeared to be minimally affected.

Table 1. Mean monthly temperatures for the 2017 growing season and long-term normals (1981-2010).

		Apr	May	Jun	Jul	Aug	Sep	Oct
		°C						
Indian Head	2017	4.2	11.6*	15.5	18.4	16.7	11.3*	5.0
	normal	4.2	10.8	15.8	18.2	17.4	11.5	4.0
Melfort	2017	2.9*	10.8	15.2	18.7*	17.2	12.5*	4.3*
	normal	2.8	10.7	15.9	17.5	16.8	10.8	3.3
Scott	2017	3.0*	11.5	15.1*	18.3*	16.6*	11.5	3.8
	normal	3.8	10.8	15.3	17.1	16.5	10.4	3.3
Swift Current	2017	4.4*	13.0*	15.7*	20.7*	18.4*	13.3*	4.8*
	normal	5.2	10.9	15.4	18.5	18.2	12.0	5.1

* The value displayed is based on incomplete data

Table 2. Total monthly precipitation for the 2017 growing season and long-term normals (1981-2010).

		Apr	May	Jun	Jul	Aug	Sep	Oct	Total
		mm							
Indian Head	2017	18.5	10.4*	65.6	15.4	25.2	12.4*	19.2	166.7
	normal	22.6	51.7	77.4	63.8	51.2	35.3	24.9	326.9
Melfort	2017	23.6*	46.4	44.1	33.3*	3.1*	13.2*	43.5*	207.2
	normal	26.7	42.9	54.3	76.7	52.4	38.7	27.9	319.6
Scott	2017	30.9*	69.0	34.3*	22.4*	53.0*	18.9	20.9	249.4
	normal	21.6	36.3	61.8	72.1	45.7	36.0	17.9	291.4
Swift Current	2017	8.6*	15.4*	31.9*	9.3*	11.2*	3.2*	51.7*	131.3
	normal	19.9	48.5	72.8	52.6	41.5	34.1	18.1	287.5

* The value displayed is based on incomplete data

Research

IHARF trials were situated at various locations in the Indian Head area, with the majority of projects located on NW28-18-12 W2 and NE27-18-12 W2. Each trial consisted of numerous plots, each representing a specific treatment being evaluated in that particular project (eg. rates, seed treatments, varieties, etc.). Apart from the specific treatments being evaluated, plots were generally cared for using best management practices and in a manner which was consistent with normal or typical practices in the Indian Head area. Deviations in agronomy and crop management have been specified where required as a result of the study objectives or treatments being evaluated and are indicated in the description of each trial. In general, plots were seeded as early as possible in mid-May to early June, with 8' x 35' plots and 12" row spacing using a SeedMaster air drill, or with 12' x 35' plots and 12" row spacing using a ConservaPak air drill. Cultivars and varieties were representative of those used by producers in the area, and recommended seeding practices (i.e. rate, depth) were typically used. Fertility and insect, weed and disease levels were normally kept non-limiting using commercial fertilizers and registered pesticide products so that yields would not be limited by anything other than the specific treatments being evaluated. Plots were desiccated or swathed when required, and harvested as closely as possible to the appropriate timing using a Wintersteiger plot combine, Kincaid-8 XP plot combine, or modified MF300 combine. Apart from the treatments being evaluated, all agronomy and crop management practices were consistent for every plot within a trial.

Statistical Analyses

The majority of trials were conducted using a randomized complete block design (RCBD), or a modified version of this experimental design, meaning each treatment is randomly assigned to plots within replicates (blocks). Split-plot designs were also frequently used. Treatments were replicated 4 times allowing for the statistical analyses of results to assess whether the observed differences in the responses (eg. plant density, height, seed yield) were an effect of the treatment being evaluated or due to natural variability or experimental error. If a difference between two treatments is significant, it should be repeatable and reasonably expected, under the conditions in which the trial was conducted. For agricultural research, a significance level of $\alpha=0.05$ is generally used, which more specifically indicates a 95% probability that an observed effect was caused by the treatment and was not due to random variability or experimental error.

In this report, statistical differences between treatments are represented by letters of the alphabet next to the observed mean (average) for each treatment. Treatment means with the same letter do not significantly differ, while means with different letters are significantly different from one another (Table 3). In the example below, there was no difference in plant density between the two treatments; however, Treatment 2 resulted in a significantly higher yield than Treatment 1.

Table 3. Example demonstrating how statistical results are presented in the report.

Treatment	**Plant Density** *(not significantly different)*	**Yield** *(significantly different)*
Treatment 1	87 a	32 b
Treatment 2	89 a	45 a

Units

Some data are reported in metric terms (i.e. yield responses shown in kilograms per hectare), particularly in cases where it was not practical to convert the values to bushels per acre (bu/ac), as in certain figures. For reference, yield values ranging from 1000-6000 kg/ha are shown with the corresponding values in bu/ac for each crop. Alternatively, multiplying the kg/ha by 0.8921 will provide the lbs/ac, making for an easy conversion to bu/ac.

Table 4. Conversion of kg/ha to bu/ac for various crops.

		kg/ha										
		1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000
Barley	bu/ac	18.6	27.9	37.2	46.5	55.8	65.1	74.3	83.6	92.9	102.2	111.5
Canola		17.8	26.8	35.7	44.6	53.5	62.5	71.4	80.3	89.2	98.1	107.1
Faba beans		14.9	22.3	29.7	37.2	44.6	52.0	59.5	66.9	74.3	81.8	89.2
Flaxseed		15.9	23.9	31.9	39.8	47.8	55.8	63.7	71.7	79.7	87.6	95.6
Oats		26.2	39.4	52.5	65.6	78.7	91.8	105.0	118.1	131.2	144.3	157.4
Peas		14.9	22.3	29.7	37.2	44.6	52.0	59.5	66.9	74.3	81.8	89.2
Soybeans		14.9	22.3	29.7	37.2	44.6	52.0	59.5	66.9	74.3	81.8	89.2
Wheat		14.9	22.3	29.7	37.2	44.6	52.0	59.5	66.9	74.3	81.8	89.2

Disclaimer

Disclosure of trade names does not imply any endorsement or disapproval of any specific product(s) and is only intended to differentiate treatments and allow producers to identify the specific technologies being demonstrated in the marketplace.

Nitrogen Response of Modern Fall Rye Varieties

Description

The introduction of new hybrid fall rye varieties in western Canada has led to renewed interest in this crop. Traditionally, fall rye has been grown as a low-input crop, likely because it has a relatively high nitrogen use efficiency compared to winter wheat and tends to be grown on lower quality land. Averaged across the major provincial zones, the five currently available hybrids yield 111-127% of the current check (and highest yielding open pollinated variety) Hazlet. It is possible that higher rates of N fertilizer are required to achieve the maximum yield potential of these modern fall rye varieties. The objective of this project was to demonstrate the nitrogen fertilizer requirements of a high yielding fall rye hybrid versus conventional open pollinated varieties. This study was conducted over three years from 2014-2017 at Indian Head, Saskatchewan. The treatments were a combination of two varieties and six N fertilizer rates. The variety was either Hazlet (open pollinated) or Brasetto (hybrid) and the N rates were 6, 50, 100, 150, 200 or 250 kg N ha^{-1}.

Results

The open pollinated (OP) rye was 12% taller than the hybrid and was more susceptible to lodging at high N rates. Nitrogen affects on plant height were small and inconsistent but, specifically for the OP variety, lodging increased when N rates were increased past 100 kg N/ha. Grain yields for the hybrid were 25-27% higher than the OP variety. The N response curves were similar for the two varieties when averaged over the three-year period. The response to N fertilization was strong with maximum yields achieved at approximately 190 kg N/ha (Figure 2) and probable economic optimum rates between 100-150 kg N/ha depending on grain and fertilizer prices.

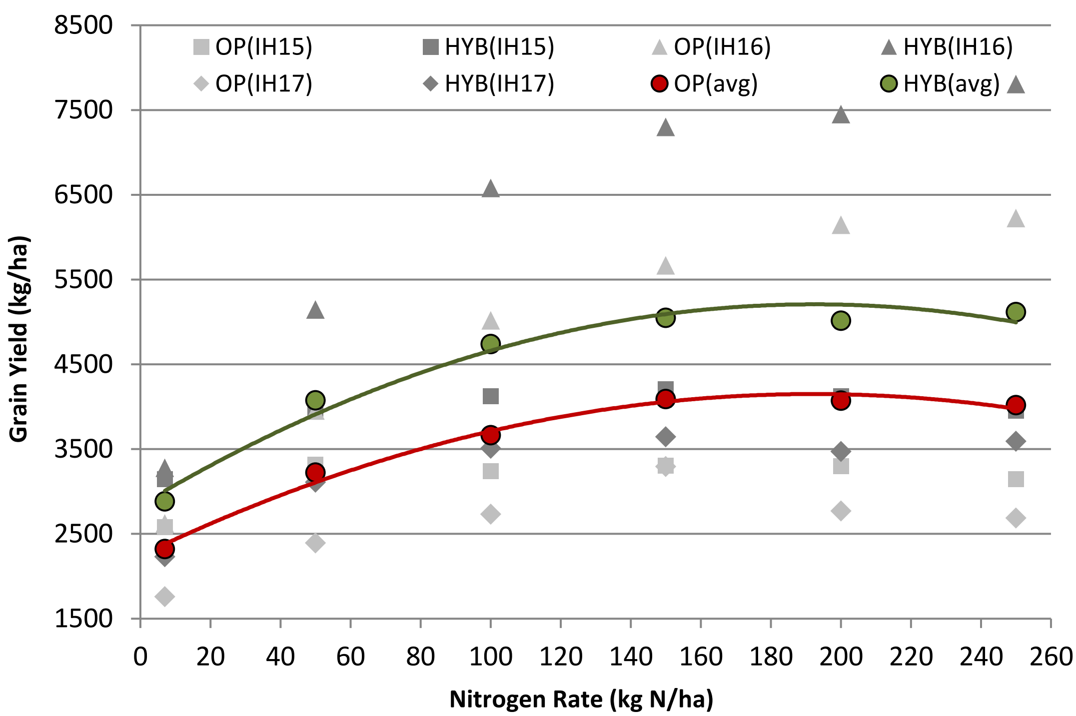

Figure 2. Nitrogen fertilizer rate effects on fall rye (hybrid versus open pollinated) grain yield over a three-year period at Indian Head (2015-17).

Protein concentrations were consistently higher for the OP variety (12.1%) than for the hybrid (11.3%). However, there are no protein premiums for fall rye so there is no economic incentive to apply rates beyond those required to optimize yield. Over the three year study, lodging severity was relatively low but there was always less lodging with the hybrid compared to the OP variety when averaged across N rates and the overall trend was for lodging to increase with N fertilizer rate but only for the OP variety. Ergot is often the most important grading factor in fall rye and was affected by year, variety and N rate. The variety effects were inconsistent as ergot concentrations were higher with the OP variety in 2015 but the opposite occurred in 2016 and 2017. Percent ergot also increased with increasing N rate in each of the three years, most prominently in 2016 when overall pressure was highest.

Conclusions

All factors considered and with the exception of lodging, OP and hybrid rye varieties appeared to respond similarly to varying N fertilizer rates. Despite the higher overall potential with the hybrid, yields for the two varieties were optimized at similar N rates and quality loss occurred with both varieties when excessive N rates were applied. These results suggest that both rye varieties respond well to higher N fertilizer rates than have often been traditionally applied.

Acknowledgements

This project was supported by the Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canada-Saskatchewan Growing Forward 2 bi-lateral agreement, with in-kind support provided by FP Genetics, Bayer CropScience and BASF. Throughout the project, Jamie Larsen (AAFC – Lethbridge) has assisted with the interpretation and dissemination of results and completed the falling number analyses as an in-kind contribution to the project.

Seeding Rate Response of Modern Fall Rye Varieties

Description

There has been renewed interest in fall rye with the introduction of new hybrid varieties that are higher yielding than previous open pollinated varieties. When transitioning to hybrids, seed costs for this crop will increase considerably. This increase is due to the combination of higher initial costs and the requirement to purchase new seed annually. The objective of this project was to demonstrate the optimum fall rye seeding rates for high yielding hybrids versus conventional open pollinated varieties. This study was conducted over a two year period (2016-2017). The treatments were a combination of two varieties and six seeding rates. The variety was either Hazlet (OP) or Brasetto (hybrid) and the seeding rates were 50, 110, 170, 230, 290 or 350 viable seeds m^{-2}.

Results

The hybrid out-yielded the OP variety by 26% when averaged across seeding rates in 2016 and by 17% under the lower yielding conditions in 2017. The OP variety was relatively unresponsive to seeding rate but yields did tend to be lowest at the lowest seeding rate (Figure 3). The hybrid variety was more responsive to seeding rate with maximum yields achieved at 170-230 seeds/m^2 and slight declines as seeding rate was further increased to 350 seeds/m^2. The optimum seeding rate and overall range in yields across seeding rates was greater under the dry conditions of 2016-17 when compared to the much wetter previous season. One of the greatest causes of down-grading in fall rye is ergot, which was higher overall in the hybrid. For both varieties, ergot was greater at sub-optimal (< 170 seeds/m^2) seeding rates and the seeding rate effect was much stronger with the hybrid.

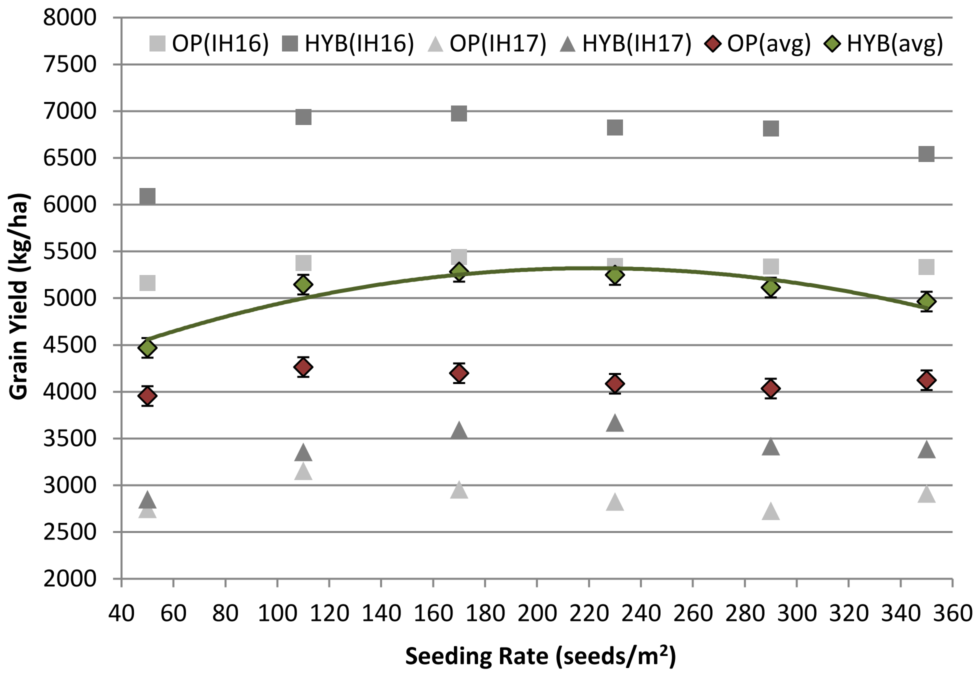

Figure 3. Seeding rate effects on fall rye (hybrid vs open pollinated) grain yield over a two-year period at Indian Head (2016 & 2017).

Conclusions

The target seeding rate of approximately 170-230 seeds m^{-2} is sufficient to optimize both yield and quality across a wide range of environmental conditions for the hybrid variety. The higher end of the range would be recommended if conditions are considered poor for establishment or dry weather is likely to be a yield limiting factor.

Acknowledgements

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Demonstrating 4R Nitrogen Principles in Canola

Description

Developing Best Management Practices (BMPs) for nutrient applications is focussed on the 4R principles which emphasize using the: 1) right source, 2) right rate, 3) right time and 4) right place. Nitrogen is the most commonly limiting nutrient in annual crop production and is often the most expensive crop nutrient, particularly for crops with high N requirements like canola. For many producers there has been movement back to a two pass seeding / fertilization system due to logistics while others have struggled with excess moisture and want to improve the efficiency of their N fertilizer through in-soil applications of EFF products or split-applications. The objective of this project was to demonstrate canola response to varying rates of nitrogen fertilizer along with different combinations of formulations, timing and placement methods relative to side-banded, untreated urea as a control. The treatments are outlined in Table 5.

Table 5. Nitrogen management treatments in 4R canola demonstration.

Trt	Formulation	Timing / Placement	Fertilizer Rate [Z]
1	N/A	N/A	N/A
2	Urea	Side-band (during seeding)	55 kg N/ha
3	Urea	Side-band (during seeding)	110 kg N/ha
4	Urea	Side-band (during seeding)	165 kg N/ha
5	Urea	Pre-seed surface broadcast	110 kg N/ha
6	UAN	Pre-seed surface dribble-band	110 kg N/ha
7	Agrotain®	Pre-seed surface broadcast	110 kg N/ha
8	SuperUrea®	Pre-seed surface broadcast	110 kg N/ha
9	Urea / Urea	50:50 Split Application [Y]	110 kg N/ha
10	Urea / UAN	50:50 Split Application	110 kg N/ha
11	Urea / Agrotain®	50:50 Split Application	110 kg N/ha
12	Urea / SuperUrea®	50:50 Split Application	110 kg N/ha

[Z] 35 kg/ha residual NO_3-N as determined by fall composite soil sample for the site. [Y] 55 kg N/ha as side-banded plus a post-emergent surface application of 55 kg N/ha at early bolting stage.

Results

Yields increased sharply from the 35 - 110 kg total N/ha and then tapered off between the 145 – 200 kg total N/ha. Side-banded urea resulted in higher yields than any other individual treatment except for the split application with Agrotain® (Figure 4). There were few differences among the alternative N management treatments except the split-application of Agrotain® yielded significantly higher than the treatment of Agrotain® broadcast prior to seeding.

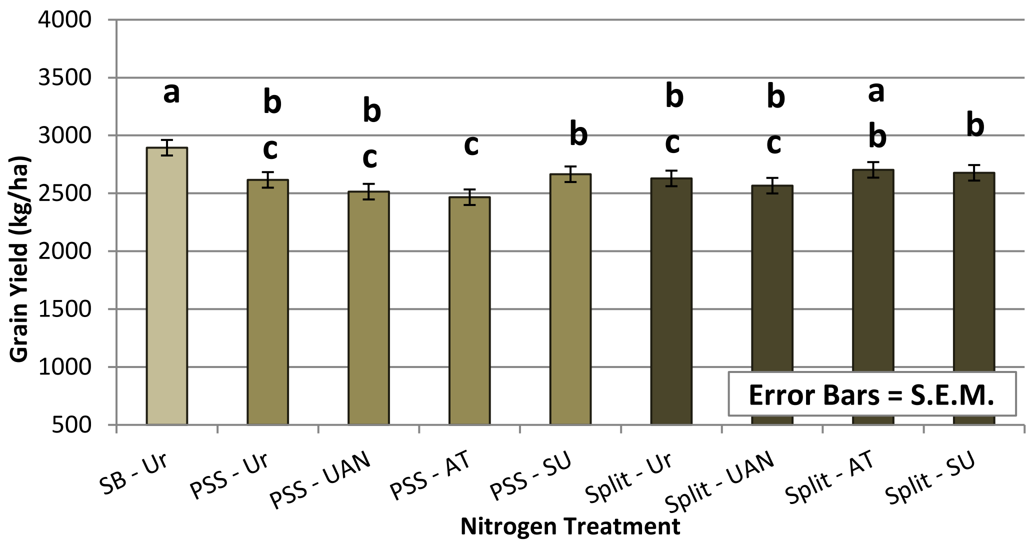

Figure 4. Nitrogen form/placement/timing effects on canola grain yield at Indian Head (2017). SB – side-band, PSS – pre-seed surface, Split – 50% side-banded urea 50% post-emergent surface, Ur - u–treated urea, UAN – urea ammonium-nitrate, AT – Agrotain, SU – SuperUrea.

Conclusions

In the 2017 season, there was initially adequate soil moisture followed by dry conditions. Under these circumstances, the traditionally recommended practice of banding fertilizer in the soil during seeding yielded the best. The surface applications did not generally perform as well as soil-applied N and there were no differences in yield between the pre-seed surface and split applications. There were no consistent benefits to Agrotain® and/or SuperUrea® detected under the 2017 growing conditions. Previous research has shown that early in-soil applications are most advantageous in dry years as surface-applications of N need either incorporation or substantial precipitation to move the fertilizer into the rooting zone and minimize losses. Under more optimal conditions, N fertilizer placement and timing of application tend to be less critical. While split-applications may generally be considered less risky than broadcasting the entire N amount prior to seeding, results can vary from year-to-year depending on precipitation amounts and timing. But a significant advantage to split-applications is the ability to adjust N rates during the season for crop and moisture conditions. In very wet years, environmental losses can be high regardless of application method depending on the formulation. It is in these years that denitrification inhibitors or split-applications are likely to be most beneficial.

Acknowledgements

This project was supported by the Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canada-Saskatchewan Growing Forward 2 bi-lateral agreement, with in-kind support provided by Koch Agronomic Services, Bayer CropScience and BASF.

Demonstrating 4R Nitrogen Principles in Spring Wheat

Description

Developing best management practices for nutrient applications is focussed on the 4R principles which are using the: 1) right source, 2) right rate, 3) right time and 4) right place. Nitrogen is the most commonly limiting nutrient in annual crop production and is often the most expensive crop nutrient, particularly for crops with high N requirements like canola or wheat. For many producers there has been movement back to a two pass seeding / fertilization system due to logistics while others have struggled with excess moisture and want to improve the efficiency of their N fertilizer through in-soil applications of enhanced efficiency fertilizer products or split-applications. By demonstrating different N fertilization strategies according to the 4R principles and providing regional data on their relative efficacy, this project was intended to help producers make better informed N management decisions. The objective of this project was to demonstrate CWRS wheat response to varying rates of nitrogen fertilizer along with different combinations of formulations, timing and placement methods relative to side-banded, untreated urea as a control. The treatments are outlined in Table 6.

Table 6. Nitrogen management treatments in 4R wheat demonstration.

Trt	Formulation	Timing / Placement	Fertilizer Rate [Z]
1	N/A	N/A	N/A
2	Urea	Side-band (during seeding)	50 kg N/ha
3	Urea	Side-band (during seeding)	100 kg N/ha
4	Urea	Side-band (during seeding)	150 kg N/ha
5	Urea	Pre-seed surface broadcast	100 kg N/ha
6	UAN	Pre-seed surface dribble-band	100 kg N/ha
7	Agrotain®	Pre-seed surface broadcast	100 kg N/ha
8	SuperUrea®	Pre-seed surface broadcast	100 kg N/ha
9	Urea / Urea	50:50 Split Application [Y]	100 kg N/ha
10	Urea / UAN	50:50 Split Application	100 kg N/ha
11	Urea / Agrotain®	50:50 Split Application	100 kg N/ha
12	Urea / SuperUrea®	50:50 Split Application	100 kg N/ha

[Z] 30 kg/ha residual NO_3-N as determined by fall composite soil sample for the site.
[Y] 50 kg N/ha as side-banded plus a post-emergent surface application of 50 kg N/ha during stem elongation.

Results

Under the 2017 growing conditions, grain yields did not significantly differ across form/timing/placing treatments. However, protein was significantly higher when all of the N was side-banded as shown in Figure 5. At the rate of 130 kg/ha soil plus fertilizer N, the average protein concentration was 13.6% for side-banded urea which was substantially higher than all other treatments at the same rate, which ranged from 11.6-12.4%. Overall, the rate response to N was strong with yields continuing to increase beyond the rate of 130 kg/ha soil plus fertilizer N. Yields were high overall considering the dry conditions, reaching 4,595 kg/ha at the highest N rate and averaging 4,251 kg/ha across all treatments with 130 kg/ha soil plus fertilizer N.

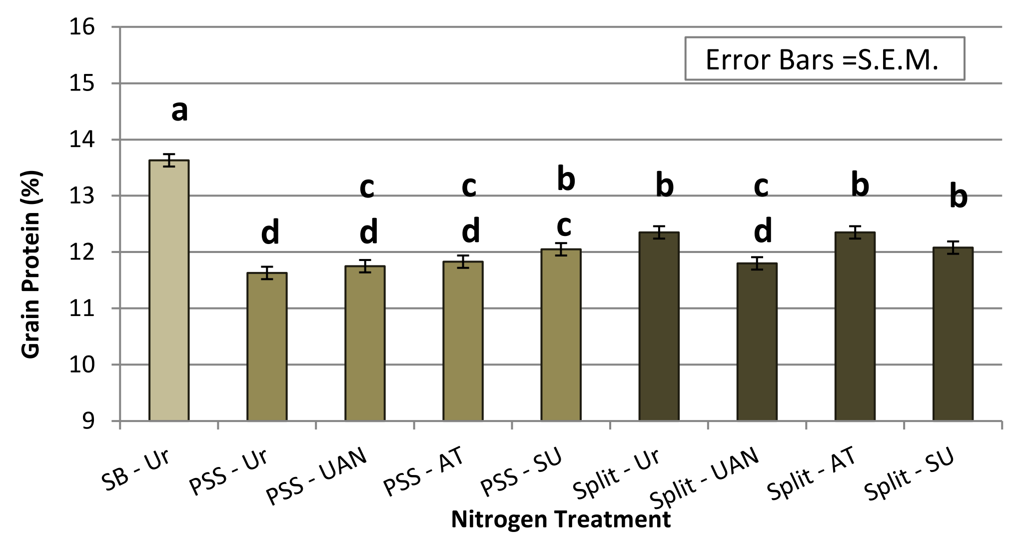

Figure 5. Nitrogen form/placement/timing effects on wheat grain protein at Indian Head (2017). SB – side-band, PSS – pre-seed surface, Split – 50% side-banded urea 50% post-emergent surface, Ur - u–treated urea, UAN – urea ammonium-nitrate, AT – Agrotain, SU – SuperUrea**.**

Conclusions

This project has demonstrated the overall response of wheat to varying rates of N fertilizer along with different strategies for managing N involving various formulations and timing/placement options. Under the 2017 growing conditions, grain yields did not significantly differ across form/timing/placing treatments but protein was significantly higher when all of the N was side-banded. This can be explained as previous research has shown that early in-soil applications are most advantageous in dry years while, under more optimal conditions, N fertilizer placement and timing of application tend to be less critical. In very wet years, environmental losses can be high regardless of application method depending on the formulation. It is in these years that denitrification inhibitors or split-applications are likely to be most beneficial.

Acknowledgements

This project was jointly supported by the Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canada-Saskatchewan Growing Forward 2 bi-lateral agreement and Fertilizer Canada as part of their 4R nutrient stewardship program. In-kind support provided by Koch Agronomic Services , Dow AgroSciences, Bayer CropScience and BASF.

Demonstrating Maturity & Heat Requirements for Grain Corn Production in Saskatchewan

Description

With recent corn varietal improvements and narrow profit margins for more traditional cereal crops, growers in southeast Saskatchewan have been experimenting with and expressing interest in grain corn production. The challenge with grain corn is that, while dramatic improvements have been made, slightly below normal growing season temperatures or early frost could have severe impacts on yield and quality. Corn also has relatively high water requirements late in the season which has potential to be a substantial yield limiting factor in many regions. Additionally, specialized seeding and harvest equipment is preferred for corn and also typically requires drying which may necessitate additional infrastructure investments. Therefore, many growers are hesitant to make substantial investments in equipment and infrastructure to grow a crop which still has uncertainty surrounding it with regard to production risk and yield expectations. The objective of this project was to demonstrate the relative heat requirements and phenological development of corn varieties with heat unit requirements of 2000-2100. While we were not equipped with the preferred seeding and harvest equipment, the results will still provide a conservative estimate of the potential yields and profits that might be expected with corn.

Results

Results for plant height, harvested grain moisture and grain yield are presented in Table 7. Plant height was similar for each of the three varieties ranging from 195-202 cm. Although differences in maturity amongst the varieties were difficult to visually distinguish, the seed moisture content at harvest differed across varieties. In general, the harvest moisture measurements revealed that combining was completed earlier than what would be considered optimal. Grain yields were low overall (3,555 kg/ha or 53 bu/ac on average), not unexpected given the variable start and dry finish to the growing season. Yields of the two earlier maturing hybrids did not statistically differ but yields in the latest maturing variety, P7332, were substantially lower. This may have been partly due to sub-optimal harvest timing and subsequently higher harvest losses. The estimated break-even yield at the assumed production costs (and $4.97/bu corn) was 80 bu/ac while the observed yield for the best hybrid in the current demonstration was only 62 bu/ac.

Table 7. Corn height, harvest moisture and seed yields of grain corn demonstration at Indian Head, 2017.

Variety	Height	Harvest Moisture	Grain Yield	
	------ cm ------	------- % -------	----- kg/ha -----	----- bu/ac -----
P7005AM	195 a	30.5 c	3677 a	58.5 a
P7202AM	202 a	35.8 b	3913 a	62.2 a
P7332	201 a	44.4 a	3075 b	48.9 b
P-value	0.193	< 0.001	0.003	0.003

Conclusions

This project has shown that corn has the potential to be grown in southeast Saskatchewan with respect to maturity but appropriate equipment is recommended and yields may be highly variable due to the risk of both late season drought and fall frost. With this in mind, potential corn growers in Saskatchewan are advised to seek the earliest maturing hybrids available and seed early. Also, growers need to be prepared to potentially harvest quite late in the season and have the ability to handle high moisture grain. In some respects, corn may be a better fit for mixed farmers who could choose to keep input levels more modest and reserve the option to silage or graze crops that are unlikely to make it to full maturity leading to sub-par yields and/or quality.

Acknowledgements

This project was supported by the Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canada-Saskatchewan Growing. Seed was provided in-kind by Dupont-Pioneer Canada.

Demonstrating 4R Phosphorus Principles in Canola

Description

Developing Best Management Practices (BMPs) for nutrient applications has long been focussed on the 4R principles which refer to using the: 1) right source, 2) right rate, 3) right time and 4) right place. The purpose of this trial was to demonstrate 4R principles for MAP fertilizer in canola. Phosphorus is the second most commonly limiting nutrient throughout Saskatchewan and, in many cases, residual P levels are declining over the long-term as a result of continuous cropping, recent high yields and inadequate application rates. Due to the large P requirements of canola and limits on how much fertilizer can be safely placed in the seed-row, growers who seed-place P must often choose between applying less than the optimal amounts of P or seed-placing rates that will potentially result in crop injury. The most popular alternative to placing P in the seed row is side-banding and most research has shown that this is an effective practice, despite concerns of reduced availability early in the season relative to seed-placement. Broadcast P is not recommended because it quickly becomes insoluble and unavailable when applied in this manner and can also be more prone to surface runoff losses. This project was initiated to demonstrate the potential risks and benefits of seed-placement relative to side-banding while also showing that either of these methods is preferable to broadcast applications.

Table 8. Phosphorus management treatments in 4R phosphorus demonstration with canola.

Trt	Formulation	Timing / Placement	Fertilizer Rate [Z]
1	N/A	N/A	0 kg P2O5/ha
2	MAP (11-52-0)	Pre-seed broadcast	25 kg P2O5/ha
3	MAP (11-52-0)	Pre-seed broadcast	55 kg P2O5/ha
4	MAP (11-52-0)	Side-banded	25 kg P2O5/ha
5	MAP (11-52-0)	Side-banded	55 kg P2O5/ha
6	MAP (11-52-0)	Seed-placed	25 kg P2O5/ha
7	MAP (11-52-0)	Seed-placed	55 kg P2O5/ha

Results

Based on NDVI measurements completed prior to bolting, early season vigor was improved slightly but significantly over the control with side-banded but not broadcast P fertilizer. The improved growth also appeared to occur with seed-placed P but the same tests of significance could not be applied to this placement method. This positive early-season response was no longer evident at the late-bolting stage. When it came to yield, the overall response was relatively weak; however, there was a slight yield increase (approximately 5%) with side-banded MAP when compared to the pre-seed broadcast P or the control. Unfortunately, an error at seeding resulted in the loss of all of Treatment #5 but despite the missing treatment, yields of seed-placed P appeared similar to those achieved with side-banding.

Conclusion

This project has demonstrated the overall response of canola to contrasting rates, timing and placement options for MAP fertilizer. While we could not demonstrate the potential risks associated with higher than recommended rates of seed-placed P on emergence, it is advised that growers exercise utmost caution if considering doing so. Negative effects associated with high rates of seed-placed P can be variable and difficult to predict as they are affected by many factors. Overall, the results of this project support the current recommendations of side-banding or seed-placing P fertilizer during the seeding operation. In most cases, low rates of P fertilizer are sufficient to mitigate yield loss within the year of application. However, rates should be based on long-term fertility objectives which, for most, involve maintaining or building residual soil P levels.

Acknowledgements

This project was supported by the Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canada-Saskatchewan Growing. Seed and crop protection products were provided in-kind by Bayer CropScience and BASF.

Demonstrating Basic Soybean Inoculation Concepts & Options

Description

Soybeans have become an increasingly popular crop option in southeast Saskatchewan with dramatic improvements in short season varieties over the past decade, along with challenges growing more traditional pulse crops. Although most growers are aware that inoculation is important for successful soybean production, there is a range of products and strategies to choose from. Under adverse conditions, such as early season flooding or prolonged drought, poor nodulation can occur even with good inoculation practices. When inadequate nodulation is confirmed, late season N applications can effectively be utilized to 'rescue' the crop from severe N deficiency and reduce potential yield loss. The objective of this project was to demonstrate the importance of nitrogen (N) fixation in soybeans along with the relative effectiveness of various inoculation strategies and rescue N applications when poor nodulation is suspected.

The treatments included inoculation strategies ranging from completely un-inoculated to seed-applied inoculant plus a 2x label rate of granular inoculant. The inoculant products included Optimize (liquid / seed-applied), Cell Tech® (granular, *Bradyrhizobium japonicum*), Tag Team® (granular, *Bradyrhizobium japonicum* plus *Penicilium billai*). For two treatments (un-inoculated and seed-applied only), poor nodulation was expected to be yield limiting and the potential benefits of late-season, surface applications of N (as dribble-banded UAN) were demonstrated in these cases. The granular products were placed in-furrow at either 4 or 8 kg/ha (1-2x the label recommendation for 30 cm row spacing). Treatments are outlined in Table 9.

Table 9. Treatment details of soybean inoculation demonstration.

Trt	Formulation	Timing / Placement	Fertilizer Rate ^{Z}
1	None	None	None
2	None	None	55 kg N/ha
3	1x Liquid ^{Y}	None	None
4	1x Liquid	None	55 kg N/ha
5	1x Liquid	1x *Bradyrhizobium* ^{X}	None
6	1x Liquid	2x *Bradyrhizobium* ^{X}	None
7	1x Liquid	1x *Bradyrhizobium + Penicillium bilai* ^{W}	None
8	1x Liquid	2x *Bradyrhizobium + Penicillium bilai* ^{W}	None
9	None	1x *Bradyrhizobium*	None
10	None	2x *Bradyrhizobium*	None
11	None	1x *Bradyrhizobium + Penicillium bilai*	None
12	None	2x *Bradyrhizobium + Penicillium bilai*	None

^{Z} Surface dribble-banded UAN applied at R3 stage; ^{Y} Optimize® liquid soybean inoculant, label rate; ^{X} 4 (1x) or 8 (2x) kg/ha Cell Tech® granular soybean inoculant; ^{W} 4 (1x) or 8 (2x) kg/ha Tag Team® granular soybean inoculant.

Results

Seed-applied liquid inoculant produced substantial yield increases over the un-inoculated control but had little impact when applied in addition to a granular product as shown in Figure 6. Granular inoculant, regardless of product or rate, produced significantly higher soybean yields than liquid inoculant. There was no benefit to the product containing *Penicillium billai* compared to the conventional *Bradyrhizobium japonicum* (Optimize®) product under the conditions encountered.

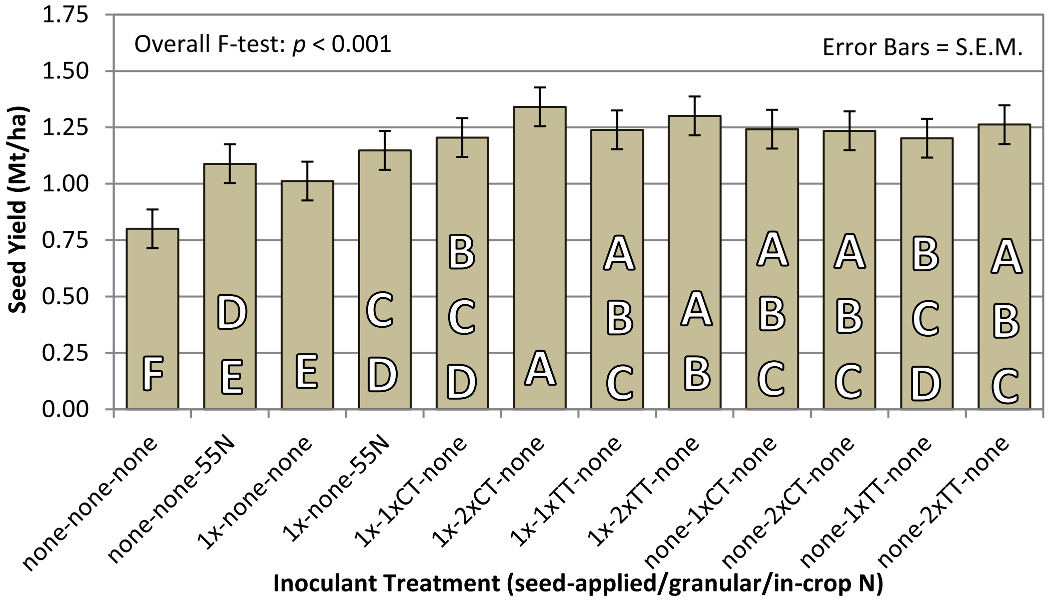

Figure 6. Soybean inoculation and rescue N application effects on plant height (Indian Head, 2017). Liquid inoculant was Optimize®. Granular inoculants were CellTech® (CT) or TagTeam® (TT) at 4 (1x) or 8 (2x) kg/ha. In-crop N was 55 kg N/ha as dribble-banded UAN (28-0-0).

Conclusions

This project has demonstrated the importance of inoculation for soybean production along with the potential for in-crop applications of N to help mitigate yield loss when nodulation is poor. The results of this project support the use of granular inoculant regardless of whether the seed is inoculated but it is less clear whether higher than normal label recommended rates or seed-applied inoculant over and above a granular product is required. The project showed that good inoculation and subsequent nodulation are critical for optimizing soybean yields; therefore, dual inoculation or somewhat higher than recommended rates of a granular product are likely good practice for fields with little or no history of soybean production. Liquid seed-applied inoculant on its own is unlikely to be sufficient under such conditions, which is consistent with previous results at Indian Head and other Saskatchewan locations. Growers should assess nodulation at the start of flowering regardless of inoculation practices and, if considered insufficient (less than approximately 5 nodules per plant), surface applications of N fertilizer can help mitigate much, but not all, of the potential yield loss.

Acknowledgements

This project was supported by the Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canada-Saskatchewan Growing Forward 2 bi-lateral agreement. Soybean seed was provided in-kind by NorthStar Genetics and all inoculant products were provided by Monsanto Bio-AG.

Hastening Maturity of Oats Without Pre-harvest Glyphosate

Description

Major oat buyers in eastern Saskatchewan have made the decision not to purchase oats which have been treated with pre-harvest glyphosate due to reductions in milling quality. Therefore producers will need to focus on other agronomic practices to hasten the maturity of oats under field conditions, particularly seeding dates, seeding rates, and fertility management. The treatments in this study were seeding dates (early May and late May), seeding rates (200 and 300 seeds m^{-2}), N rates (40, 65, and 90 lbs N per acre) plus an additional treatment with a lower rate of P fertilizer, fully randomized in each of the early and late seeded blocks. This was a multi-site project conducted in Indian Head, Melfort and Yorkton over the 2017 season. The objective was to demonstrate the interacting effects of these factors on oat maturity, yield, and milling quality. A secondary objective was to demonstrate the importance of adequate P fertilization in crop development and achieving earlier maturity.

Results

With all sites combined, there was a significant three-way interaction of seeding date, seeding rate, and N rate on the number of days to maturity as shown in Figure 7. With all sites combined, grain yield increased significantly with N rate, but was not affected by seeding date or seeding rate. Milling quality data showed test weight and percent thins were not affected by seeding date, seeding rate, or N rate. In both the multi-site and single-site analyses, the number of days to maturity was significantly affected by seeding date but there was no significant effect of P rate. With all sites combined, grain yield was significantly higher when seeded late and increased significantly with P rate.

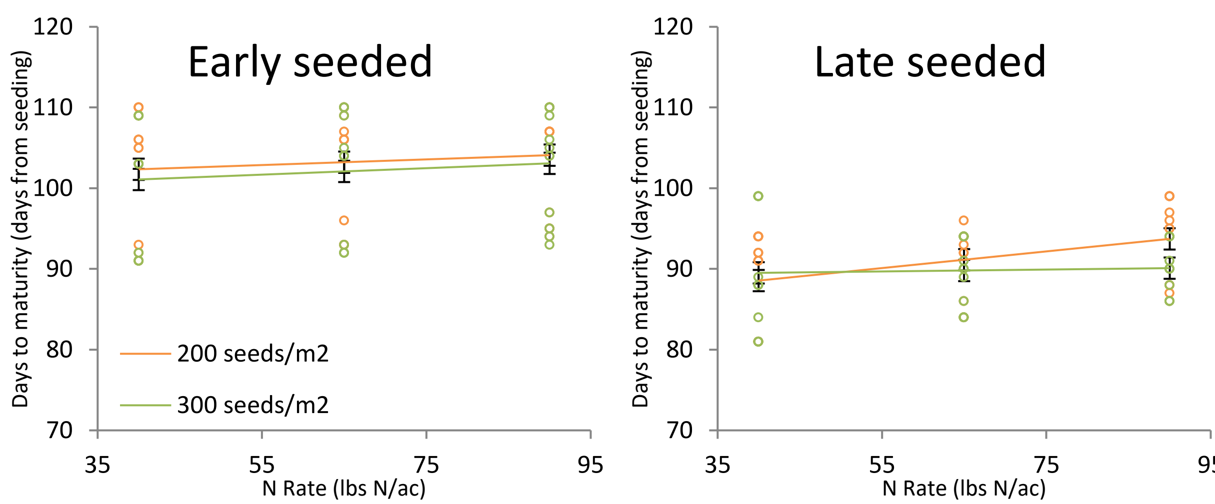

Figure 7. Treatment effects on the maturity of oats, all sites combined.

Conclusions

Results from this trial have demonstrated that oats compensate for a later seeding date by hastening maturity, and that this does not necessarily result in a yield penalty. However, if oats are seeded late, increasing the seeding rate may be the most important consideration in order to hasten maturity while still maintaining a high N rate to preserve yield potential, as maturity is significantly delayed when lower seeding rates are combined with higher N rates at later seeding dates. Reducing the nitrogen rate will also hasten maturity significantly, but the benefit of earlier maturity will need to be weighed against the corresponding yield loss. That being said, environmental conditions at all three sites were much drier than normal in 2017, and this may have influenced the results. It would be beneficial to observe the crop response under wetter conditions.

Acknowledgements

This project was supported by the Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canada-Saskatchewan Growing Forward 2 bi-lateral agreement. Crop protection products were provided in-kind by industry partners. Mike Hall from the East Central Research Foundation (Yorkton) initiated the trial proposal and designed the protocol.

Seed Treatment Effects on Flax at Varying Seeding Rates and Dates

Description

Surveys conducted during the 2016 Saskatchewan Oilseed Producer meetings identified seed treatment performance evaluations with flax as a top priority amongst attendees. For optimal flax yields, minimum plant populations of 300 plants/m^2 are generally recommended. Research with early no-till equipment found that, even with typical seeding rates (i.e. 50 kg/ha), this minimum threshold was only achieved 60% and 73% of the time with early and late plantings, respectively. The objectives of this project were to demonstrate the potential benefits of seed treatments for flax when combined with low (35kg/ha), medium (55kg/ha) and high (75kg/ha) seeding rates and either early (May 3) or late (May 30) seeding dates. The study was conducted at Indian Head in 2016 and 2017 and at Melfort in 2017.

Results

Plant Populations

Flax emergence was affected by seeding date at Indian Head 2016 and Melfort 2017 but not at Indian Head 2017, with higher populations associated with delayed seeding in 2/3 site-years. The use of a seed treatment increased plant densities by 11% at Indian Head 2016 but had no effect at either Indian Head or Melfort in 2017. Somewhat inexplicably, the site-year where seed-treatment applications improved flax establishment (Indian Head 2016) was also the site-year where conditions for emergence were most optimal and the highest overall plant populations were achieved. In both years at Indian Head, average plant populations continued to increase through all seeding rate increases while in Melfort populations increased from 312 plants/m$_2$ at the 35 kg seed/ha to 415-422 plants/m^2 at 55-75 kg/ha with no difference between the two highest seeding rates. As expected, increasing seeding rates was an effective means of increasing plant populations; however, it can result in more plants than are desired under some conditions which could lead to increased lodging or disease pressure

Maturity

Seed-applied fungicides resulted in a statistically significant but agronomically inconsequential reduction in maturity of 0.4-0.6 days. The effect of seeding rate on maturity was also small with less than a 2 day spread (on average) between the highest and lowest rates; however, it did show the potential for lower plant populations to delay maturity. Seeding date had, by far, the greatest and most consistent effect on days to maturity with the later seeded crop maturing up to 10 days ahead of the early seeded crop. That said, the early seeded crop was still always ready to harvest first so if earlier harvest or reduced risk of fall frost damage is an objective then seeding earlier is still the most desirable option.

Yield

Flax yield was not affected by seed-applied fungicide treatment at any site-years, regardless of when or at what rate the crop was seeded as shown in Table 10. The highest yields were consistently achieved with early seeding although the response was not always statistically significant. Seeding rate effects on flax yield were rare and, when observed, inconsistent with the expected results.

Table 10. Main effect means for flax yield and orthogonal contrast results for seeding rate for three Saskatchewan site-years.

Main effect	IH-2016	IH-2017	ME-2017
Seeding date	------------------------------------	kg/ha	------------------------------------
Early	2552 a	1529 a	2285 a
Late	1456 b	1277 a	2094 b
Seed Treatment			
Untreated	2035 a	1385 a	2159 a
Treated	1973 a	1422 a	2220 a
Seeding rate			
35 kg/ha	2055 a	1413 a	2184 a
55 kg/ha	2055 a	1385 a	2201 a
75 kg/ha	1902 b	1411 a	2182 a

Conclusions

Overall, results from this demonstration suggest that flax should be seeded early (within the first 2 weeks of May) at rates of approximately 55 kg/ha to achieve the earliest maturity possible with optimum yield. Seed treatments have the potential to improve establishment but this will not necessarily occur under all circumstances, and yield responses are likely to be even less frequent. It is possible and worth noting that small plot trials, typically conducted on relatively uniform and well drained land, may not be ideal for capturing the potential seed-treatment benefits that may occur on a larger scale where the factors affecting emergence and development of root disease are more spatially variable.

Acknowledgements

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Demonstrating the Merits of Potassium and Sulphur Fertilization in Flax Production

Description

With high residual levels, deficiencies of potassium are unlikely in the heavy clay soils northeast of Indian Head. However, responses to potassium chloride fertilizer are occasionally reported**.** Sulphur availability is frequently marginal on Saskatchewan soils and occasionally limits yields, especially in sensitive crops such as canola. While documented flax responses to K and S fertilizer application are rare in peer-reviewed literature, demonstrations at Indian Head in 2013 showed a 2.2 bu/ac average yield increase (4.5%) with the addition of 12 lb S/ac plus 12 lb K2O as KCl. In 2014, mean yields with S were 1.4 bu/ac (7%) higher than without; however, the observed difference was not significant. These results were not repeated in 2015 under low residual S levels and reasonably good yield potential (~35 bu/ac). In 2016, with high yields (~50 bu/ac) and low residual S, flax yields increased quadratically with S. The magnitude of the increase was less than 5% and the lowest rate (15 kg S/ha) was sufficient to optimize yields. There was some evidence that the response was stronger with the flax variety CDC Neela relative to the other varieties**.** The objectives of this project were: 1) to demonstrate the potential response (or lack thereof) to applications of potassium and sulfur fertilizer alone and in combination, 2) to demonstrate the relative performance of three high yielding flax varieties and 3) to explore whether the potential for responses to these important, albeit less commonly limiting, macronutrients differed across varieties. The varieties showcased were the popular check variety, CDC Bethune, and two newer varieties CDC Glas and CDC Neela.

Results

Compared to the check variety CDC Bethune, yield results were 110% and 106% for CDC Glas and CDC Neela, respectively. Established plant populations were similar across varieties and not considered potentially limiting to yield ranging from 386-410 plants/m^2 while the recommended minimum flax population is 300-400 seeds/m^2. Flax establishment was not affected by the K/S treatments but this was not unexpected given that all K and S fertilizer products were side-banded as opposed to seed-placed. Spring soil tests from the site showed residual levels of 762 ppm of extractable K in the top 15 cm of soil and 57 kg S/ha (0-60 cm). These initial residual levels of K and S did not necessarily suggest that applications of these nutrients were likely to improve yields.

Conclusions

The observed variety performance rankings were consistent with those from the previous year showing statistically significant yield advantages to the newer varieties. This supports the recommendation that growing modern, regionally adapted varieties is an important component of achieving top flax yields.

Consistent with the soil test predictions, neither K nor S fertilization impacted flax yield, regardless of variety, form or combination with other nutrients. While K deficiencies are rare in most Saskatchewan soils, some consider applying fertilizer as important for maintaining soil productivity over the long-term. While S is not commonly limiting for most crops either, deficiencies do occur and challenges arise as this nutrient is difficult to accurately test for due to high spatial variability and mobility. While low soil test results for S can generally be relied upon, high test values are often suspect. When growing sensitive crops (i.e. canola) or if deficiencies have been observed in the past, it is often recommended to apply small quantities of S regardless of soil test results. Overall, growers are recommended to take into account soil test results, past experience and long-term fertility objectives when determining whether to apply K and S fertilizer when growing flax.

Acknowledgement

This project was supported by the Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canada-Saskatchewan Growing Forward 2 bi-lateral agreement and was a collaborative effort between SaskFlax and IHARF. In-kind support was provided by BASF and FMC of Canada.

Strategies for Management of Feed and Malt Barley

Description

Trials were established at Yorkton, Scott and Indian Head with the objective of demonstrating the importance of early seeding and nitrogen management when producing malt versus feed barley. Another objective was to provide an economic analysis for feed and malt barley scenarios, including the scenario where a malt barley variety is sold as feed. The treatments were 1) seeding dates of early and late May, 2) malt variety "AC Metcalfe" against the feed variety "CDC Austenson", 3) nitrogen rates of 40, 80 and 120 lbs/ac of actual at IHARF and WARC and 60, 80, 100, 120 lbs/ac of actual at ECRF. Thus, 12 treatments were tested by IHARF and WARC and 16 treatments were tested by ECRF.

Results

The feed variety CDC Austenson was 16% higher yielding than the malt variety AC Metcalfe at Yorkton and Scott. It was only 6% higher yielding at Indian Head. At Yorkton, seeding AC Metcalfe early with no more than 60 lbs/ac of N produced 96 bu/ac and was the only treatment to meet malt barley grade based on protein. At Scott, the early seeded barley did not make malt quality due to low plump kernels, chitting and low germination. However, late seeded barley at Scott did make malt quality with up to 80 lbs/ac of N, which is also where yields were maximized for both the feed and malt varieties. At Indian Head, achieving malt barley was possible with early and late seeding. Yields were maximized for AC Metcalfe and CDC Austenson at 80 and 120 lbs/ac of N, respectively.

Conclusion

Despite the higher yield potential of the feed variety CDC Austenson, it would likely be more economical to grow the malt variety AC Metcalfe. Growing CDC Austenson would only prove to be more economical if the chance of achieving malt with AC Metcalfe was less than once in 2.5, 4.3 and 6.7 years based on the results from Yorkton, Scott and Indian Head, respectively. There may be little reason to grow feed varieties in the future as higher yielding malt varieties are selected by the market place. Seeding barley early provided the highest yields and best probability of making malt at Yorkton. At Indian Head, seeding early and late produced malt barley with similar economic results. At Scott, only late seeded barley made malt as early seeded barley was adversely affected by rain prior to harvest. Nitrogen management appears to be key to producing malt barley as excessive amounts of nitrogen often increased protein and decreased kernel plumpness beyond acceptable levels.

Acknowledgement

This project was funded through the Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canada-Saskatchewan Growing Forward 2 bi-lateral agreement.

Seed-Placed vs Side-Banded Phosphorus Effects on Faba Bean Establishment and Yield

Description

While the seeded acreage of faba beans in Saskatchewan is relatively small, interest in this crop continues to be strong due to its high yield potential, improved resistance to root diseases and ability to withstand prolonged wet periods much better than field peas and lentils. With the potential for increased production of this crop, farmers need exposure to the management factors that should be considered when growing faba beans. The objectives of the project were to: 1) demonstrate and gather information on faba bean response to phosphorus fertilization (MAP rates of 20, 40, 60, 80 kg P_2O_5/ha) in low P soils, 2) compare the overall response to seed-placed versus side-band placement of P fertilizer, and 3) demonstrate the maximum safe rates of seed-placed MAP and provide information on faba bean sensitivity to seed-placed P fertilizer when seeded into clay soils using a hoe drill with low seed-bed utilization. This project was conducted over a two year period from 2016-2017.

Results

Faba bean emergence was assessed at 15 days after emergence, and plant densities were similar between the two years (25-30 plants/m^2 on average) and not affected by P treatment. At 30 days after planting, the average plant density values were higher in 2016 than under the drier conditions of 2017 but there was no P treatment effect. Averaged over the two years, yields increased linearly by 440 kg/ha (14%) as the P rate was increased from 0 to 80 kg/ha as shown in Figure 8. There were no apparent yield differences associated with P placement either for individual years or when averaged across years. P treatment effects on faba bean seed weight had little effect, which indicates that the observed yield increases with P fertilization were not due to larger seed size but were attributable to some other factor (i.e. more pods per plant or more seeds per pod).

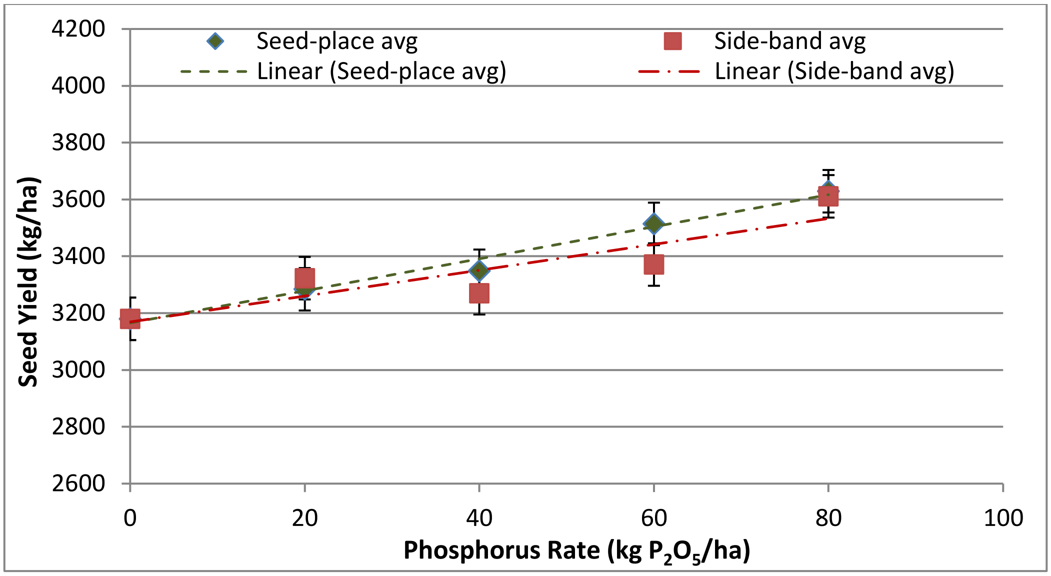

Figure 8. Phosphorus rate and placement effects on faba bean seed yield in 2016 & 2017.

Conclusion

The results were generally consistent with past research which has shown that faba beans are less sensitive to seed-placed fertilizer but, with respect to yield, relatively responsive to P fertilizer application compared to other traditional pulse crops. The yield increases that were realized with P fertilization in the current study were as high as 14% but the actual response will vary from year-to-year and field-to-field. Although the observed response was linear and the highest yields were achieved at the highest application rates, it will not necessarily be practical or economical to use rates this high. The results demonstrate the high potential phosphorous requirements of this crop. There were no noteworthy differences in response across the two placement methods indicating that either seed-placed or side-banded P fertilizer is effective. However, these results should not be taken to suggest that high rates of seed-placed P (i.e. > 40 kg P_2O_5/ha) will be safe under broader circumstances. Seedling injury associated with P fertilizer toxicity is affected by several environmental factors and can vary dramatically from year-to-year and across variable landscapes.

Acknowledgments

This project was initially funded in 2016 through the Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canada-Saskatchewan Growing Forward 2 bi-lateral agreement. In 2017, funding for the project was secured through the Saskatchewan Pulse Crop Development Board (Sask Pulse Growers) in order to build on the previously completed work. The crop protection products evaluated in this demonstration were provided in-kind by BASF and FMC.

Enhancing Canola Yield with Improved Phosphorus Fertilizer Management

Description

Current canola hybrids can readily yield more than 3,500 kg/ha. This results in the crop removing two or more times the amount of phosphorous that is replaced by fertilizer applied at the safe rate for seed placed P. Although several studies indicate that seed row placement of fertilizer P is the most efficient way to meet this nutrient requirement, when rates of seed placed phosphate exceed 28 kg/ha, excessive seed damage can occur. The objective of this project is to provide the basis for updated recommendations for fertilizer P rate and placement for canola production in Saskatchewan. This project was conducted in 2016 and 2017 in Melfort, Indian Head and Scott. The treatments are shown in Table 11.

Table 11. Phosphorus rate and placement methods used to evaluate improved phosphorus management in canola.

Treatment	Fertilizer Rate (kg/ha)	Fertilizer Placement
1	0 P_2O5	Side-Band
2	20 P_2O5	Side-Band
3	40 P_2O5	Side-Band
4	60 P_2O5	Side-Band
5	80 P_2O5	Side-Band
6	0 P_2O5	Seed-Placed
7	20 P_2O5	Seed-Placed
8	40 P_2O5	Seed-Placed
9	60 P_2O5	Seed-Placed
10	80 P_2O5	Seed-Placed
11	0 P_2O5 & 15 S	Seed-Placed
12	20 P_2O5 & 15 S	Seed-Placed
13	40 P_2O5 & 15 S	Seed-Placed
14	60 P_2O5 & 15 S	Seed-Placed
15	80 P_2O5 & 15 S	Seed-Placed

Results

Plant populations declined significantly as P rates increased with the P-seed placed and the P+15S-seed placed treatments but not with the P-side banded placement. Damage from these two seed placement methods was evident at 2, 4, and 6 weeks after seeding as well as post-harvest. It was apparent that the damaging effects of seed placed P and S were additive. Biomass production increased with phosphorus fertilizer application rates and was greatest when applied in a side-band. Yield was largely unaffected by placement but significantly impacted by phosphorus rate as shown in Figure 9. Side-banded phosphorus fertilizer resulted in yield increases of up to 263 kg/ha. Canola grain yields often increased with phosphorus application and optimal yields were often achieved between 40 and 60 P_2O_5 kg/ha, depending on location. Therefore, if high rates of phosphorus are required, fertilizer P should be side-banded to maintain maximum yields without seed damage. TKW and green seed were largely unaffected by treatment application however, percent green seed tended to increase while TKW decreased with Seed-Placed P & S. Higher rates of phosphorus tended to increase % green seed and mean seed weight.

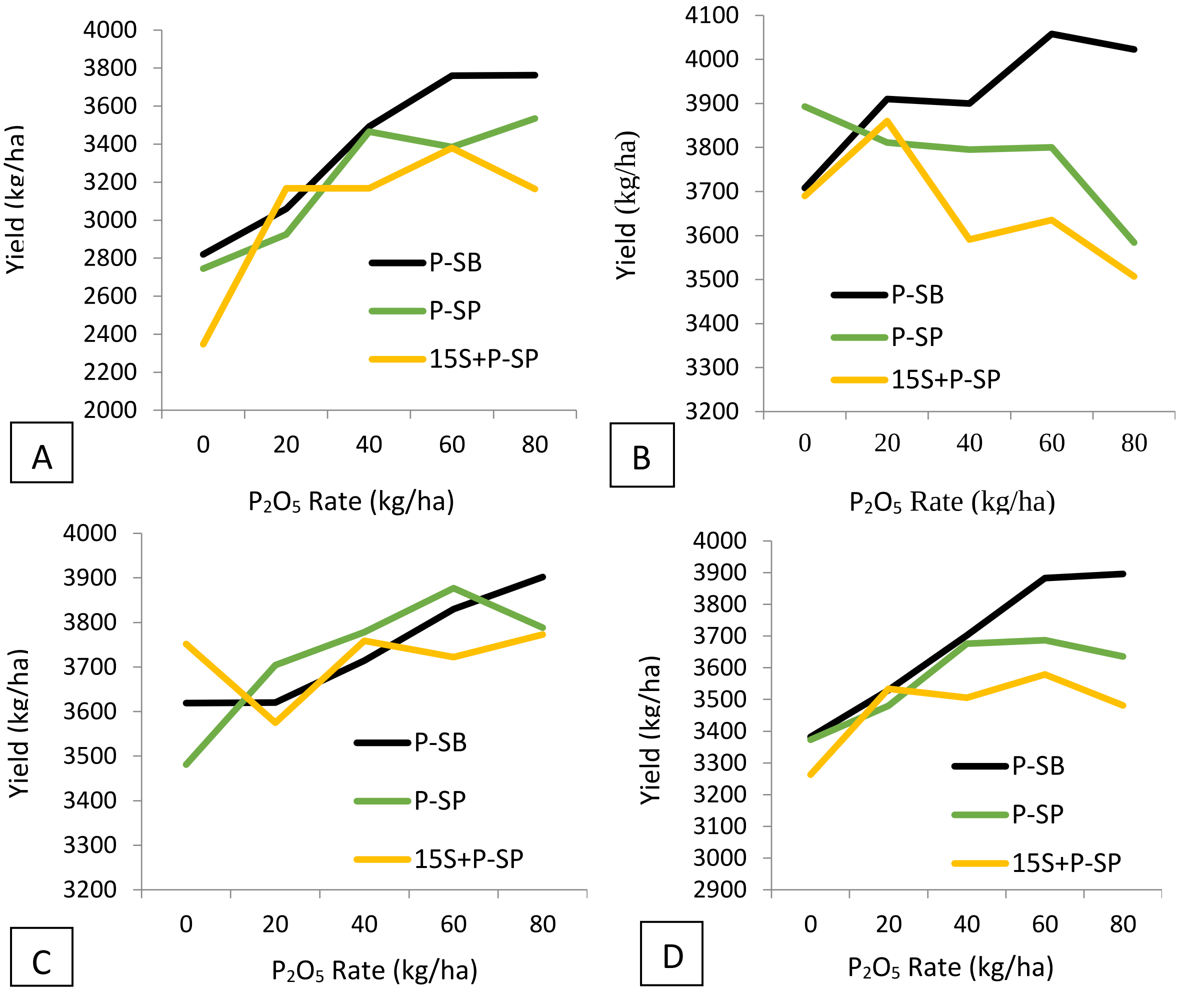

Figure 9. Yield response of canola to rate and placement of P fertilizer. A: Melfort 2016; B: Scott 2016; C Scott 2017; D: Average of 3 responsive locations.

Conclusions

It appears that the optimal phosphorus management may be changing for growing canola in Saskatchewan. After two-years of the study, it appears that phosphorus fertilizer should be side-banded, especially when high rates are required. Results to date suggest that damage in these trials from seed placed P alone may not be as great as in initial studies used to establish safe seed placed rates. This may reflect the greater seedbed utilization with the hoe type openers used in these trials compared with disc type openers used in earlier trials. Furthermore, the effects of applying sulphur in the seed row appear to be detrimental to crop establishment and are additive to damage caused by seed row phosphorus.

Acknowledgements

This project was supported by the Saskatchewan Canola Development Commission. This project was a collaborative effort of NARF, WARC and IHARF.

Developing Nitrogen Management Recommendations for Soybeans in Saskatchewan

Holzapfel, C. (IHARF), Hnatowich, G. (ICDC) and Pratchler, J. (NARF).

Description

The objective of this project was to improve upon current N management recommendations for soybean production in Saskatchewan. The treatments evaluated were four N fertilizer treatments (0 N or 55 kg N ha^{-1} as side-banded urea, side-banded ESN® or post-emergent surface dribble-banded urea ammonium-nitrate) and four granular inoculant rates (0, 1x, 2x and 4x the label recommended rate of 4.5 kg/ha). All treatments received seed-applied inoculant and the surface-dribble band was targeted for early pod fill (R2-R3).This project was performed at three Saskatchewan locations for three growing seasons from 2015 -2017 for a total of nine site-years. Only one site, Outlook 2016, had a previous history of soybean production.

Results

At the 8 sites with no previous soybean history, there were strong yield responses to dual inoculation with a mean overall benefit of 497 kg/ha or 24% as shown in Figure 10. At 5/8 sites there was no benefit to increasing rates beyond the 1x label rate but at 3 sites (all in 2017) there was evidence of stronger responses. The Outlook 2016 site with a history of soybeans in production was analyzed separately and there was found to be no practical benefit to dual inoculation for this site. The benefits to starter N were inconsistent across the 8 sites and nearly always only observed in the absence of granular inoculant when nodulation was presumably inadequate to meet the N needs of the crop. Starter N had a negative impact on nodulation in double inoculated treatments. Top-dressing UAN at early pod fill increased yields by 368 kg/ha (18%) when no granular inoculant was applied but inadequately nodulated soybeans never yielded as high as those with good inoculation. Depending on yield, 81-242 kg N/ha was removed in the harvested seed with an overall average of 158 kg N/ha as shown in Figure 11**.** If we assume that this was approximately 88% of the cumulative N uptake (Heard 2006), total uptake could be estimated at 180 kg N/ha on average and as high as 275 kg/ha. Seed protein levels increased with granular inoculant in a similar manner to yield, with the greatest increase going from the 0-1x inoculant rate. Starter or in-crop N was not beneficial to seed protein when inoculation was adequate and sometimes led to lower seed N concentrations.

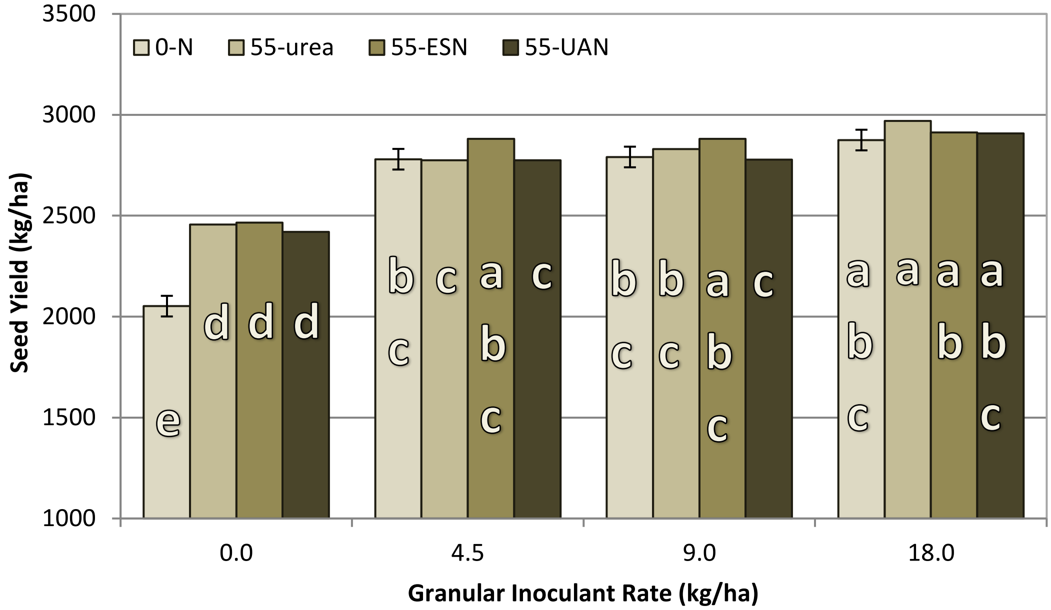

Figure 10. Average soybean yield response to contrasting N management strategies and dual inoculation across 8 site-years in Saskatchewan (all sites had no previous history of soybeans). The N rate was 55 kg N/ha in all applicable treatments - urea and ESN were side-banded while UAN was dribble-banded at the R2-R3 stage.

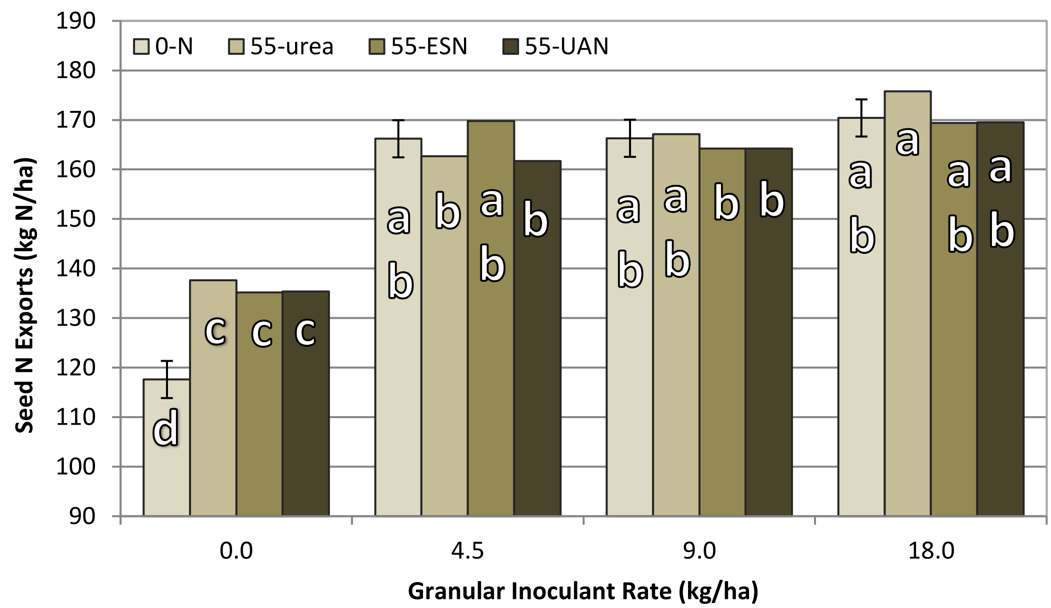

Figure 11. Average soybean seed N export response to contrasting N management strategies and dual inoculation across 8 site-years in Saskatchewan (all sites had no previous history of soybeans). The N rate was 55 kg N/ha in all applicable treatments - urea and ESN were side-banded while UAN was dribble-banded at the R2-R3 stage.

Conclusions

The observed N removal and estimated peak uptake of soybeans in this study clearly illustrates the need for strong nodulation and N fixation to produce high yields. In well inoculated soybeans, starter N resulted in added cost without yield benefit and therefore cannot be recommended. The small amounts of N provided with P and S fertilizer products are likely to be sufficient to prevent yield limiting N deficiencies before biological N fixation can take over in the vast majority of cases. In-crop N applications have a fit for mitigating yield loss when poor nodulation is suspected. However, top-dressing N on inadequately nodulated soybeans never resulted in yields as high as could be achieved with good inoculation. While low seed protein concentrations have occasionally been flagged as a concern for soybeans in Saskatchewan, the results of this project generally indicate that the optimal management for both yield and protein are similar. The results support the recommendation of dual inoculation (liquid plus at least a 1x rate of granular inoculant) in fields with limited history of soybean production. While in fields with a history of soybeans (i.e. Outlook 2016), the potential benefit to dual inoculation is smaller.

Acknowledgements

This project was funded by the Saskatchewan Pulse Growers. In-kind support was provided by Monsanto Canada.

Developing Phosphorous Management Recommendations for Soybeans in Saskatchewan

Holzapfel, C. (IHARF), Hnatowich, G. (ICDC), Pratchler, J. (NARF), Weber, J. (WARC) and Flaten, D. (U of M).

Description

The objective of this project was to improve upon current P fertilizer recommendations for soybean production in Saskatchewan. This project was conducted at Indian Head, Melfort, Scott and Outlook in from 2015-2017 for a total of twelve site years. The treatments were three rates of P (22, 45 or 90 kg P_2O_5/ha) and three placement methods (seed-placed, side-banded or pre-seed broadcast) plus a control where no P fertilizer was applied.

Results

Plant densities averaged across all site-years were similar with all P rate by placement combinations (45-48 plants/m^2) except for the highest rate of seed-placed P (90 kg P_2O_5/ha) which was 18% lower (38 plants/m^2). When the results were averaged across all twelve sites, yields increased linearly with increasing P rate from 2734 kg/ha to 2900+ kg/ha at 90 kg P_2O_5/ha with side-band and broadcast placement (~6% yield increase) as shown in Figure 12. The response was quadratic for seed-placed P with yields increasing in a similar manner as the other placement methods up to 45 kg P_2O_5/ha but then declining back to a similar yield as the control when rates were increased further to 90 kg P_2O_5/ha. When comparing the overall yield responses to P fertilizer to residual Olsen-P levels for each of the individual sites it was shown that the sites where positive responses occurred were always low in residual P (<15 ppm) but yield responses did not always occur in low P soils. Crop removal ranged from 16-55 kg P_2O_5/ha (14-49 lb/ac) with an overall average of 39 kg P_2O_5/ha (35 lb/ac).

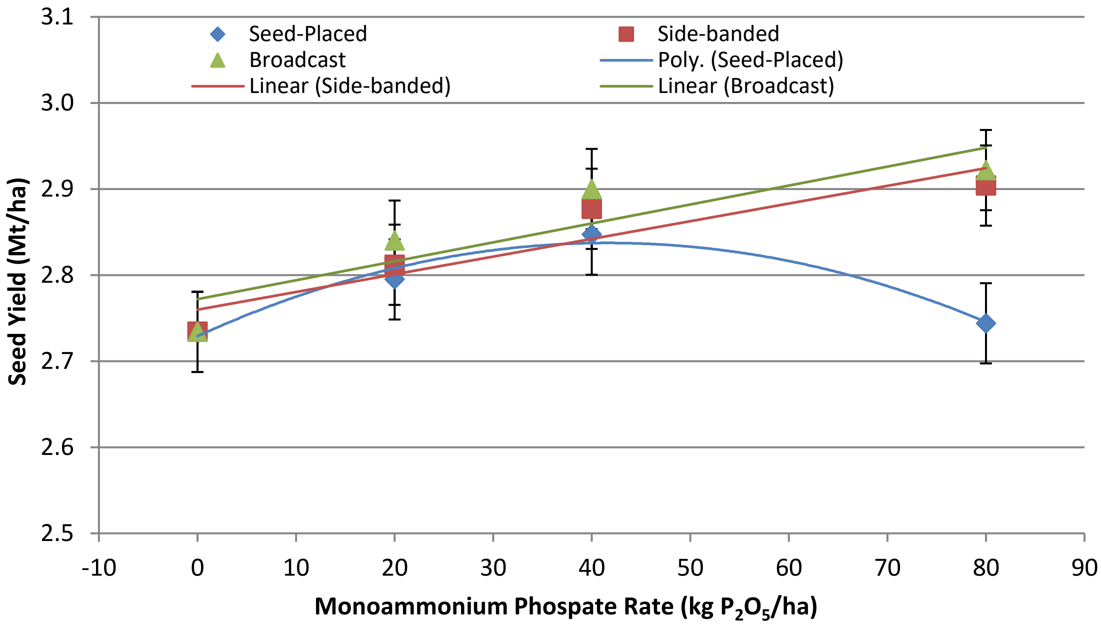

Figure 12. Phosphorus placement and rate effects on soybean seed yield averaged across 12 site-years in Saskatchewan. This average response should be interpreted cautiously as the specific effects varied from site-to-site

Conclusions

Appropriate phosphorous rates depend on both the potential soybean yields that can expected and the long-term fertility goals for the field in question. If the objective is to maintain soil P over the long-term, rates should be approximately equal to crop removal. The results suggest that significant yield responses to P fertilization are rare on a field-to-field basis but can occur when yield potential is high and soil residual P is low. On average, slightly higher (~6%) yields may be expected with adequate P fertilization.

In terms of safe rates of seed-applied phosphorus, while it was often minor, stand reduction with seed-placed P was detected approximately 50% of the time but was generally only large enough to be of concern at the highest rate of 90 kg P_2O_5/ha. Reponses to seed-placed P were never better than side-banded or broadcast P and, when averaged across all sites, yields were reduced at the highest rate of seed-placed P. These results suggest the current recommendation of no more than 10-20 kg P_2O_5/ha seed-placed may be more conservative than necessary. However, side-banding is still a preferable method for applying P, especially at high rates. While soybeans responded well to broadcast P, this is still not considered an ideal option from either a fertilizer efficiency or environmental perspective.

Acknowledgements

Support for this project was provided by the Saskatchewan Pulse Growers with in-kind support provided by Monsanto Canada. Special thanks are extended to Gustavo Bardello, Don Flaten (U of M), John Heard (MAFRD) and Cindy Grant (AAFC, retired) for sharing their protocol and allowing us to build on their work, especially to Don Flaten for assisting with interpretation of results and reporting in the current project.

Lentil Input Study

Weber, J (WARC), Holzapfel, C. (IHARF), Hall, M. (ECRF), Nybo, B. (WCA), Hnatowich, G. (ICDC) and Shirtliffe, S. (U of S).

Description

The objective of this study was to determine which combination of common agronomic practices had the greatest effect on crop and weed growth, lentil yield and overall seed quality. The study was conducted at Indian Head, Scott, Outlook, Yorkton and Swift Current in 2017. The treatments included three seeding rates (130, 190 and 260 seeds/m^2), three fungicide treatments (no application, single application, two applications) and two herbicide management practices (pre-seed burn-off vs. pre-seed residual).

Results

When results from all sites were combined, no differences in weed density were detected for the herbicide treatments. Seeding rate did not have an effect on weed densities but did have a significant effect on crop density at all sites consistently. As the seeding rate increased the plant density was increased as well. Prior to fungicide application, disease pressure was very low (<2%) across all sites. At 14-21 days after fungicide application, seeding rate had a significant effect on disease pressure, which tended to decline as seeding rate declined. Dual fungicide applications tended to have the least amount of disease pressure compared to single applications and unsprayed lentils. When yields were averaged across locations, maximum yield was achieved when seeding rates exceeded 190 seeds m^{-2} (Figure 13).

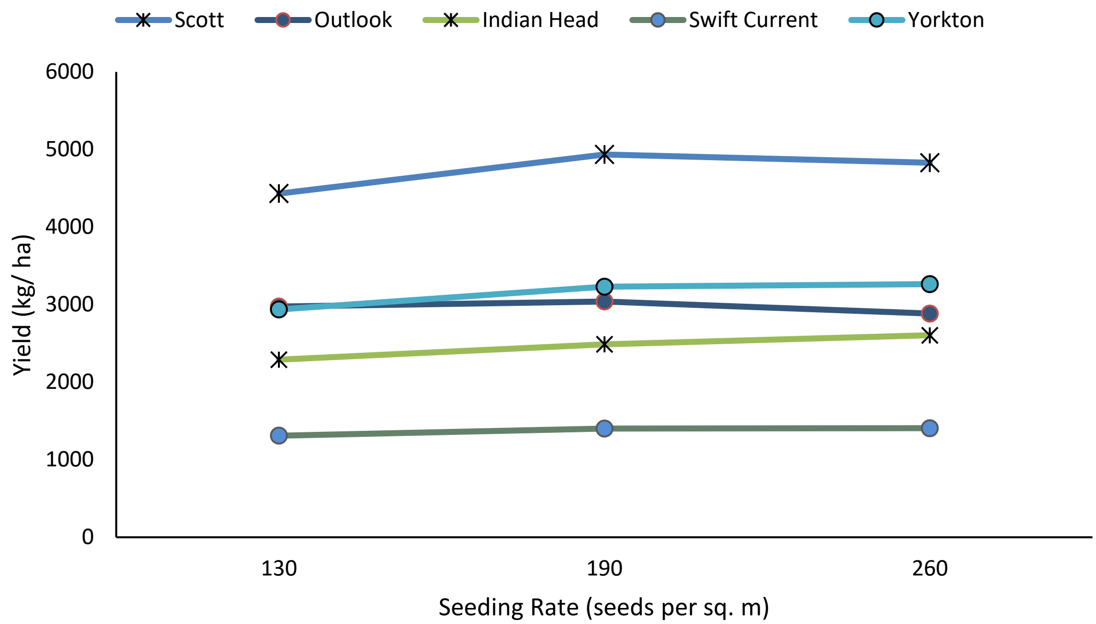

Figure 13. Lentil seed yield response to seeding rate (seeds per m^{-2}) at five locations across Saskatchewan, Canada (2017).

Conclusions

During the first year of this study the conditions were very dry. The pre-seed residual treatment required soil moisture to be activated and therefore responses were inconsistent among locations. Disease pressure was low and fungicide treatment effects were limited. The seeding rate of 190 seeds m^{-2} resulted in the highest yield and also provided enough canopy closure to compete with weeds. The seeding rate of 260 seeds m^{-2} did not substantially increase yield and resulted in higher input costs. The economic analysis demonstrated that the highest gross profit system is a single fungicide application with a seeding rate of 190 seeds m^{-2}. The high input costs associated with dual fungicide application could be justified if severe disease pressure is present.

Acknowledgements

This project was funded by the Saskatchewan Ministry of Agriculture (ADF) program, Saskatchewan Pulse Growers and Western Grains Research Foundation. This project was a collaborative effort between WARC, IHARF, ECRF, Wheatland Conservation Area, ICDC and the University of Saskatchewan.

Flax Response to a Wide Range of Nitrogen & Phosphorus Fertilizer Rates in Western Canada

Holzapfel, C. (IHARF), Schoenau, J. (U of S), Brandt, S. (NARF), Hall, M. (ERCF), Mohr, R. (AAFC). Nybo, B. (WCA), Shaw, L. (SRF), Slaski, J. (InnoTech), and Weber, J. (WARC).

Description

This project investigated flax response to nitrogen and phosphorus fertilizer applications under a broad range of western Canadian environments using modern varieties and seeding equipment. This is a three-year project initiated in 2016 with eight locations including six in Saskatchewan (Indian Head, Melfort, Redvers, Scott, Swift Current and Yorkton), one in Alberta (Vegreville) and one in Manitoba (Brandon). The treatments were a factorial combination of four N rates (13, 50, 100 and 150 kg N/ha) and four P rates (0, 20, 40 and 60 kg P_2O_5/ha).

Results

Yield

All locations except Vegreville were direct-seeded into cereal stubble and all fertilizer was side-banded during seeding. At Vegreville, the plots were tilled prior to seeding and fertilizer was mid-row banded. Out of 16 site-years, 3 were discarded due to data quality issues resulting from weather, wildlife and equipment issues. Therefore, 13 site-years were used for statistical analysis. This project has shown consistent flax yield response to nitrogen with 12/13 site years having a response with sometimes strong yield responses to relatively high rates of N fertilizer (i.e. > 100 kg N/ha). The observed yield increases at N responsive site-years ranged from 192-1229 kg/ha or 13-115% over the lowest 13 kg N/ha rate. Averaged across all 13 site-years, the observed yield increase was 46% with no further increases past 100 kg N/ha as shown in Figure 14. Responses to P fertilizer were less frequent occurring <50% of the time with 6/13 site-years having a response. Responses to P fertilizer were smaller among the responsive sites as yield increase ranged from 3-19% as shown in Figure 15.

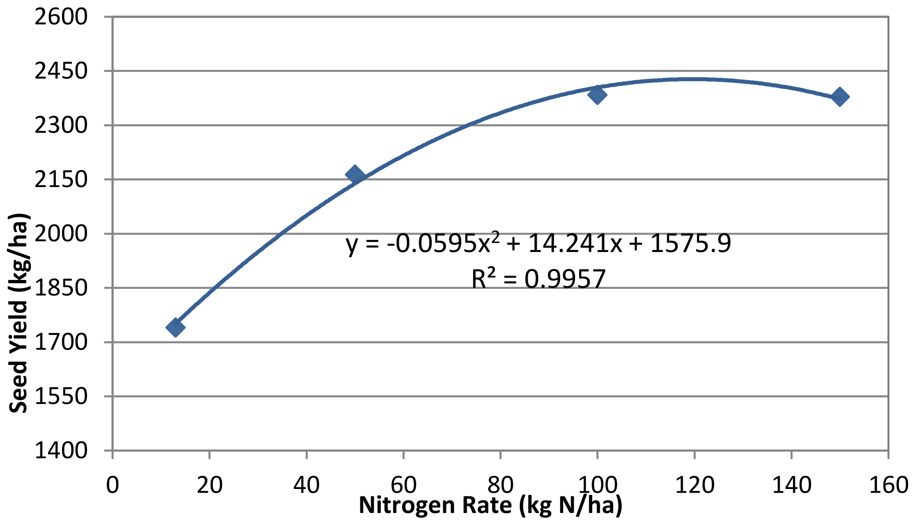

Figure 14. Overall flax seed yield response to N fertilizer rate averaged across 13 site-years (2016-17).

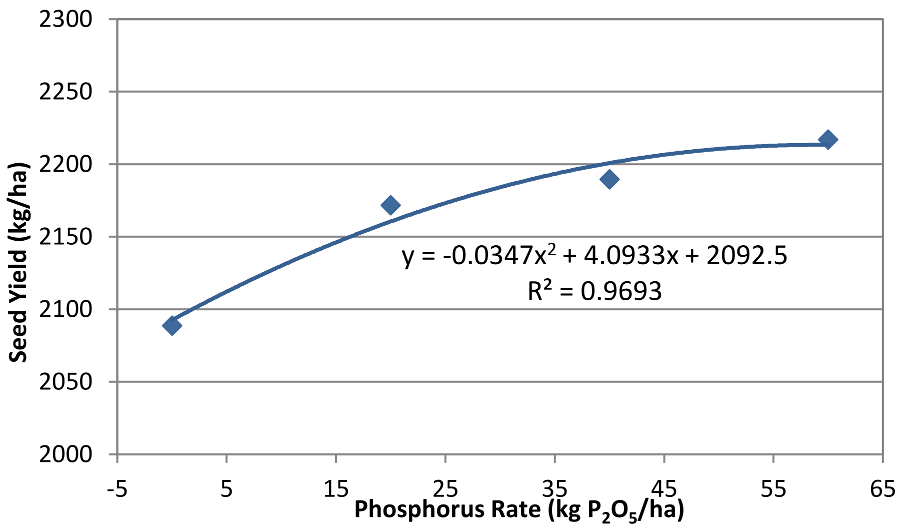

Figure 15. Overall flax seed yield response to P fertilizer rate averaged across thirteen site-years (2016-17).

Emergence

Nitrogen rate significantly affected emergence at 11/16 site-years and, in all cases, emergence declined with increasing N rates. The exceptions were sites under the wetter conditions of 2016 (emergence was affected by N at all of these locations in 2017) and Vegreville where the fertilizer was mid-row banded and therefore farther away from the seed than at the other locations. The extent of seedling loss associated with N at the affected sites ranged from 14-51%, while high rates of P fertilizer did not negatively affect emergence in any cases.

Maturity

Nitrogen fertilizer delayed maturity by <1-5 days but this delay coincided with higher yields and was unlikely to result in any agronomic challenges, particularly when combined with early seeding.

Phosphorus rate only affected maturity in one case where maturity was delayed by approximately one day in the unfertilized control. This response occurred at a site where a relatively strong yield response to P was also observed.

Conclusions

The results are largely consistent with previous research and it should be noted that the optimum economic N rate will generally be slightly lower than where maximum yield is achieved. The lack of a P yield response at many sites does not suggest that P fertilizer should not be applied to flax, but rather that, in any given year, current P fertilization practices are not likely major limiting factors to yields of this crop in western Canada. The lack of response to P fertilization at many sites may be explained by contributions of residual inorganic P and organic P mineralization in addition to the strong AM fungi relationships that flax can develop to assist with P uptake. The significant reductions in plant density frequently detected with high rates of side-banded N suggest that care must be taken to ensure adequate seeds separation from fertilizer during planting and/or that seeding rates must be sufficient to account for potentially reduced emergence. These conclusions should all be considered preliminary as 2018 is the final year of a three-year study.

Acknowledgements

Financial support for this project was provided by Saskatchewan Agriculture Development Fund, the Saskatchewan Flax Development Commission, and the Western Grains Research Foundation. Initial project input was provided by the SaskFlax Board of Directors and scientific guidance and oversight was provided in-kind by Dr. Jeff Schoneau of the University of Saskatchewan's Department of Soil Science. This was a collaboration with Indian Head Agricultural Research Foundation, Northeast Agricultural Research Foundation, Western Applied Research Corporation, South East Research Farm, East Central Research Foundation, Wheatland Conservation Area, InnoTech Alberta, and Agriculture and Agri-Food Canada.

Adaptation and Establishment of soybean (*Glycine max*) Under No-till in Southern Saskatchewan

Holzapfel, C. (IHARF) and Nybo, B. (WCA).

Description

In 2014, three experiments were initiated in Indian Head and Swift Current to evaluate soybean performance relative to other broadleaf crops including pea, canola and faba bean and improve regional recommendations for this crop. In the first trial, soybeans were planted alongside canola, field peas and faba beans at three seeding dates ranging from early May through early June. The second experiment evaluated soybean response to seven seeding rates (15-85 seeds/m^2) and two seeding depths (17-20 mm versus 33-38 mm). The third experiment evaluated row spacing at 25, 31, 36, 41 and 61 cm. These three experiments were conducted over four seasons from 2014 - 2017.

Results

Yield

Soybean yields varied widely with environmental conditions, ranging from <500 kg/ha under severe drought to >2500 kg/ha under favourable conditions. While late maturity was occasionally a concern, low yields were more frequently attributable to a lack of moisture. As expected, soybeans were better adapted to the black soil zone; however, excellent yields were achieved in the brown soil zone with above-average precipitation. Focussing on seeding dates, mid to late May proved optimal; however, seeding earlier in May was preferable to June seeding. While yields were usually similar between the first two seeding dates, soybeans seeded early in May took longer to emerge and therefore had virtually no maturity advantage. While late seeded soybeans consistently matured in fewer days, yields suffered (14-20% reduction) from a shorter vegetative period and, occasionally fall frost.

Seeding Depth

In response to seeding depth, although responses varied, when emergence, pod height, maturity, and yield were considered across all sites, the results favoured shallow seeding. Across sites and seeding rates, deeper seed placement led to 5% fewer plants, slightly reduced pod height, slightly later maturity, and 7% lower yields. The only site where the results differed was Indian Head 2017 where, under dry conditions, there was an establishment and maturity advantage to deeper placement but no effect on yield.

Seeding Rate

Focussing on seeding rate, the overall mean mortality was 15% ranging from 0-43% amongst individual sites. The seeding rate response was stronger than expected and optimal plant populations tended to be higher under low yielding conditions. The effect of seeding rate on yield at the 2017 Indian Head site is shown in Figure 16. Across sites, yields at 70 seeds/m^2 were significantly higher than at any of the lower rates; however, at individual trials, yields frequently leveled off at 50-60 seeds/m^2. Overall, a target of 55-60 seeds/m^2 is recommended to ensure optimum yields across a wide range of environmental conditions. Slightly lower seeding rates may suffice under favorable growing conditions and, potentially, with later maturing soybean varieties.

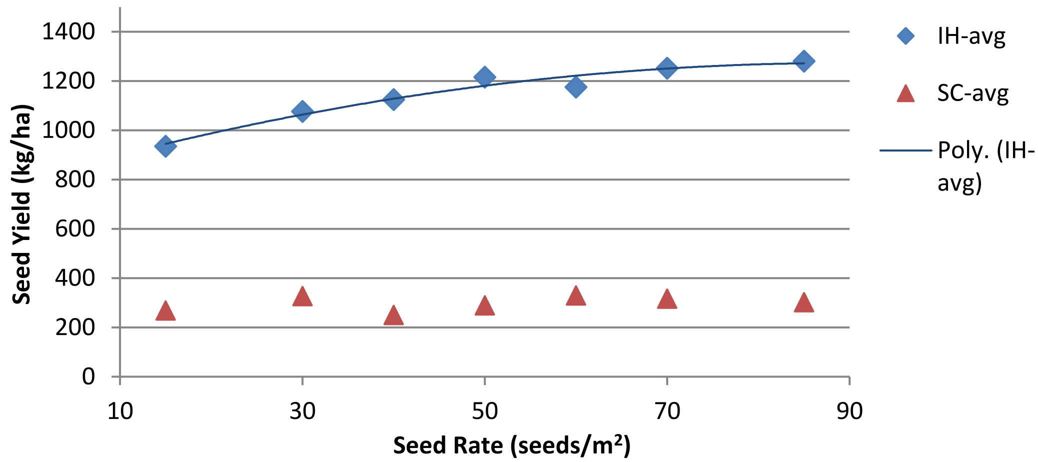

Figure 16. Seeding rate effects on soybean seed yield at Indian Head (IH) and Swift Current (SC) in 2017.

Row Spacing

Focussing on row spacing, the response varied from year-to-year but, on average, there was a slight linear yield increase with increasing spacing (7% yield advantage at 61 cm versus 25 cm row spacing) despite higher seedling mortality. This was primarily due to the response under stressful conditions and was likely due in part to better nodulation at wider row spacing. Under higher yielding conditions, there was either no row spacing effect or yields were slightly higher at the narrower (25-31 cm) row spacing.

Conclusions

In conclusion, the optimal seeding dates for soybeans based on this three year study is mid to late May with seeding earlier in May preferable to June seeding. The overall results favoured shallow seeding except for the 2017 Indian Head site-year which experienced dry conditions. Based on the results from this study, the recommended seeding rate is 55-60 seeds/m^2 to ensure optimum yields across a wide range of environmental conditions.

Acknowledgements

Support for this project was provided by the Saskatchewan Pulse Growers and Agriculture and Agri-Food Canada, through the Agri-Innovation Pulse Cluster 2 program, with in-kind contributions provided by BASF and NorthStar Genetics.

Intensive Wheat Management

Bandt, S. (NARF), Pratchler, J. (NARF). Hozapfel, C. (IHARF). Hall, M. (ECRF). Weber, J. (WARC). Nybo, B.(WCA).

Description

This project was initiated at Melfort, Indian Head, Scott, Swift Current, and Yorkton in 2017. The project consists of 6 wheat cultivars from 3 wheat classes which differ in fusarium head blight resistance, lodging resistance, maturity, yield, and protein as shown in Table 12. Each cultivar was grown under 3 progressively intensified management levels as shown in Table 13. Together the six cultivars under three management levels were combined to develop an 18 treatment study.

Table 12. Cultivar attributes for the input study as documented by the Saskatchewan Variety Guide.

Cultivar	Class	Fusarium Resistance	Lodging resistance	Maturity[z]	Yield[z]	Protein[z]
Carberry	CWRS	Marginally Resistant	Very Good	99	100	14.6
AAC Cameron VB	CWRS	Intermediate	Fair	-2	118	-0.7
CDC Utmost VB	CWRS	Marginally Susceptible	Fair	-2	112	-0.4
AC Andrew	CWSWS	Intermediate	Very Good	+2	137	NA
SY Rowyn	CPSR	Marginally Resistant	Fair	-1	107	-1.1
AAC Ryley	CPSR	Marginally Susceptible	Poor	-2	110	-1.2

[z] In relationship to Carberry

Table 13. Management level descriptions for the intensive wheat management study at five locations in 2017.

	Seed Treatment	Seeding Rate (viable seeds/m2)	N fertility (lb/ac N)	P fertility (lb/ac P2O5)	Fungicide at Flag Leaf	Fungicide at Anthesis	PGR
Conventional	No	200	75	25	No	No	No
Enhanced	No	300	98	33	No	Yes	No
Intensive	Yes	360	120	40	Yes	Yes	Yes

Results

Grain Yield

In 2017, both variety and management had a significant effect on yield at all locations, except for Swift Current where only variety had a statistically significant effect on yield. Average yields at Melfort, Indian Head, and Yorkton were very similar ranging from 71 to 77 bu/ac (Table 14)

Overall, AC Andrew was the highest yielding variety, averaging 83.5 bu/ac. AC Andrew was significantly higher than the other varieties at all locations except at Swift Current. There was an increase in yield with increasing management level intensity (Figure 17). The conventionally managed wheat averaged 71 bu/ac across varieties at 4/5 locations. There was an average yield increase of 6 bu/ac by increasing to enhanced management, and a further 8 bu/ac increase by utilizing the intensive management

Table 14. Influence of variety on grain yield (bu/ac) at five locations in 2017.

Variety	Melfort	Yorkton	Indian head	Scott	Swift Current	ALL
Carberry	65.8b	69.3c	68.7c	87.0c	45.2a	67.2
AAC Cameron	68.0b	70.0c	68.0c	86.3c	43.5ab	67.2
CDC Utmost VB	73.5b	68.1c	68.3c	88.3c	44.3ab	68.5
AC Andrew	84.3a	96.4a	81.0a	108.1a	47.7a	83.5
SY Rowyn	67.6b	80.6b	71.7b	95.5b	39.9b	71.1
AAC Ryley	71.0b	80.2b	69.4bc	96.1b	46.8a	72.7

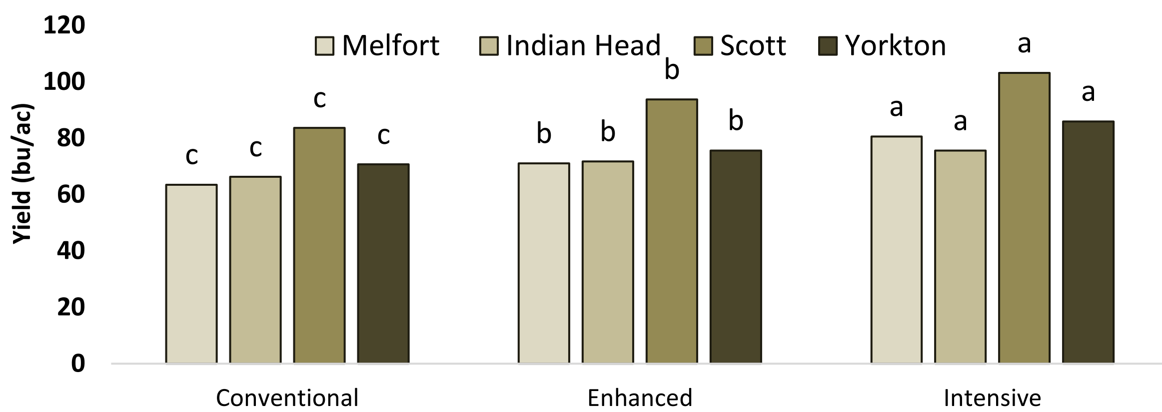

Figure 17. Management effects on yield (bu/ac) at four locations in 2017.

The statistical test for interaction between cultivar and input level for yield was not significant at any site. When averaged across four locations, excluding Swift Current, the yield of AC Andrew was 20 bu/ac greater at intensive management compared with conventional management (Table 14).

By contrast, AAC Cameron only yielded 10.5 bu/ac more at intensive than at conventional management. CDC Utmost and SY Rowyn also responded very well to intensive management. Interestingly, the three most responsive varieties represent each of the three classes of wheat tested. This would suggest that responsiveness of yield to management may be variety specific rather than being related to wheat class.

Grain Quality

Variety had a significant effect on protein at all locations in 2017, while management only had a significant effect at Melfort, Indian Head, and Yorkton. Carberry generally had the greatest protein levels of the CWRS varieties averaging 13.2% across the five locations and three management intensities. At all locations, there was approximately 0.5% increase in protein between the conventional and enhanced management treatments, and at Melfort and Indian Head, this trend was repeated between the enhanced and intensive management treatments. Overall, due to the environment during the 2017 growing season, percent FDK was low. The percentage of FDK in Melfort, Indian Head, and Scott were very similar averaging 0.28%. Levels at Yorkton were slightly lower and averaged 0.16% while Swift Current had only 0.04%. Variety had a significant impact on FDK at four of the five locations and management only had an effect on FDK in Melfort and Yorkton. AC Ryley tended to have the most FDK present ranging between 0.3 to 0.6%. There was a tendency for Carberry, AAC Cameron VB, and CDC

Utmost to have less FDK present. The enhanced management treatments tended to have less FDK, and the conventional and intensive treatments were similar.

Conclusions

First year results indicate that wheat should be managed differently based on climate and soil zones as wheat responded differently at each location. There is also some evidence that we should manage wheat classes and/or varieties differently. However, results to date are not conclusive as this was the first year of the three year study. For each variable measured, there was a consistently significant response to variety and less frequently to management. There were a few significant interactions found between variety and management, but effects were not always consistent. Results to date do support use of more intensive management of all wheat classes when growing conditions are conducive to high yields. Overall, our results suggest that varietal testing may need to be conducted under different management systems to identify varieties that are responsive to more intensive management.

Acknowledgements

Funding for this project was provided by the Agriculture Development Fund of the Saskatchewan Ministry of Agriculture and the Saskatchewan Wheat Development Commission. With in-kind support from Secan and Alliance Seeds for helping source the seed required to complete this project. We would also like to thank Engage Agro for the donation of Manipulator for all collaborative locations.

New Insights into Natural Air Grain Drying

Description

In 2017 this project tested the effect of an absolute humidity control strategy against a continuously-run fan strategy. The continuously-run fan strategy remains the industry standard for grain drying because it is simple and requires no sensors or fan control. However, this strategy is not energy efficient and does not provide the safest storage as it heats and wets the grain during the day. To investigate whether the use of an absolute humidity control strategy could be suitable for large grain bins, two 20,000 bushel bins were operated and monitored with an absolute humidity controller with a collaborator in the Indian Head area. IHARF also explored the use of supplementary heat to dry grain in response to the large quantity of phone calls received regarding the topic during the 2016 harvest.

The three fan control strategies used in the 2017 trials are described below:

Continuous: Fans were run continuously from the start to the end of the trial period and only shut down during rain periods.
Absolute Humidity: Fans were programmed to run only when the absolute humidity of the outside air was less than the absolute humidity inside the bin.
Supplemental Daytime Heat: Supplemental heat was provided to the bin from 9:00am to 9:00pm using a 60,000btu propane burner with the aeration fan run continuously.

Results

Supplemental heat to dry grain

The very dry growing season in 2017 provided conditions that were favorable for drying. A full summary of results can be found in Table 15. Bins 9 and 10 compared the use of supplemental heat to a continuously run fan strategy. Bin 9 used only the continuous fan and was run a total of roughly 400 hours while bin 10 was run roughly 200 hours using a continuous fan and supplemental heat. These results suggest that the use of supplemental heat on barley may cut the drying time required to reach the acceptable moisture level for safe storage in half compared to simply running a fan continuously. The amount of moisture removed or added in bins 9 and 10 was also calculated. Peaks in moisture removal were consistently higher for the supplemental heat strategy than the continuous fan strategy. The continuous strategy re-added roughly 156 kg throughout the trial period, whereas the supplemental heat strategy only re-added approximately 55 kg.

Table 15: 2017 trial run specifics and results.

	Bin 9	Bin 10	Bin 16	Bin 17	Bin 18	Bin 19	Bin B14	Bin B15
Control Strategy	cont. fan	cont. fan/ supplemental daytime heat	cont. fan	abs. hum. control	cont. fan	abs. hum. control	cont. fan	abs. hum. control
Grain	Barley	Barley	Wheat	Wheat	Barley	Barley	Peas	Peas
Bin Size (bu)	2,250	2,250	3,500	3,500	3,500	3,500	20,000	20,000
Fan Start	Aug 19	Aug 19	Aug 30	Aug 30	Aug 22	Aug 22	Aug 11	Aug 11
Fan Shut Down	Sept 5	Aug 28	Sept 6	Sept 6	Sept 6	Sept 6	Sept 9	Sept 9
CFM/bu	0.89	0.89	0.3925	0.3925	0.50	0.50	0.283	0.233
Average Initial MC (%)	15.8	15.3	13.9	14.3	16.3	16.7	13.8	15.9
Average Final MC (%)	12.0	12.2	12.7	13.0	13.1	13.4	13.8	14.7
MC Change (%)	3.8	3.1	1.2	1.1	3.0	3.5	0.0	1.2
Initial Temp (^oC)	18.6	19.1	30.6	27.5	25.8	24.6	34.3	25.3
Final Temp (^oC)	14.7	21.5	13.6	13.1	14.0	13.4	16.7	17.3
Temp Change (^oC)	3.9	2.4	17.0	14.3	13.5	11.1	17.6	8.0
Water Removed (kg)	1983.5	1577.9	1093.6	1087.2	2490.0	2880.9	N/A	N/A
Duty Cycle (%)	96.2	92.5	100.0	90.6	95.6	82.3	79.3	77.4
Safe Days Initial	77.6	116.4	47.0	66.9	25.9	26.1	31.8	33.5
Safe Days Final	815.6	687.3	682.5	611.6	580.4	597.2	267.3	163.7
Spoilage Index	8.96	8.76	2.54	2.53	12.03	10.64	16.91	20.22

Absolute humidity controller vs. continuously run fan

Bins 16 to 19 were used to compare the use of an absolute humidity controller to a continuous fan strategy. Bins 16 and 17 contained wheat while bins 18 and 19 contained barley. Bins using an absolute humidity controller strategy had a lower duty cycle, running an average of 11.4% less during the trial than their continuous fan counterparts resulting in greater fan efficiency. Both strategies resulted in a high number of safe days, due to the favorable drying conditions in 2017.

Absolute humidity controllers on large grain bins

Bins 14 and 15 tested the use of absolute humidity controllers on large 20,000 bu hopper bottom bins which contained peas. On multiple occasions sensor readings were taken at irregular increments of time and due to technical difficulties, several sensors stopped reporting data on September 1 in bin 14 and didn't report data for the rest of the trial. Bins 14 and 15 had duty cycles of 79% and 77%, respectively. The bins were cooled significantly during the trial period.

Conclusions

In conclusion, an advantage to using supplemental heat is that it requires roughly half the amount of time to dry grain to a safe moisture content compared to using only a continuous fan. Additionally, it was also found that supplemental heat may re-add less water to grain than a continuous strategy. While the supplemental heat strategy had greater fan efficiency (92.5% duty cycle) than the continuous strategy (96.2% duty cycle), it should be noted there is an energy cost to running the propane burner required in this strategy.

It can also be concluded that the use of absolute humidity controllers can increase fan efficiency, resulting in a lower duty cycle and greater energy savings. In 2017, conditions were ideal for drying, therefore results may be more exaggerated in a season where conditions for drying were not optimal. Furthermore, our trials demonstrate that absolute humidity controllers can ensure that moisture is not re-added to grain bins. This trial indicates that absolute humidity controllers can be used to dry grain to acceptable moisture levels for safe storage. Results indicate that they will dry grain evenly. Future research should be conducted to test bin-scale absolute humidity controllers in a wetter growing season to determine the level of energy savings that can be achieved with this technology.

This research indicates that using an absolute humidity controller on large bins can be used to cool and dry grain for safe storage. Running bins on this technology also results in energy savings for producers. However, retrofitting bins with the necessary temperature and relative humidity sensors is costly, and as was experienced, errors with bin monitoring equipment can result in long periods of time between readings, which will impact the effectiveness of the systems.

Acknowledgments

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Pre-harvest Herbicide and Desiccation Options For Straight-Combining Canola: Effects on Plant and Seed Dry-down, Yield and Seed Quality

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Description

Field trials were completed at four locations: Indian Head, Melfort, Scott and Melita. The varieties 233P (Liberty Link® - LL - glufosinate ammonium tolerant) and 45M35 (Roundup Ready® - RR - glyphosate tolerant) were seeded into cereal stubble in mid-May at a rate of 120 seeds/m2. Pre-harvest herbicide treatments were targeted for 60-70% seed colour change (glyphosate and saflufenacil) or 80-90% seed colour change (glufosinate ammonium and diquat). The objective was to evaluate differences in stem and seed dry-down with various pre-harvest herbicide and desiccant options for the two dominant herbicide systems (Liberty Link® and Roundup®). A total of 10 treatments were randomized with four replicates (Table 16).

Table 16. Treatment list for Canola Pre-harvest Herbicide / Desiccation Study.

Liberty Link (LL) Variety	Roundup Ready (RR) Variety
1) Untreated	6) Untreated
2) Glyphosate (890 g ai/ha)	7) Glufosinate ammonium (408 g ai/ha)
3) Saflufenacil (50 g ai/ha)	8) Saflufenacil (50 g ai/ha)
4) Glyphosate (890 g ai/ha) + saflufenacil (50 g ai/ha)	9) Glyphosate (890 g ai/ha) + saflufenacil (50 g ai/ha)
5) Diquat (40 g ai/ha)	10) Diquat (40 g ai/ha)

Results

The results were only analyzed on an individual site basis in order to assess data quality going into the 2nd year of the project. The following is a summary of the results of the Indian Head site in 2017.

At the time of harvest, visual dry-down values for untreated canola were statistically similar for both varieties (37-41%) and consistently higher in the treated plots. For LL canola, visual stem dry-down was statistically similar for glyphosate, glyphosate + saflufenacil and diquat (62-67%) but lower for saflufenacil applied alone (46%) as shown in Figure 18. With RR canola, values were statistically similar for glufosinate ammonium and both treatments containing saflufenacil (44-48%) but higher for diquat (58%) as shown in Figure 19. Based on visual dry-down, there was an advantage to the saflufenacil + glyphosate tank-mix over saflufenacil alone and to diquat over saflufenacil, with and without added glyphosate.

Due to differences in maturity, seed moisture content at harvest was lower for the LL compared to the RR hybrid. Looking at individual treatments in LL canola, seed moisture contents were statistically similar across treatments. For the RR canola, seed moisture did not significantly differ between the control (11.9%) and the saflufenacil treatments (11.1-11.4%) but was lower with glufosinate ammonium (8.5%) and lowest with diquat (5.3%). Total above-ground plant moisture at harvest was 31% and 39% in the LL and RR control treatments, respectively. No significant differences were detected amongst pre-harvest treatments in the LL hybrid while in the RR hybrid the only product that significantly reduced whole plant moisture was diquat. Averaged across varieties and products, the contrasts showed only diquat had a plant dry-down benefit.

Due to later maturity and the fact that all treatments were harvested on the same date, there tended to be higher green counts with the RR hybrid. Treatments containing glyphosate, saflufenacil or glufosinate ammonium had no effect on percent green seed; however, results with diquat varied. With the LL variety, which was more advanced at the time of the treatment applications, percent green seed was 0.5% with diquat compared to 0.0-0.1%. In the RR variety, percent green seed was 13.2% with diquat compared to 0.7-2.1% for the other treatments. These results illustrate the dangers of applying a fast-acting product like diquat too early. While comparing hybrid performance was not an objective of this study, yields for both were similar at this site-year.

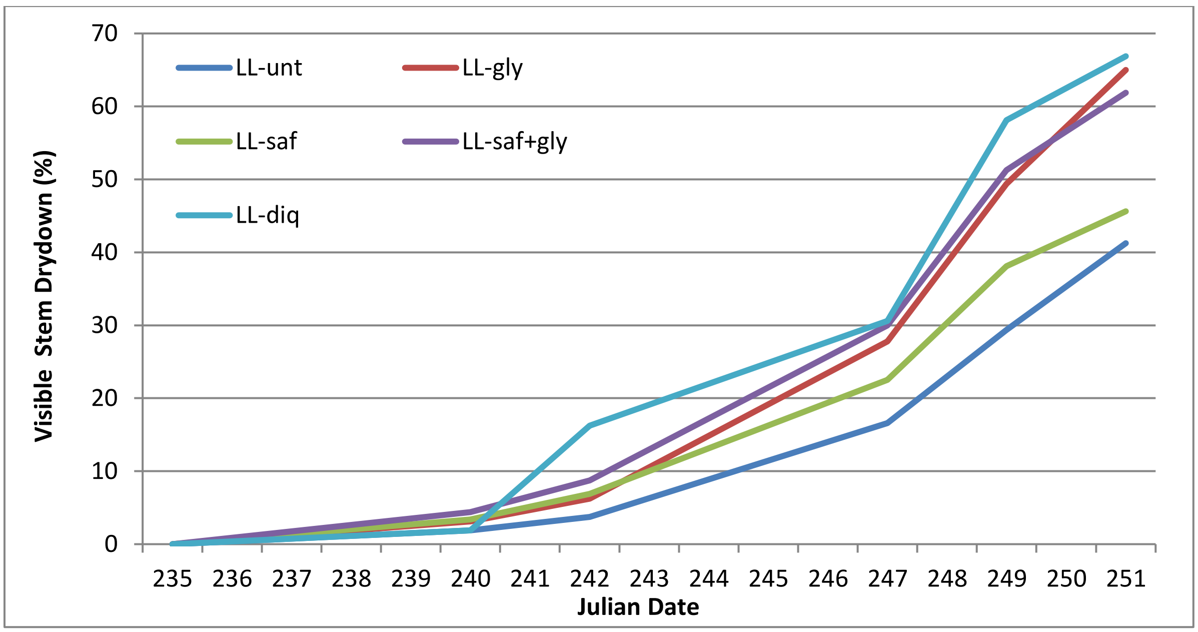

Figure 18. Rate of visible stem down for various pre-harvest treatments in glufosinate ammonium tolerant canola.

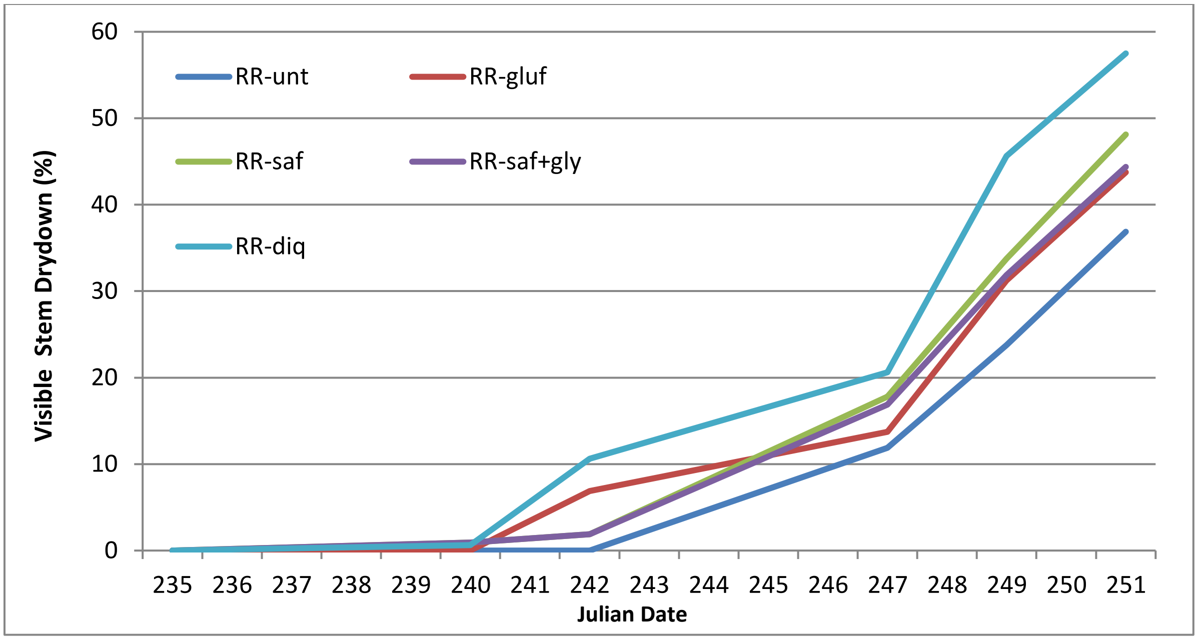

Figure 19. Rate of visible stem down for various pre-harvest treatments in glyphosate tolerant canola.

Conclusions

These are preliminary findings as this is the first year of the study. More in-depth analysis will be conducted as the project gathers additional site-years of data.

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